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THE NAVAL ARCHITECT
International Journal of The Royal Institution of Naval Architects

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Printed in Wales by:
Stephens & George Magazines
Merthyr Tydfil

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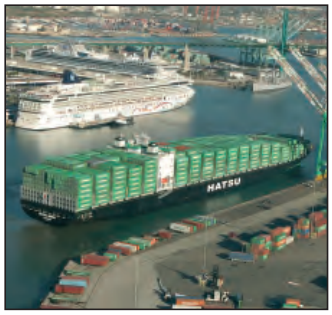
Registered charity No. 211161

A one-year subscription in 2007 to *The Naval Architect* costs £110 (UK), £115 (Europe), and £125 (Rest of the world).

Audited Circulation 10,482
JAN - DEC 2005
ISSN 0306 0209

THE NAVAL ARCHITECT



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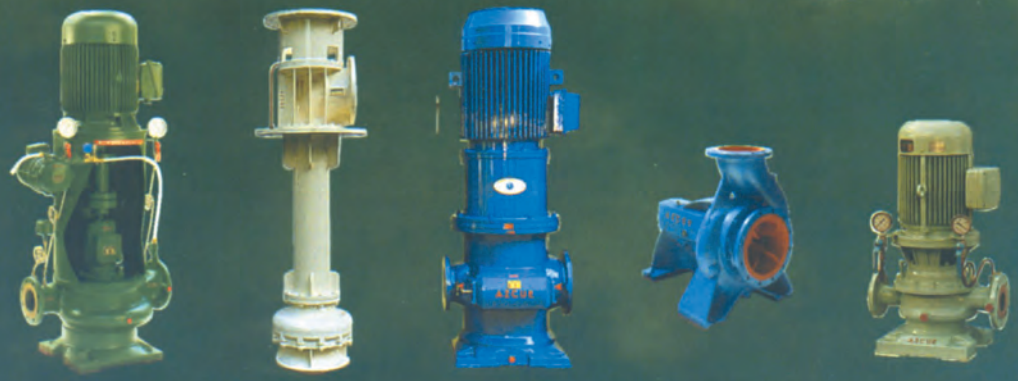

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Getting the ship that you want – still an intractable problem

BEING gently – or perhaps forcefully - harangued by a shipowner is probably one useful way that naval architects, marine engineers, and others can ensure that ship designs and the equipment on them are what the customer wants. The November audience at the 2006 President's Invitation Lecture of The Royal Institution of Naval Architects certainly heard what at least one prominent shipowner wants – but cannot always get!

David C Koo, as managing director of Valles Steamship Co (primarily a tanker and bulker operator) and chairman of the Hong Kong Shipowners' Association, is in a first-class position to specify and influence what he wants from a new ship. His lecture was titled 'A shipowner's perspective of standards' but, in a provocative preamble, he carefully noted that today there were minimum standards, good standards, and sub-standards, not to mention the new boy, goal-based standards.

There were also hurriedly-implemented standards such as Permanent Means of Access (which 'the industry could well do without'), and – in his view – impractical ones such as the new Ballast Water Convention! In addition, the industry has to cope, he claimed, with a proliferation and duplication of rules and regulations.

Defining minimum standards which result in a ship that is at least fit for trade is still not a reality, claimed Mr Koo. Nevertheless, he acknowledged with gratitude the IACS UR S25 regulations for bulk carriers – something for which his association had been lobbying hard.

Mr Koo's association is a strong supporter of goal-based standards; unfortunately, he believes that an anticipated clear setting of design goals has degenerated into multi-tiers and a mass of bureaucratic red tape. Sadly, Mr Koo also notes the shipping industry's eternal pivot point – operating at minimum standards and barely meeting regulatory levels – has become even more prominent in today's exceptionally competitive world. Such a philosophy should be condemned, he maintains, but at the same time, operating at levels higher than a standard 'rarely results in commercial return'. Therefore, he urged, standards should be set at a level where they were fully acceptable to all.

It may appear good – and should indeed be assembled to the correct specification - but is the result what the owner really wanted?

As a leading tanker operator, Mr Koo noted that today a standard shipyard specification for a vessel would - amazingly - probably be rejected by most oil terminals worldwide. In a comparison with the squeaky clean safety-conscious image of the airline industry with its new planes and new airports, today's shipping image in the public's eye often means oil slicks, dead birds, and most recently, the *Probo Koala* slops scandal in Nigeria.

Looking into the more detailed aspects of ship technology, Mr Koo noted, that despite MARPOL regulations defining how engineers should deal with sludge, it is often the case that incinerators are 'no better than toys' and sludge holding tanks are totally inadequately sized. Yet such arrangements are approved by classification societies! Should an owner's technical team try to negotiate greater capacity, shipyards will often, claimed Mr Koo, strongly resist, because it will mean steelwork and other alterations, coupled with delays to production schedules. He wanted to know why yards and class societies could not ensure that ships are fitted with proper equipment.

Much of the sludge problem, he continued, could be resolved if the marine industry lobbied refineries strongly to supply clean distillate fuel; this would largely avoid the need for special heavy-fuel cleaning and disposal equipment on board. Ships should no longer, urged Mr Koo, be used as convenient dumping grounds for residual products from refinery cracking towers.

There would also be great benefits in terms of cleaner air (more details of marine industry moves in this sector are reported in our Green Ship Technology feature elsewhere in this issue). As a starting point, Mr Koo reckoned that MARPOL Annex VI should be amended to mandate a 1% cap on sulphur content.

Further, Mr Koo is much concerned over the consequences of a fall in demand for new ships when the current boom is over but when huge new yard capacity – still expanding – remains. He believes that yards will, as history has shown, try and recover reduced profit margins by relaxing specifications and quality – the results can be witnessed today in ships at sea, which were delivered during the late 1980s.

At the same time, some yards are currently offering berths on a so-called 'tender' basis, which precludes both supervision and plan approval. How, asks Mr Koo, can an owner be considered responsible in the application of any standards on such ships?

It all comes back to the old story: you get what you want, what you demand, and what you inspect – and at a yard that you trust. In this manner, class comments such as 'this item is not covered by class rules' or yard comments that 'this item is class approved' can be overcome. Unfortunately, says Mr Koo, the majority of quality control departments report to the yard chief of production and – perhaps even more importantly today in an era of steel-section subcontracting – fail to extend their remit to subcontractors.

Yards could take a leaf out of the books of the aircraft industry, which assembles large precision components at different sites – and to a very high standard. Maybe some of these unfortunate difficulties can be overcome by annual tripartite meetings between owners, yards, and class societies, the most recent of which was held in September in Seoul.

Finally, Mr Koo is disappointed in the fact that owners and builders rarely consult each other after the end of the 12-month guarantee period for a new ship, therefore minimising the volume of useful feedback for subsequent ships. He endorses the IACS Early Warning System, which would issue reports to owners and operators of similar ships, and believes that shipping must be still more pro-active in promoting a healthy image.

He could have added that even items which owners want beyond the 'standards' level are equally hard to obtain: Brian Sherwood-Jones and Roy Smith, from Lloyd's Register and the port of Felixstowe respectively, suitably subdued their audience at RINA's recent container ship conference with sober tales of naval architects' almost total failure to provide quality structural hardware for stevedores - our report next month will explain.

GL thwarts BV acquisition bid

GERMANISCHER Lloyd (GL) has successfully defended itself against a hostile takeover bid initiated by the French classification society, Bureau Veritas (BV). A Hamburg businessman, Günther Herz, stepped in and made an unconditional binding purchase offer to all shareholders, which should secure strategic independence for GL. This has been met with wide approval from GL's existing shareholders, with over 90% of shares changing hands, making Mr Herz the new majority shareholder.

BV had attempted to acquire GL as it claimed that with little overlap between the client bases of the two societies (BV's main strengths being in the industrial sector, while GL is very strong in marine work, especially in the container-ship sector, with much technical expertise), an alliance would benefit them both, be crucial to long-term success, and create one of the world's leading organisations in the maritime classification sector. BV also believed that a joint society would be able to take advantage of the opportunities in the fast growing Asian marketplace, where GL is already well entrenched.

The initial and improved offers were both rejected by GL, and GL's Works Council reacted angrily to the attempted takeover, claiming that ship classification only contributes 11% of BV's turnover and that BV is very profit-orientated. The Works Council feared that in the event of a takeover, profit would be put before safety, and job losses would be incurred. BV tried to reassure GL that there would be no redundancies and that the combined headquarters would be situated in Hamburg, but GL's Works Council felt that the merger would be used to achieve synergy effects, which would automatically mean a reduction of the workforce.

More than 450 GL workers demonstrated against the proposed takeover at the National Maritime Conference in Hamburg on December 4 2006, as the Works Council believed that GL's reputation would suffer if the acquisition bid were accepted. It believes that GL will now be able to continue its global expansion alone.

An artist's impression of the forthcoming Stena vessels to be built at Aker Ostsee and believed, at 62,000gt, to be one of the largest such ferries ever.

AKER EXPANSION AND NEW CONTRACT – Aker Yards, which last year acquired the Alstom Marine yard in Saint-Nazaire, France, plans to triple its French turnover by 2009. It is estimated that 2000 jobs will be created in the local area to support the growth, and around 240 Aker employees will need to change their jobs, with training and support provided. A new business model was presented to the work council and management of Aker Yards, France, including around 150 initiatives to be implemented over the next three years, thought to create savings of €100 million with around €60 million of that figure in France alone.

Aker has also won a contract with Stena Rederi AB in Gothenburg, Sweden, to build possibly the world's largest ferries. Two have been ordered, with two further vessels as a possibility. The contract is believed to be worth €400 million and the deliveries are scheduled for the first and third quarters of 2010. The design will take place in Finland, and the building at Aker Ostsee in Germany. The 62,000gt ships will be 240m long and 32m wide, with vehicle space of 5500m trailer lanes and 700m car lanes. Passenger capacity is 1200 and the main engine output will be 4 x 8000kW four-stroke diesel engines, which will enable the ferry to reach a speed of 22knots.

SIXTH DATABASE VERSION – The Korean Register of Shipping has released the sixth version of KR-CON, the international database of IMO conventions and codes. This version contains the newly adopted IMO instruments, such as the 81st Maritime Safety Committee resolutions and the 54th Maritime Environment Protection Committee resolutions. Also included are the completely revised IOPP and IBC checklists, reflecting the revised MARPOL Annex I and Annex II. The MEPC and MSC have now approved MSC-MEPC.2/Circ.2, which allows the publication to be carried onboard ships in electronic format. KR-CON is available on both CD and through the Internet.

NORTH SEA EMISSION STANDARDS – The SOx Emission Control Area (SECA) for the North Sea will come into force on November 22 2007, following the air pollution regulations introduced on November 22 2006 – related to amendments to Annex VI of MARPOL. Ships in the North Sea will have to demonstrate strict compliance to these exhaust emission standards. In a SECA, the sulphur content of fuel oil used onboard ships must not exceed 1.50%. Since May 16 2006 there has already been a SECA in place for the Baltic Sea area.

TRAN COMMITTEE REPORT – A draft report has been released from the EP TRAN Committee, by Mr Luis de Grandes Pascual, MEP, regarding the European Commission's Draft Classification Societies' Directive. The draft report sets a target to harmonise class rules and regulations. This has been welcomed by the European Marine Equipment Council (EMEC), as it believes the amendments proposed significantly improve the text proposed by the Commission and will greatly benefit both safety and competitiveness.

ACQUISITION OF FT EVERARD – James Fisher has acquired FT Everard in a deal worth £23.7 million, plus the assumption of £28 million of debt. FT Everard is a long established and well known UK short-sea operator, with 11 clean product tankers, including the advanced new *Speciality* (*The Naval Architect* November 2006, page 6).

It also owns and operates the Cattedown Wharves port facility at Plymouth. James Fisher is a marine services operator, particularly in offshore oil, specialist technical and marine oil services.

The acquisition will bring James Fisher a predominantly modern double-hulled fleet and will enable the company to accelerate the expansion of its other divisions, while FT Everard will gain the ability to bring its fleet under the tonnage tax.

The enlarged company will be known as James Fisher Everard, and Michael and William Everard will join the board on completion of the takeover.

DUAL-CLASS ARCTIC TANKERS – A pair of 70,000dwt double-acting ice-class shuttle tankers are to be dually classed by Lloyd's Register (LR) and Russian Maritime Register of Shipping (RS). Ordered in a trilateral contract at Admiralty Shipyards, by Sevmorneftegaz, (owned by Gazprom) and Sovcomflot (*The Naval Architect* February 2006, page 36), the vessels will transport oil from the Pechora Sea, to Murmansk.

The principles of co-operation were formally agreed at RS' headquarters in St Petersburg last year, and mark the first co-operation of its kind between the two societies. The tankers will be built to RS JIU6 ice class standard, and LR will verify the structural and fatigue performance of the hulls.

PEOPLE

WILLIAM J SEMBER has been appointed as president and chief operating officer of ABS Europe, effective from January 1 2007. Mr Sember was previously vice-president of energy development and is credited with successfully securing classification work for the growing number of LNG carriers.

Estonia re-visited

Naval architect Anders Björkman* reconsiders some technical aspects of the disaster.

YOUR article in the September 2006 edition (page 47) of *The Naval Architect* concerning the new research project being conducted by HSVA, in Hamburg (funded by the Swedish government agency VINNOVA) suggests that '*the required damage stability* (of existing safety regulations for passenger ships) *does not guarantee the survival of a ship*' (no regulation can guarantee this), according to the HSVA model test tank. It would be interesting to see any evidence to this effect and why IMO does not react.

The suggested reason seems to be, according to HSVA, that passenger ships are alleged to capsize (!) after collision (!) in severe weather (!). As far as I am concerned, no passenger ship has ever collided in severe weather (in significant wave heights of 5m-6m) and later capsized. The probability for collision in severe weather is very small and, regardless, a passenger vessel (with its two-compartment flooding standard) should survive the damage, according to existing safety regulations. It should float safely upright on its hull within a certain range (20 deg) of positive stability GZ.

To capsize such a vessel, one would need an additional force x lever = moment to exceed that inherent stability after damage. From where would that come: external, severe waves, or from water loaded somewhere inside the ship above the waterline, or a combination of the two?

HSVA suggests that external sea water accumulates on a passenger ship main deck (still above the waterline after collision), due to rolling, and causes the vessel to capsize, ie, to turn upside down and to float upside down, ie, not to sink. Is there any evidence for this? Has it ever happened?

What does the space above the main deck of a passenger ship look like, whether it is a superstructure or a deckhouse? There are normally no watertight divisions above the main deck. There might be some fire-resistant bulkheads on a pure passenger ship, but they are not watertight. There may be an open vehicle deck on a ro-pax ferry, with or without moveable transverse partitions, to prevent the spread of any inflow in a large volume - but not to prevent inflow.

Regardless, if water flows in due to rolling, it also flows out due to rolling, and there is, in my experience, no evidence that water should accumulate and cause capsize. There is no registered accident in history to this effect. Of course, conventional freight ro-ro ships without passengers will sink rapidly after collision/flooding (a probable very recent example is *Finnbirch*, due to flooding of the hull) since they are not subject to any damage stability criteria (only one-compartment flooding standard). Many people mix up these two types of ships.

The news is, however, that HSVA has been awarded funding by Swedish VINNOVA to explain the 1994 sinking of *Estonia*, a ro-pax ferry. Officially**, *Estonia* neither collided nor capsized but sank with a 100% intact hull, and this has very little to do with the above research by HSVA .

The official cause of the *Estonia* accident, still very much under debate, is faulty locking devices on the main-deck bow doors (visor and ramp opening due to wave loads), thus permitting ingress of water into the superstructure 2.5m above waterline. It was and is officially suggested that water caused *Estonia* to list to a certain angle, but not to capsize, and later to sink with increasing angle of list … but, I repeat, not capsize. The actual sinking has never been described and now, 12 years after the accident, HSVA is expected to explain it, based on official information.

It is recommended that anyone participating in the discussion agrees to the following definitions based on the ILLC:

Hull – watertight and subdivided parts of vessel on which it floats and which provides buoyancy and stability, ie, on *Estonia*, all compartments below deck 2

Reserve buoyancy – volume between assigned waterline and freeboard deck

Superstructure – weathertight compartments on freeboard deck (deck 2 on *Estonia*), which provide buoyancy and which contribute to stability when submerged during rolling, pitching or listing, ie, the compartments below open weather deck 4 and above freeboard deck 2. It should be mentioned that the superstructure of *Estonia* – the complete car deck - was gas-tight and fire-insulated, protecting the stairwells and engine casing. No water on the car deck could, eg, flow down into the engineroom or other spaces below (readers are invited to read the Chalmers University report in this connection – Ed)

Weathertight – all openings in a superstructure above the waterline which can be closed to prevent water ingress due to rolling, pitching, and green water

Freeboard deck – in the case of *Estonia*, deck 2. It should be pointed out that the freeboard of *Estonia* was based on SOLAS two-compartment damage criteria for passenger ships, ie, that the ferry would float in stable condition with two watertight hull compartments flooded, ie, with sufficient (reduced) reserve buoyancy in those cases to survive. Thus the freeboard was much larger than that assigned to a cargo vessel.

A NEW research project into the exceptionally controversial disaster that befell the passenger/vehicle ferry *Estonia*, on September 28, 1994, is being carried out for VINNOVA, the Swedish government agency for innovation systems, in its capacity as government agency responsible for the national Sea Safety Programme. A consortium headed by SSPA Sweden AB (the model test tank, in Göteborg) has been contracted to do this work, which aims to present the most likely foundering scenario of *Estonia*.

Partners include Ship Stability Research Centre/Safety at Sea (at the Universities of Glasgow and Strathclyde), MARIN (from The Netherlands), and Chalmers University of Technology (Göteborg). The results will be used for improving maritime safety for passenger ships of today and in future.

Some new hypotheses were published in October 2006 by Chalmers University and in September 2006 by Safety at Sea, which make highly interesting reading. These consider various possibilities, including open watertight doors (associated with possibly faulty colour-lamp controls on the bridge), flooding through lift shafts, flooding through various ventilation ducts, and a consideration that accumulated water would not necessarily have flowed out from the car deck. Although this complex disaster took place 12 years ago, the chilling events of that night still make captivating reading for technically minded readers. The two reports can be read at the following websites:

www.safety-at-sea.co.uk/mvestonia/downloads/WP2%201%20Final%20Report% (Chalmers University report)

www.safety-at- sea.co.uk/mvestonia/downloads/VIES01-RE-001-AJ-e.pdf (Safety at Sea report)

In view of these developments in the still-running saga of the *Estonia* disaster, readers may be interested in the accompanying viewpoint by naval architect Anders Björkman. This is followed by a copy of a letter to VINNOVA, submitted to us for publication by Maciej Pawlowski (a member of the STAB standing committee) regarding the little-publicised capsizing in January 1993 during a Baltic Sea storm, of the Polish train ferry *Jan Heweliusz*.

Readers should be aware that Mr Björkman has made various previous submissions concerning *Estonia* to authorities and to this journal, and that his brother, Mr Per Björkman, is a lawyer involved in new representations to the governments of Sweden, Finland, and Estonia, to re-examine the disaster.

***The Naval Architect* also hopes that a summary of some research work on *Estonia* by the SNAME Forensics Panel, from the USA, can be published in a future issue.**

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** 'Final Report on the Capsizing on 28 September 1994 in the Baltic Sea of the Ro-ro Passenger Vessel MV *Estonia*'. Published by The Joint Accident Investigation Commission of Estonia, Finland, and Sweden. 1997. ISBN 951 53 1611 1.

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Deckhouse – non-weathertight compartments on the weather deck above the superstructure which do not provide any buoyancy and do not contribute to any stability, ie, all compartments above deck 4 on *Estonia*

Capsize is sudden loss of stability (GZ<0) causing a vessel to turn upside down, unless it is stopped by an outside support, eg, the sea floor or a quay. *Estonia* never capsized.

It should be agreed that any water on a car deck flows out by gravity through drains and 'other openings' since the car deck is several metres above the waterline. If the 'other opening' is, eg, the bow ramp, any water that entered due to forward speed will flow out through the same opening when the speed is stopped; the water trims the vessel on the bow when pitching on the bow and flows out.

Evidently, the first step by HSVA is to:

- establish and confirm the amount of water that will enter the superstructure 2.5m above the waterline and accumulate at the side to cause the list; and to
- establish what happens with this water, when the vessel stops.

According to official information, the mean water ingress (Fig 12.16 in the official report) into the superstructure with an open bow ramp was 320tonne/min at 15knots (initial speed), 140tonne/minute at 10knots, and 80tonne/min at 5knots with head seas of 150deg. *Estonia*, however, slowed down after one minute very quickly, reached 9knots after two minutes, and changed course 160deg away from the waves after a few minutes, and then stopped. HSVA has to establish what happened then.

One would expect that the water ingress first becomes zero and then negative, ie, that water already accumulated inside the superstructure flows out again through the same opening through which it entered. Thus, the heeling moment due to water inside the superstructure would become zero, and the vessel would return to its upright position after a few minutes.

It is evidently very easy to verify what happens with free water inside a superstructure of a vessel of *Estonia's* type, with an open bow ramp away from the waves in severe weather at zero speed using a model. This water always trims and heels the vessel, so that the water flows to the lowest point of the main deck. Model tests verify this.

When the vessel/model pitches on the bow, all water flows to the bow and trims the vessel more on the bow, and since the bow is open, all water flows out. Evidently, one cannot load water on a deck with a large opening at one end and expect it to remain there. All water flows out, when the speed is zero.

Estonia had very good intact stability with an intact hull. She could load a lot of water on her car deck without capsize (as reported in the Chalmers University report – Ed). Any water temporarily loaded on the car deck 2.5m above the waterline would just heel the vessel until capsize, which would require 2000tonnes. However, since the ferry stopped very quickly, this water would flow out again and there would be no capsize.

This is what, I believe, would have happened to *Estonia*, and it is very good news that 12 years later HSVA now will actually establish this simple fact. However, according to official data, no water flowed out when the vessel had stopped. On the contrary, more water flowed up and in, and the angle of list increased. That more water flowed in at zero speed is very strange and cannot be explained by laws of physics. It should flow out.

According to the official investigation, there was, after eight minutes of increasing water ingress, at least 2000tonnes of water at one side of the superstructure, and the angle of list was 38deg - but there was no trim! In this condition - the vessel had stopped four minutes earlier with the bow in a lee - any person would expect *Estonia* at least to capsize and float upside down, since both GZ and range of positive stability were zero. No ship can remain upright in such condition.

But that did not happen either. The ferry did not sink until 30minutes later one mile further east while drifting sideways at >2.2knots when the hull suddenly disappeared - no capsize. According to the official investigation, the lower deckhouse, decks 4 and 5, started to flood after eight minutes after it was submerged under water; however, very strangely, decks 6 and 7 of the upper deckhouse were 100% watertight and dry. The ferry apparently floated on the upper deck house, decks 6 and 7, which prevented capsize. It is suggested that deck 6 and the windows above deck 6 were 100% watertight. Then, mysteriously, all watertight compartments in the hull - deck 0 and 1 - filled with water.

These facts lead to the apparent conclusion that the official investigation used totally false assumptions when calculating *Estonia's* alleged stability in 1994. This was evidently pointed out to responsible persons in 1996; it was suggested that there was no water at all in the superstructure but that the ship sank due to leakage below the waterline (open watertight doors or defective bilge pumps). It will be most interesting to see what results are revealed by the HSVA study.

Learning from the often-forgotten *Jan Heweliusz* disaster

READERS may be interested in the following letter, which was sent to Mr John Graffman, programme manager, the Swedish research organisation VINNOVA, by Prof Maciej Pawlowski, concerning the ro-ro ferry *Estonia*, which is currently the subject of a new study at the HSVA model test tank in Hamburg, Germany. Professor Pawlowski is employed at the School of Ocean Engineering & Ship Technology, the Technical University of Gdansk, Poland, and is a member of the international STAB standing committee. He sent a copy of his letter to *The Naval Architect* for consideration.

Dear Mr Graffman,

It was nice to meet you recently at the STAB Conference in Rio de Janeiro. I listened with great interest to your presentation on the revival of an investigation into the sinking sequence and loss of *Estonia*, with the budget of €840,000. You indicated that the justification for the re-investigation was due to great pressure from the public, the large loss of life, and the need for a better understanding of the causes of capsizing. You illustrated the importance of the problem by a slide showing a number of ro-ro passenger ferries, which had capsized within the last 20 years or so.

I welcome your initiative, endorsed by the Swedish Government, but I have some reservations. Firstly, you did not make mention of a Polish ro-ro train ferry, *Jan Heweliusz*, which capsized and sank in January 1993, 18 months before *Estonia*, with a loss of 55 lives. Secondly, you did not produce any new evidence, which could shed light on the fate of *Estonia*. Without new evidence, it is unlikely that the investigation will be anything more than a series of speculations.

It is now well known that the main hazard for ro-ro vessels comes from water on deck, even a relatively small amount of water can capsize a ship. The question is then - what was the reason for water on the deck? In view of the lack of new evidence we can only speculate.

It is worth recalling three accidents: *European Gateway* in 1982, *Herald of Free Enterprise* in 1987, and *Estonia* in 1994. All of them triggered off substantial R&D investigations. In the aftermath of *Estonia*, a large multinational project was started, known initially as the Nordic Project, but later named the North-West R&D Project.

As a result, in 1995 the Static Equivalent Method was developed at Strathclyde University, which was the first ever rational method capable of predicting the critical sea state in which a damaged ship could survive. Were we dissatisfied with the former Nordic Project that we now resume the investigation? Contrary to the three disasters mentioned earlier, the *Jan Heweliusz* tragedy did not attract any research, either in Poland or abroad. This tragedy therefore merits as much investigation as *Estonia*.

Like the latter ship, *Jan Heweliusz* was operating between Sweden and a port across the Baltic Sea, and the wreck lies in international waters.

The flag was non-Swedish, but among the 55 victims were a number of Swedes. Should they not receive the same attention from your government as those who were lost on *Estonia*? I do not understand the Swedish Government's attitude to this. Another investigation is being launched for *Estonia* and yet no investigation into the capsizing of

Jan Heweliusz. Why is this? I believe lessons can be learned from the *Jan Heweliusz* disaster.

It is intriguing that both ferries sank within around 20 minutes. This indicates the importance of the initial stages of flooding being overlooked in all previous research, which focused on survival after the completion of flooding.

From this perspective, watertight decks seem to be very detrimental for ship safety. For this reason, decks that can be accidentally flooded should be made transparent for floodwater, to avoid a repeat of the *Estonia* tragedy (the first such ships have been already built in Poland by the Szczecin yard Nowa). Besides, bilge pumps should be equipped with probes for detecting floodwater.

I think it would be beneficial for our profession if the Swedish authorities launched a similar investigation into the sinking sequence and loss of *Jan Heweliusz*. I appeal to you, as the Swedish Government seems to show a different attitude from the Polish authorities, which turns its back on research. We should not miss an opportunity to learn from the *Jan Heweliusz* tragedy, unless there are constraints imposed by some politics, which should not be mentioned here. In view of the catastrophic hurricane that foundered the *Jan Heweliusz*, some claim that her sinking was an Act of God, whereas I claim it was an Act of Human Fault and Ignorance.

BOOK REVIEWS

The Way of the Ship in the Midst of the Sea

The Life and Work of William Froude

By David K Brown. Published by Periscope Publishing Ltd, 33 Barwis Terrace, Penzance, Cornwall TR18 2AW, UK. 2006. 265 pp. Hard back. ISBN 1-904381-40-5. £60.00.

The author, David Brown, will be well known to many members of RINA as both an eminent naval architect and a naval historian. Like so many of us, David first became aware of the work of William Froude - known by naval architects all over the world - while he was at university. He became much more deeply involved later in his career whilst serving what was then still the UK Admiralty Experiment Works.

As with David's other books, this one is very well researched. Many references are cited, and the author gives us his views on their reliability and the background against which they were made. Quite a lot of extracts are quoted in the main text; his gives the reader very good insight to the way Froude developed his various theories. This was often against the prevailing views of respected engineers of the day.

Froude founded the art and science of ship model testing. It is a testimony to the value of his work that there are today more than 150 ship-model test tanks throughout the world, based on and still using his 19th century ideas. It may be said of Froude that his '…great breadth of understanding was his greatest strength in technical advance, many individual aspects of his work were already known; his genius lay in putting everything together and applying the result to the solution of important problems.'

This new book will, however, have a wider appeal than just to naval architects. It describes Froude's early work with I K Brunel (the iconic Victorian engineer) on England's railways, and his correspondence with a number of great engineers of the day. Froude was a friend of John (later Cardinal) Newman and they exchanged views on religious matters, on which they chose to differ. Their views on the similarities, and differences, between 'certainty' based on scientific reasoning on the one hand, and on religious experience on the other, make interesting reading.

William was born in 1810 in Devon, where his father was the Archdeacon of Totnes. He entered Oriel College, Oxford, in 1828 and in 1832 achieved a First Class in Mathematics and a Third in Classics. In 1833 he began working as a railway engineer and in 1836 joined I K Brunel and developed a new approach to the design of masonry bridges. He also worked on the curvature of track, needed to minimise the jolt due to sideways forces on trains entering a bend, and gained the respect of Brunel, who placed great trust in his work. It is interesting that later Brunel's son, Henry, did much work for Froude.

Froude gave up full-time professional work in 1846 for family reasons, and it was about 10 years later that he began work on ship-related problems, having been consulted by Brunel on the launching and also the rolling of *Great Eastern*. It is impossible to do justice to all the engineering matters in which Froude took an interest - an improved seal for the South Devon Atmospheric Railway; the boundary layer concept; a boring machine for a Channel tunnel; gas turbines; a pipe scraper; and even flying machines (he realised that existing power plants were too heavy for powered flight).

Froude's greatest achievement was to break the total resistance of a ship into two components, each scaling differently from model to full scale. The book covers the *Swan* and *Raven* experiments, with Froude using a range of models to study the affect of form on resistance and the two wave systems produced at the bow and stern.

The more scientific aspects of Froude's work are dealt with in annexes to the main text. Many great minds of the day became involved in resistance and propulsion, and the fact that they made limited progress before Froude shows the latter's genius. He realised that he was making a number of simplifying assumptions and discussed these.

He also appreciated the importance of interaction between hull and propellers, and again broke the problem into a number of different elements, allowing a practical approach to the prediction of the power needed to drive a ship at the desired speed. The fact that his approach is still the basis of modern methods indicates the soundness of his ideas.

Often these ran counter to the perceived wisdom of the day. David Brown's comments on present-day opinions/knowledge on the various topics reinforce this. Not least, the testing tank Froude created at Torquay, and the equipment he designed to tow models and measure forces, became a template for most modern tanks.

Froude's success followed from his method of working. He thought about a problem, and applied the best theory to solving it approximately. He then set up tests to observe and measure what happened. Careful and critical analyses of the observations led to an improved idea of the physics of the problem. A revised theory was then tested - by full-scale trials where possible.

After William's death in 1879 in Simon's Town, South Africa, his work was applied and developed by his son Robert Edmund (Eddy), who had helped his father in earlier work. For completeness, the book devotes a chapter to Edmund's work, including the circular notation, the move to Haslar, and the need to use a 'standard' model – the Iris model.

Three years before his death Froude was awarded the Royal Society's Royal Medal and, in the same year he was presented with an Honorary Degree of LLD by Glasgow University. He was a truly great engineer and craftsman, to whom naval architects are much indebted. He was a kind man and treated everyone with kindness, whether a lord or a workman. There is much in his character and way of working, that modern engineers would do well to emulate. David Brown is to be thanked for giving us such a clear insight into the man and his work.

Eric Tupper

BONDSHIP Project Guidelines

Edited by Jan R Weitzenböck and Dag McGeorge. Published by Det Norske Veritas, Veritasveien 1, N-1322 Høvik, Norway. 216 pages. Hardback. ISBN: 82 515 0305 1. Available from the BONDSHIP website: http://www.dnv.com/research/BONDSHIP_guidelines/index.asp at a cost of NKr399.00 (Europe) or NKr449.00 (rest of world).

Adhesives are being increasingly used in mainstream shipbuilding; therefore this new book (first published in 2005) will be of great interest to those shipbuilders and designers likely to use such technology. The BONDSHIP project (yet another R&D programme part-financed by taxpayers of the European Community) ran for three years, April 2000 to June 2003, and involved, in typical EC fashion, 13 partners from seven nations. Some of them are household names in the marine industry, eg, Fincantieri, Vosper Thornycroft (VT), CETENA, the University of Southampton, and Meyer Werft.

The aim was to summarise all the steps necessary to design, build, and inspect all types of shipboard bonded joints. There are two parts to the book: the code, and recommended practices. The editors believe – probably correctly – that 'most' designers, builders, and owners are not yet aware of the possibilities – and limitations – of adhesive joints.

The book is mainly aimed – naturally – at high-speed craft and passenger ships, where the benefits will perhaps be most obvious, and at joining lightweight and dissimilar materials and structures. It is recommended that adhesives are first applied in less critical areas of a ship and as service experience

is gained, at more strategic and load-bearing points. Probably the most hesitation over the use of glue in place of welds, rivets, or screws must arise because of the possibility of delamination and subsequent repair or replacement problems, but this book hopes to overcome such fears.

Having said this, the text does acknowledge that the long-term performance of a bonded joint cannot be predicted reliably from the results of accelerated ageing tests, also that numerical analysis cannot reliably predict joint failure without additional large-scale tests.

The editors also point out that adhesive glueing is a complex process with many variables, whose interaction is not yet fully understood. Potential users may, of course, also be put off by the very recent delamination problems of Gaz Transport/ Technigaz (GTT) with its new CS1 LNG cargo containment system. Quality control and approved personnel are clearly prerequisite essentials for any bonding project.

BONDSHIP Project Guidelines aims to overcome such inhibitions and presents a highly detailed and technical examination of all aspects of adhesives in a shipboard environment. Naval architects will find the chapter on the design and analysis of bonded joints of special interest. The editors point out that adhesives are especially suitable for joining long or large areas and for transfer of shear or compressive loads for limited times (only with flexible glues) and for shock loading.

Bonding techniques enable relatively uniform stress distribution, and avoid the introduction of pre-stresses in substrates. Adhesives are additionally said to be good for joining dissimilar materials, offer good insulation against sound and vibration, and can compensate for differences in thermal expansion or stiffness.

An important aspect of adhesive-bonded joints is their fire resistance, and a large chapter is devoted to this subject. As a result of practical tests – some are illustrated in the publication – carried out under the BONDSHIP project, it is suggested that adhesives used in fire-sensitive situations should not have heat resistance below 80°C–100°C, while is it possible that necessary insulation thickness might cause problems in certain parts of a ship; however, the small volumes of adhesive generally used do not present any special flame or smoke problems. Detailed load analyses should however, be carried out, and close contact should be maintained with the relevant class society – especially since experience with glue is not yet great. It is noted that careful joint design can be a considerable aid to fire resistance.

In line with these major attractions, the successful design of a bonded joint additionally requires 'profound knowledge of the behaviour of adhesives under loading and selection of suitable materials and surface preparation.' The key to success is said to lie in detailed dialogue between the product designer, adhesive manufacturer, and a shipyard's production department. The book includes a good selection of technical diagrams, some equations for the mathematically minded, and a small number of colour illustrations showing joints and tests.

Adhesives do offer many attractions to shipbuilders, and anyone interested in considering their use would find the book invaluable. It may even contribute to their greater use.

Tim Knaggs

Bureau Veritas on course for record-breaking year

PARIS-BASED classification society Bureau Veritas (BV) has enjoyed another record-breaking year in 2006. Turnover was forecast to rise by around 15% over the course of the year, to more than US$2.2 billion, and by the end of 2006, the size of the BV-classed fleet was expected to have passed the 55 million gt mark, with over 5400 vessels under class. Moreover, BV's newbuilding orderbook is now more than 17.4 million gt, comprising almost 1300 vessels of various types, with deliveries stretching to 2011.

Speaking at the tenth annual BV Beaujolais Nouveau reception, held at Trinity House in London on November 16, the company's marine division managing director, Bernard Anne, said, 'New orders received in 2006 to date total over 8.2 million gt, representing a market share of more than 11%, and we now have 640 ships under construction worldwide. I think this figure will become 9 million gt by the end of 2006.' Additionally, Mr Anne noted that BV was amongst the best-performing IACS members in rankings issued by various Port State Control authorities.

One of the highlights of the past year has been BV's growing success in the container ship market. Most notably, it has been announced that BV is to class the series of eight 11,800TEU liners that CMA CGM has ordered from Hyundai Heavy Industries - the biggest single shipbuilding order ever received by that South Korean yard (*The Naval Architect* October 2006, page 34). These vessels, which will be delivered between 2008 and 2010, will have an overall length of 363m, a beam of 45.6m, and will be powered by a single 72,240kW main engine, providing a service speed of 24.7knots.

BV has also continued to make progress in the gas carrier sector. It now claims to have a 20% share of this fast-growing market, with contracts covering a significant number of LNG and LPG carriers secured over the course of 2006.

Mr Anne pointed out that BV is concentrating on developing services in key, high-technology areas. 'We are classing some of the largest container vessels now coming onto the market; we are undisputed innovators in the gas carrier market, with re-gasification and 'pressure-rise' designs (the 7500m^3 Anthony Veder ship under construction at Remontowa in Poland) under construction; and we have played a leading role in the successful implementation of the common structural rules for bulk carriers,' he said.

Referring to BV's recent announcement of its bid (see page 4 of this issue) to acquire a majority stake in Germanischer Lloyd (GL), Mr Anne observed that such an alliance would have created the biggest force in ship classification, in terms of numbers of vessels, order book size, and global revenue, and would have made such a union number three or four in terms of tonnage in class. He added that, within 10 years, the new grouping would have had a 20% share of the market in China, by then arguably the world's largest shipbuilding nation, and 13% of the world's largest shipowning market, Greece.

BV said the headquarters of the merged group's marine division would be based in Hamburg, and that there was no threat to employee jobs within either BV or GL. However, the GL board fiercely and successfully opposed the takeover and found an alternative buyer.

However, Mr Anne argued that the offer represented an opportunity for BV and GL to grow together, to become the undisputed leader in marine classification. 'The offer is the right thing for both companies, and I believe that with GL we will be able to offer an even better service to our customers,' he said.

Expanded Seattle technology office for Laser Design

THE US manufacturer of 3D laser scanning systems, Laser Design Inc, based in Minneapolis, is expanding its Seattle technology office, which is responsible for laser probe manufacturing, R&D, software engineering, and worldwide customer support.

The company recently moved its Seattle operations into a larger office in the Fremont area and installed several of its high-end scanning systems plus an array of specialised test equipment there. The larger office was needed in order to accommodate the additional machinery and growing staff in the area.

Laser Design's Seattle technology office continues to test new platforms for its laser scanning systems and integrate them with the best systems. Currently, work is taking place on a special project to improve the lasers' triangulation accuracy and data-capture speed. Other projects for advancing this technology are also being planned.

Laser Design has been the leading supplier of ultra-precise, 3D laser scanning systems and services since 1987. Used for capturing the 3D shape of objects with complex geometries and free-form surfaces, Laser Design's Surveyor line of automated and portable scanning systems is ideal for 3D scanning applications involving inspection and reverse engineering of complex-shaped plastic and metal parts.

The company's patented laser line-probe technology claims to reduce dramatically scanning time by collecting data substantially faster and more accurately than conventional metrology technologies. Laser Design also operates GKS Inspection Services, an in-house service division offering complete 3D scanning, modelling, and dimensional measurement services.

The Royal Institution of Naval Architects

RINA Historic Ships Conference

21-22 February 2007

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Courtesy: F Walker

There are a huge number of historic ships that are in need of restoration/preservation. Several organisations exist, who aim to preserve these ships for the benefit of future generations.

This conference is aimed at exploring the technical and engineering issues involved in the construction, preservation and restoration of historic vessels from large passenger ships and warships to coastal and inland waterway craft, and of all nationalities and of local, national or international importance. Topics to be included are:

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- Materials and structural analysis, including appropriate material replacement, repair or replication.
- Propulsion systems, rigs and sails.
- Layouts and the need to meet current safety legislation.
- Techniques for conservation and restoration.
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- The balance between preservation afloat or dry.
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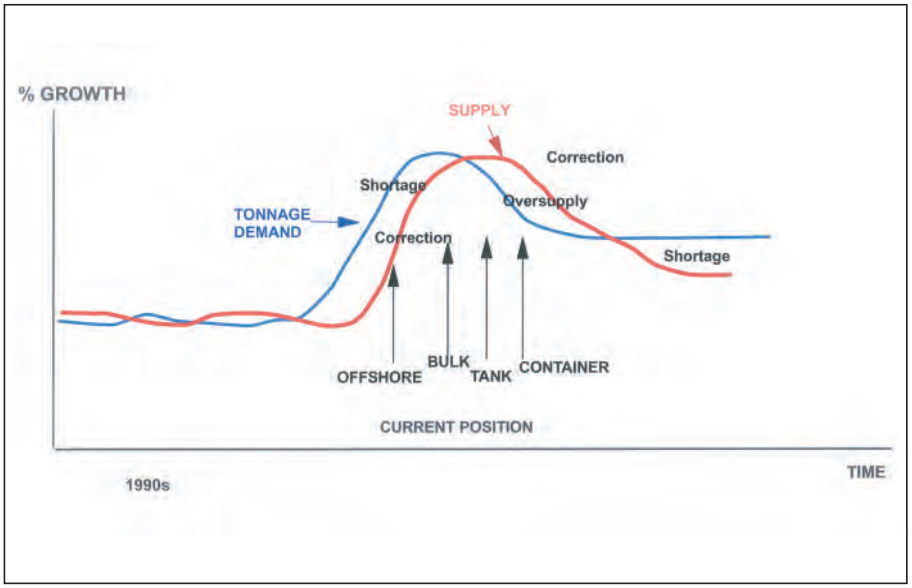
Norway – gold rush, golden age, or both?

Norwegian shipyards and equipment suppliers have seen a dramatic turn around since the thin days of 2003/4. Then, yards were fighting for the few contracts around and struggling to keep their design teams and key workers, in the hope of better times to come. Better times have indeed come, not just with a great upsurge in offshore activity but also in shipping generally. Richard White reports.



A graph revealing that supply of new ships tends to lag demand, followed by corrections, which may create shortages or over-supply of tonnage in different sectors. Source: R S Platou Economic Research AS.

RARELY has demand been so high over such a broad spectrum of the marine industry. Norway has, in general, a well educated and skilled workforce but one that is small in number. Much of the demand for manpower at the shipyards has consequently been tackled by using contract labour, primarily from Poland but also from other East European countries.

Over the past decade or two, Norwegian shipyards have re-balanced their activities to suit the changing labour market and international situation. From efficient section building and early outfitting in Norway, the emphasis moved to subcontracting the hull and superstructure steelwork to lower cost countries. A natural next step has been to acquire control of yards in those countries, for example, Aker Yards with its facilities in Romania. With costs in those countries tending to increase, the balance is today being re-examined, though the outcome is not yet clear. Currently, Norwegian shipyards as a group have more than enough orders in hand, some having good coverage as far out as 2009 and 2010.

Full order books

The great demand for specialised vessels to be built either in Norway or in shipyards abroad is also providing a good workload for naval architects, ship design houses, and test tanks. Similarly, Norwegian equipment producers are enjoying full order books. A major headache is the supply chain, with long lead times for key engineering components.

Norway, as a country, has always suffered from huge economic swings in industries such as fishing and farming, and not least in the marine business. When times are good, the question is always how long will it last and what comes next. As a major oil and gas exporter, Norway is currently rolling in oil income. With oil and shipbuilding going full out, is this some kind of a golden age, or a brief gold rush to be followed by lean and hungry years?

This was among the questions posed when a representative section of the Norwegian marine industry met in Ålesund for Verftskonferansen 2006, the national shipyard conference. The most important question from the Norwegian yards' point of view is how long will the present offshore boom last, and what other type of vessel might be in world demand when and if the offshore market weakens?

Ship designers are also intensely involved with offshore vessels, but for them the question is slightly different, since many of the designs are being built at yards around the world which do not necessarily dance to the same economic tune. The question is again different for the equipment suppliers. In most cases, the offshore service vessel industry, also the rig, platform and shuttle tanker industry connected to exploration and production, is the main focus. But many are also supplying the cruise liner market and merchant vessels construction in Asia.

Not surprisingly then, a major theme at Verftskonferansen was market trend analysis. Those factors affecting world merchant fleets were seen as the current high utilisation and profitability over the past few years. A demand for tonnage is being driven by the phasing out of single-hull tankers by 2010, and by economic growth in China creating a demand for shipping to carry raw material and energy imports and finished goods exports.

But whatever actual demand is, this will always be tempered by the cycle of the shibuilding industry. A demand for ships produces a supply of ships with a delay. The inertia of the system and long lead times during building booms implies that supply continues even after demand has slackened. This is happening now with container ships, while bulkers are forecast to follow, but the offshore supply side is forecast to continue strongly somewhat longer.

Offshore boom

The more optimistic analysts consider that weakening offshore vessel demand may be a blip rather than a massive crisis, much depending on the price of oil and gas and on rig utilisation. Another analyst noted that offshore rig utilisation is, in practice, full and, despite a large building programme, long lead times mean current shortage.

High rig utilisation has brought with it a corresponding good market for service vessels since rigs have to be moved, positioned, and supplied. The view is that with so many offshore supply vessels under construction or on order, the market will be oversupplied since, in principle, if all existing rigs are employed, extra supply needs tend to come from new additions to the fleet.

For the time being, day rates are high and this means that the incentive to scrap old vessels in the PSV (platform supply vessel) fleet disappears. But it is not just a question of number but also of quality. Oil majors have been tending to raise their game and their demands for offshore vessel quality.

The trend is to even out regional inequality around the world and for newer and environment-friendlier designs to drive out old tonnage. Anchor handlers are forecast to follow some of these trends, but the more optimistic analysts believe that there may not be an over-supply because the exploration and production industry is moving its activities into deeper waters and harsher climates, calling for specialised and high-class vessels.

Also, significant numbers of vessels under construction in Norway are workships for offshore and similar specialised tonnage, reflecting a growing focus on subsea construction in the oil and gas industry, together with interest in carrying out jobs such as well stimulation from vessels rather than platforms.

What should shipyards build if offshore vessel demand weakens? Nicolai Hansteen, of Lorentzen & Stemoco, has reviewed the possibilities for shortsea shipping. A distinguishing factor is the age of the world fleet and the need to replace old vessels. The indication is that Norway is becoming a little more competitive in these smaller vessels as prices in lower cost countries harden. Product tankers are of interest and Norwegian designers and yards are being successful in this area. The same applies to chemical tankers.

Here the volume of goods to be transported is rising on an annual basis and with Korea and Japan quoting 2011 deliveries for chemical tankers with stainless-steel tanks, opportunities are there already. Norway has the skills and

capacity since the Aker Yards site at Florø (formerly Kleven Florø) has built up a reputation for this type of vessel over a long period and also builds larger specialised liquid carriers, such as 42,000dwt orange juice carriers built to transport fresh and concentrated juice from South America to Europe. A further new ship of this type is due for delivery soon.

Shipowning

Norway has a large foreign-going fleet totalling nearly 40 million dwt (taking into account NIS and NOR registers and vessels under foreign flags). According to figures provided by the Norwegian Shipowners' Association, the number of vessels is, at 1742, the highest ever recorded. New orders covering ships for Norwegian account have increased radically. If January 2005 is taken as a base the increase to date is 117%.

The largest category by number is offshore service vessels, but other categories of ship are on order, for example 55 chemical tankers, 34 gas tankers, 40 other dry cargo ships plus bulk carriers, oil tankers, and five passenger vessels. Norwegian orders for mobile offshore units also amount to about 30% of the world order book.

Norwegian yards account for the largest number of vessels on order; 102 ships, with Korea second, China third, and India increasing its market share significantly. Around 98% of the vessels on order in Norway are offshore service vessels.

An analysis of the Norwegian-owned foreign-going fleet shows that in terms of deadweight tonnage the leading category is oil tankers, followed by gas and chemical tankers and bulk carriers with a roughly equal share. On the other hand, if the dollar value of the fleet is considered, then gas and chemical tankers are well ahead, followed by offshore service vessels.

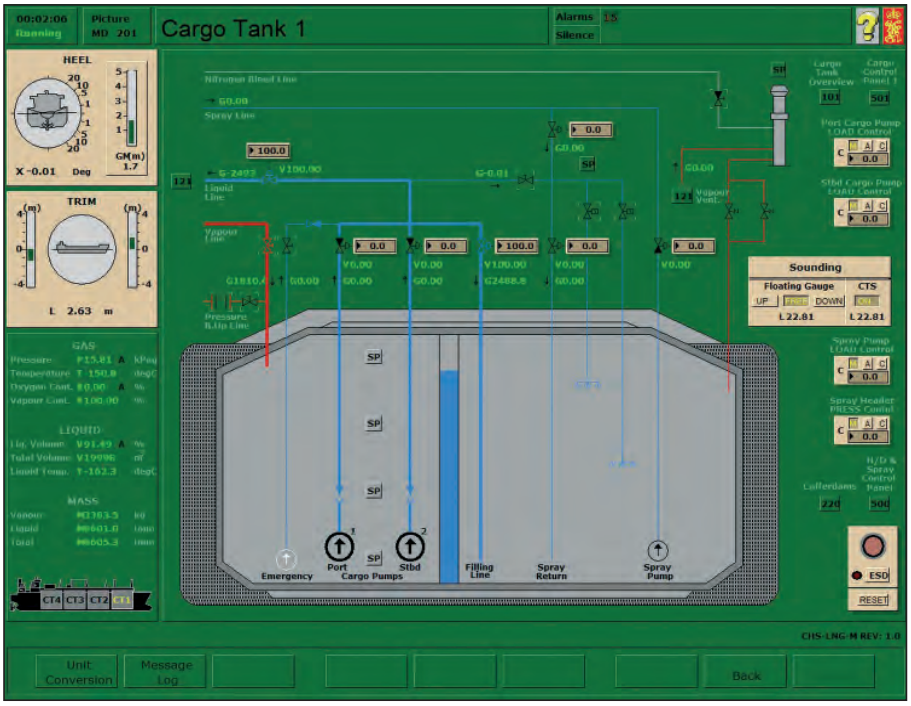
Kongsberg package for OSG LNG carriers

THE first K-Bridge consoles have been delivered by Kongsberg Maritime as part of the company's contract to supply bridge, cargo, and integrated automated systems to four new LNG carriers ordered by Overseas Shipholding Group at the Samsung and Hyundai shipyards in Korea. These ships, destined for the QatarGas 2 project, are the first to utilise Kongsberg's K-Bridge system, which is part of a new integrated shipboard network named K-Line.

This concept is based on common-system technology to supply safe and advanced solutions for navigation (K-Bridge), automation (K-Chief), dynamic positioning and joystick (K-Pos), propulsion and thruster control (K-Thrust), also tank gauging (K-Gauge) and safety (K-Safe). Each can be installed as a stand-alone subsystem or as a more extensive network-based management layout. In the case of the new LNG carriers, the owner was keen to have one supplier for critical equipment, so the K-line concept fitted in very well. Part of the K-Line system now includes a new dynamic positioning control module, which extends the principles of segregation and redundancy.

In addition, Kongsberg has evolved a new-generation cargo-handling simulator to provide training for ship crews in handling the careful transfer of gas from a process or loading platform to a membrane-type LNG carrier. This CHS-LNG-M real-time software suite can be used for both basic operations as well as more complicated ones such as cargo cooling and venting.

The model consists of four Technigaz and Gaztransport-type membrane tanks able to handle fully refrigerated cargoes and uses an advanced mathematical gas model comprising components of methane, ethane, propane, and butane, as in real situations. The system can also simulate boil-off rates, over-pressure, and cooling – all factors that can induce tank and equipment damage if operations are mishandled. Advice and feedback is provided to students automatically during exercises. This enables self-paced training to be undertaken either in a classroom or on the Internet. If necessary, a number of student stations can be connected to a single instructor point.



One of the screen displays from Kongsberg Maritime's new LNG cargo handling simulator.

Helping to solve today's marine challenges

A CAMPAIGN to raise the awareness of its activities is being carried out by DNV Maritime Solutions, a company within the maritime division of the Norwegian group, most well-known, of course, for its classification activities. DNV Maritime Solutions is a fast-growing management and technical consultancy, aiming to help owners (mainly), but also shipyards, designers, manufacturers, and others, to solve current and future critical challenges, to gain competitive advantages, and to change company cultures.

Special competency is claimed in sectors dealing with safety, the environment, and energy management, with an emphasis on being pro-active and viewing all aspects of a problem from a global perspective. Additionally, the aim is to be involved on a long-term basis.

Today, as most readers are aware, both owners and operators – including navies - are under great pressure from economic, environmental, and regulatory standpoints, as well as trying to achieve greater transparency in all marine and maritime aspects; even blue-chip companies are seeking the consultancy's services to improve their operations. The provision of total environment-related packages is one of the aims.

In particular, DNV Maritime Solutions believes that substantial potential is open to achieve efficient energy management. With tailor-made solutions, improvements in all sectors can, believes the consultancy, realistically be harnessed to show overall fuel savings of around 10% annually.

Optimistic future for short-sea shipping

BECAUSE of the country's close links with the EU, the way Norway's short-sea shipping develops in the future is likely to be strongly influenced by local factors and European initiatives, for example, the Motorway of the Sea project. Driving forces are a poor and straggling road infrastructure and increasing road congestion.

Fortunately, much of Norwegian industry has water access and along much of the coastline, shipping lanes are partially protected by offlying islands. In the past, attempts were made to collect and transport farmed fish to the UK for onward transport by air to the USA. These failed, partly because the technology was not quite adequate and partly through problems with port infrastructure and road competition.

Norway's ambitions for short-sea shipping were presented in the so-called Soria Moria Declaration, made when the present 'red/green' coalition government discussed its party differences and hammered out a common policy. At Verftskonferansen 2006, Egil Rensvik, of Marintek, analysed the situation.

The government's ambitions are to strengthen short-sea shipping, while natural gas as a fuel should have a major role in this. Mr Rensvik showed that although coastal shipping has traditionally played an important part in Norwegian transport, given the lack of railways, the long-term tendency has been for trucks to take over the transport of goods. Forecasts from 2003 covering the period to 2020 indicate a slow but steady growth in sea transport but a somewhat greater rate of growth in road freight.

Mr Rensvik pointed out that there are various ways in which the short-sea shipping sector can improve its competitiveness. One is by developing new vessel concepts, for example, module-based for lower construction costs and to provide a more effective transport platform. There are energy savings to be made through improved hulls and propulsion. An important factor would be to see the ship as part of a total transport infrastructure. Not least, using natural gas as a fuel would help to increase the use of natural gas ashore.

Unlike many European countries, Norway has an extremely limited domestic and industrial gas distribution network, despite being a large exporter of gas. It was felt that a realistic potential for marine use of LNG was around 20% of the total Norwegian bunker volume, amounting to some 350,000 tonnes of LNG annually. The attraction is greatly reduced NOx emissions and a substantial reduction in CO_2.

The coastal gas infrastructure would comprise LNG reception terminals and storage at strategic locations along the coastline fed by small LNG ships, probably less than 10,000m³. This would fuel the intermodal transport chain and would also be used in power generation.

Exporting fish products

Fishing is one of Norway's largest industries, covering both fishing vessels and fish farming. Europe is a major market for the produce and much thought is being given to sea transport of fish to market. One objective is to establish a competitive, high-capacity and fast route for sea food from the west coast of Norway to the continent. This would involve three main elements: logistics, ship design, and cargo handling, including super-chilling of the fish. The logistics chain is complex: from the sea food manufacturer, then by local transport to the port terminal, followed by long-distance transport to the reception terminal, then local distribution before the fish arrives in the hands of the customer.

Photo: Harald M Valderhaug.

Part of the plan to revitalise the export of fish products from Norway is the newly delivered 2737dwt *Storfoss*, from Vaagland Båtbyggeri. The owner is Store Line and the operator is Eimskip, the expanding Iceland company.

***Storfoss* is the second of a pair of 16knot refrigerated ships designed by Multi Maritime and known as the MM80 type. A particular feature of both (the first is *Svartfoss*, completed as *Kristian With*) is the specification of a Kappel tipped CP propeller of 4.00m diameter; this is driven by a MAN B&W Alpha 9L27/38 engine through an Alpha gearbox fitted with a Newage Stamford 1000kW power take-off shaft.**

The propeller blades were cast and machined in Germany by MMG, and a Brunvoll transverse thruster is fitted at the bow and stern to aid efficient manoeuvring.

Refrigerated cargo capacity is 4345m³, with space for 28 x 40ft containers plus 4 x 20ft units, and cargo handling gear comprises a deck crane and a side-loading system with lifts, both designed by TTS. *Storfoss* is classed with Det Norske Veritas to meet the standards: +1A1, Reefer (-27°C/+32°C sea), Container, Ice C, E0.

New solutions

Various solutions have been proposed, from all-sea routes to combinations of road, rail and ship. Taking a Norway-Benelux chain, for example, dedicated high-speed ships are a possibility. The brand-new MM80 designs from Multi Maritime, illustrated above, represent another aspect, although they are much slower at 16knots.

The alternatives are transport by truck the whole way, a combination of truck and conventional ferry using the Oslo-Kiel route, or a through rail transport link, for example, Trondheim to Oslo then through Sweden, Denmark, and Germany. There are also other possibilities for a combination of truck and ship. Marintek argues that ships for this type of transport need to move closer to the 'truck and trailer of the sea' concept, and that there is something for the marine industry to learn from other industries. Among the proposals are series production and focus on flexible standard modules, which is the route the road transport business has taken.

A key requirement is to recognise that the ship is only one link in a chain, and that more effective cargo handling will reduce the need for tonnage because today short-sea shipping spends much of its time in port. The conclusions are that the technology is, to a large extent, available at present and that this is a market with great potential both for Norwegian shipowners and for shipyards. However, it is vital to consider the entire logistics chain door to door and not just the quay-to-quay element. Marintek also makes the point that the conditions need to be the same across Europe to ensure a level playing field and that renewing the small vessel fleet will demand a large injection of capital.

SIGNIFICANT SHIPS OF 2006

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The Royal Institution of Naval Architects will publish the seventeenth edition of its annual *Significant Ships* series in February 2007. Produced in our usual technically-orientated style, *Significant Ships of 2006 will* present approximately 50 of the most innovative and important commercial designs delivered during the year by shipyards worldwide. Emphasis will be placed on newbuildings over 100m in length, although some significant smaller cargo ships, fast ferries and offshore vessels will be considered, including a cross-section of ship types, with each vessel being either representative of its type or singularly significant. Each ship presentation will comprise of a concise technical description, extensive tabular principal particulars including major equipment suppliers, detailed general arrangement plans and a colour ship photograph.

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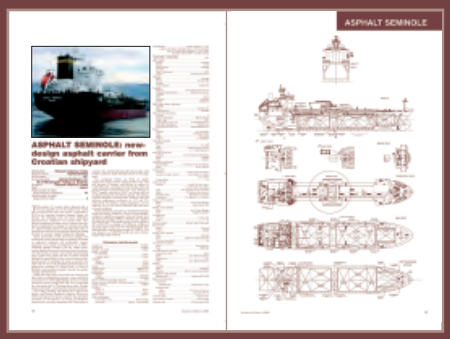

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Going strongly for gas

NORWEGIAN companies are investing heavily in the technology for burning natural gas as a marine fuel. Several vessels are already in service, and there will be significant additions to the fleet in the very near future.

There are several reasons for this interest. Although Norway is one of the largest exporters of LNG, there is remarkably little in the way of internal distribution or domestic consumption. This was partly caused by historical factors such as, until recently, as much hydro-electric power as the country needed. Now, however, there are good reasons to build up the gas infrastructure.

Viewed from the marine side, the spotlight is on emissions. Because sea transport and marine activities play a much bigger part relative to land industry compared with many other countries, it is estimated that around 40% of NOx emissions come from shipping. At the same time, there is pressure to reduce CO_2 emissions to meet the terms of the Kyoto Agreement.

One way to reduce both these problems is to switch from oil fuel to LNG. As noted elsewhere in this feature, the plan is to use small LNG carriers to transport fuel from main centres to storage and distribution centres, possibly up to 30 of these at strategic locations along the coast. Ferries and other vessels taking bunkers from LNG stations would provide a base load to justify other distribution.

The process of moving to gas started some years ago with the cross-fjord ferry *Glutra*. Equipped with Mitsubishi gas-engined generator sets and re-fuelled by tank truck, *Glutra* has been giving good service. The capital cost of the vessel was substantially higher than a standard ferry because the authorities imposed every conceivable safety measure. Observers have noted that, metaphorically, belt, braces, and safety pins were called for. This led to discussions aimed at rationalising the safety measures and harmonising them between the various classification society requirements and what the flag state wants. The situation is now seen as more positive for future vessels.

From *Glutra*, the scene moved to offshore, and in 2003 Eidesvik Offshore put into service *Viking Energy*, the world's first LNG-fuelled platform supply vessel. Her sister, *Stril Pioneer*, was built for Møkster by the same yard, Kleven Verft. They went on charter to Statoil where the reduction in emissions could be offset against other Statoil sources. LNG supplies are available for these vessels operating in the North Sea but they are equipped with four Wärtsilä dual-fuel engines each, and these can operate on oil or gas, depending on what is available, allowing the vessels to operate worldwide if necessary. The LNG is carried in an insulated container resembling a large thermos flask laid horizontally amidships, and the liquid is drawn off and warmed to a usable gas as required.

***Bergensfjord*, the first of five new double-ended ferries (two types) for Fjord 1, will continue the pioneering movement started by *Glutra* to use gas fuel in its main engines. This ship, built by the Aker Søviknes yard and of the larger variant, features spark-ignition Bergen KVGS-G4 engines – two with 16 cylinders and two with 12. Electric power is supplied to four Schottel propulsors (SCD 2020 integral-motor pod types on the larger ferries and electric cardan-shaft drives to STP 1515 units on**

One of the Bergen 12-cylinder spark-ignition engines (KVGS12-G4 model) for the new Fjord 1 ferries ready to leave the factory.

Five new-generation ferries

The next phase in the gas story is five ferries which will form an essential link in the road system on the west coast of Norway. At the time of writing, the first vessel, *Bergensfjord*, had been completed at Aker's Søviknes yard, and the service using gas-fuel ships was due to start at the beginning of 2007.

These are large double-ended ferries for passengers and vehicles. They form two groups: three ships and two ships of essentially the same design but powered for different speeds to suit the service requirements. The larger one also has two vehicle decks, although the hull length is the same.

Three of the double-ended vessels will operate between Halhjem and Sandvikvåg on the E39 road south of Bergen; the other two

Will run between Arsvågen and Mortavika in the Stavanger region. These are the second and third most intensively used ferry links in Norway in terms of passenger and vehicle numbers.

Bergen lean-burn spark emission gas engines from Rolls-Royce have been chosen to power these ferries. The Halhjem trio, of which *Bergensfjord* is one, will run at 21knots carrying up to 530 passengers and the equivalent of 198 cars. This will require over 12,000kW provided by two KVGS-16G4 engines with 16 cylinders each and two 12-cylinder engines of the same type. For the Arsvågen route, only 17 knots is required, for which two of the 12-cylinder engineers will be sufficient.

New coastal gas transport network

Transport of LNG along the Norwegian coast also requires suitable vessels. The Dutch owner Anthony Veder has ordered a vessel at the Remontowa yard in Poland (our *Gas Carriers* supplement, October 2006, page 26), which will be on long-term contract to Gassnor, of Norway. This ship is especially interesting, since it will also be able to carry LPG and other petrochemical gases, using so-called 'pressure-rise' technology.

Equally interesting is the propulsion system. This will have two gas-fuelled and two diesel generator sets, an electric transmission system, and Azipull thrusters (pulling propellers) for main propulsion backed-up by a tunnel thruster For manoeuvring; all this equipment will be from Rolls-Royce. Such an arrangement allows the vessel to run in different modes. When loaded with suitable gas, the boil-off is used as fuel for the gas engines. When in ballast, the ship will use its diesel engines burning distillate bunkers and this will also be the case if the cargo being carried is not suitable for fuel.

Eidesvik Offshore, owner of *Viking Energy* mentioned above, is taking emissions reduction very seriously through a variety of tactics. At Verftskonferansen 2006, Eidesvik's Jan Fredrik Meling presented some of the tactics. He noted how difficult it is going to be for the country to meet its target of reducing NOx emissions by 18,000tonnes annually by 2010. This would equate to another 120 ships with the same reduction as *Viking Energy* or another 100 gas-fuelled ferries, which would be a difficult target for the industry to reach even with substantial state aid.

Running the PSV *Viking Energy* on gas is reckoned to reduce NOx emission by around 89% and CO_2 by some 20%, compared with the same operating profile but running on diesel.

The unusual supply vessel *Viking Avant*, which went into service at the end of 2004 uses a catalyst and selective catalytic reduction (SCR) system to treat its diesel engine exhaust. This ship is unusual in PSV terms in placing the accommodation aft and carrying the deck load amidships between the Raised forecastle and the superstructure. However, the catalyser and SCR system is seen as having distinct drawbacks. It only functions when the engine load is above 30% although NOx is reduced by 63%. The catalyser has a limited life and there is the problem that urea has to be supplied to the system.

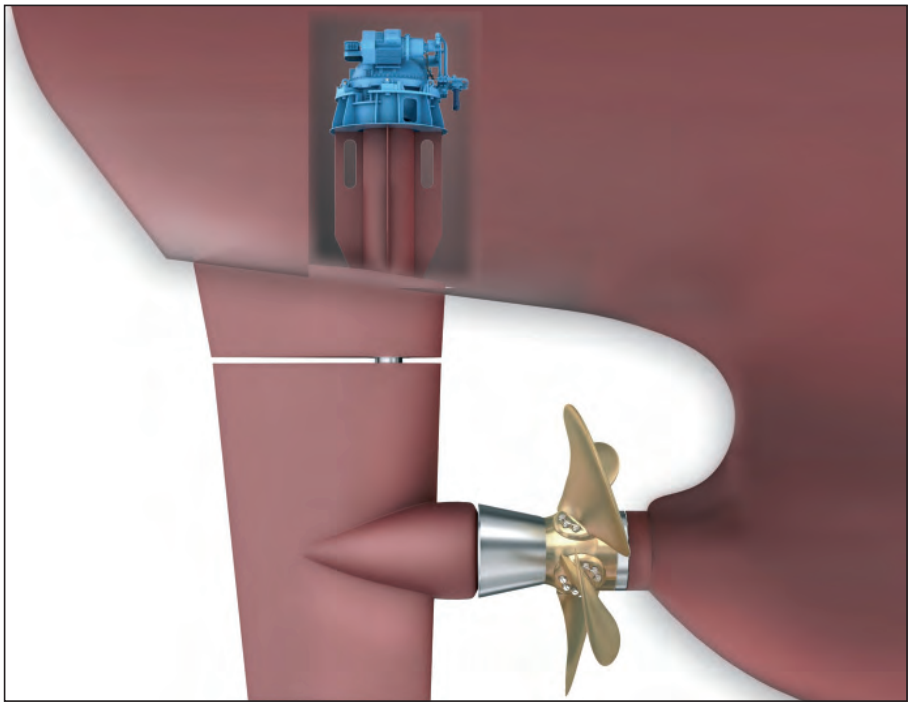
The next stage for Eidesvik is to build a next generation version of *Viking Avant-Gass-Avant*, which will be built, like its predecessor, to a Vik-Sandvik design. This ship will combine *Viking Avant's* general layout with gas-fuelled engines.

There is great interest in fuel cells as a way of reducing pollution from vessels. Eidesvik has ambitions to be the first in Norway to put them to serious commercial use. It has worked with fuel cells for the past three years and wants to see them installed by the end of 2008. The attractions are 50% reduced emission of CO_2 and no emission of NOX, SOX, or particulates.

LNG or methanol would be used as fuel and a patent has been granted for a system solution combining fuel cells and steam power. Eidesvik is a member of the FellowShip initiative, which is led by DNV and includes Vik-Sandvik, MTU CFC Solutions, Wallenius, and Wärtsilä in various phases. The FellowShip project aims to develop and demonstrate completely integrated hybrid fuel cell systems in ships, and to qualify the technology for future use.

Innovative designs from Norway's yards and consultancies

IT is clear that 'offshore' is the dominant force in Norwegian shipbuilding for the time being, accounting for some 98% of the total order book in value terms. Many of these are vessels to meet the general requirements of the market – supply vessels and anchor handlers. But there are also many designs which are breaking new ground as oil exploration and production moves into ultra-deep waters and the harsh operating conditions of the Far North, whether it be Sakhalin or the Barents Sea. This is providing work for consultancies, giving them a chance to come up with designs to meet new requirements and innovative solutions to meet existing requirements better. Designers, yards, and equipment manufacturers have also been working to introduce systems for reducing the risk to the crews of offshore vessels who have to work on deck, handling cargo at platforms, and involved with chains and wires under load when anchor-handling. As is typical with the 'maritime cluster ' in Norway, companies are both co-operating and competing with each other., which helps to sharpen wits and keep the industry ahead of external competition. Some very interesting technical solutions for deck machinery are now entering commercial service.



An interesting new product from the Rolls-Royce group, based at Ulsteinvik, is a twisted rudder allied to a Costa-type bulb and fairing joined to the propeller. The rudder would be turned by a group-built rotary-vane steering gear. To date, no orders are yet believed to have been secured for such a package.

Despite the dominance of the offshore sector, several yards are competing in world markets for other types of tonnage. Fosen Mek Verksteder, for example, signed a contract in 2004 covering the building of two new ro-pax ferries in the Stena Seabridger class. The first of these, *Stena Trader*, was delivered earlier this year. With the superstructure forward, loading over the stern and a single funnel arranged aft to port, these ships offer about 3100 lane metres of vehicle space for trucks and trailers, plus room for 300 passengers with 100 cabins. Service speed is around 23knots. In this case, the hulls were subcontracted to Baltiysky Zavod in St Petersburg, Russia; outfitting took place at the Fosen yard, Rissa, near Trondheim.

Fosen is one of the rather few shipyards in Europe and Scandinavia with the capacity to build large passenger vessels. In the past few years it has built ships for the Hurtigruten service and also the notable residential cruise vessel *The World*.

Aker Yards, which is part of the new-look and re-organised Aker Group, has built up a large international shipbuilding group focusing on sophisticated vessels. It now has 17 yards worldwide in Brazil, Finland, France, Germany, Norway, Romania, and Ukraine. In Norway alone, there are six yards - Aukra, Brattvåg, Brevik, Langsten and Søviknes, also the recently acquired Florø yard. Most of these are currently building offshore vessels of various designs.

In the summer of 2006, Aker Yards acquired the former Kleven shipyard in Florø, also Kleven Design, from Kleven Maritime. This move, together with a joint venture agreement with the Damen Shipyard Group in Ukraine, has opened the way to develop a competitive line of chemical tankers. The yard in Florø built its reputation on this type of ship, a demanding technology involving combining stainless steel tanks with conventional shipbuilding steel construction. The yard has also built large specialised carriers such as the orange juice vessels,which broke new ground in being able to transport fresh juice in bulk as well as concentrate.

Recently, Aker Yards signed a contract with Stolt-Nielsen Transport in The Netherlands for four new chemical/oil product tankers. These 182m long and 43,000dwt vessels will have cargo capacity of 45,350m³ and are scheduled for delivery in 2008 and 2009. Construction will be split between Aker Yards Florø and the Damen facility in the Ukraine.

The fore and aft sections of the ship will be built in the Ukraine and at the same time the mid-body section will be built at Florø in Norway. The fore section of the ship will be welded to the aft section to create a small ship which can be taken to Norway; on arrival this will be separated and then joined to the mid-section. Cargo will be carried in stainless steel tanks, and the ships will have low-speed two-stroke diesel propulsion.

An unusual vessel was ordered by Aker Biomarine from Aker Yards Søviknes for delivery towards the end of 2009. This will be a 144m long by 27m beam vessel designed to catch and process krill, and extract oil from these tiny creatures. Skipsteknisk, in Ålesund, is responsible for the design. At the time of writing, the contract was an option and the final contract was planned to be signed early in 2007.

Coastguard vessels are an important activity involving many Norwegian companies. As part of improvements to the country's control over its long coastline easily damaged by oil pollution, and its extensive offshore oil and fishery interests, Norway has been updating its coastguard fleet. The first of a series of five vessels for the inshore fleet recently entered service. Designed by Skipsteknisk and built in Poland for Remoy Shipping, these ships are chartered by Remoy to the Norwegian Coastguard. Diesel-electric propulsion is being used, providing secure and economical propulsion in several operating modes, with Scandinavian Electric Systems responsible for the four-generator, two-frequency-controlled main motor electric solution.

Rolls-Royce has built a strong position in this market sector, supplying designs and packages of equipment. UT-Design vessels have in the past few years been built for coastguard and pollution prevention duties for the UK, France, and Norway. The first of two new vessels is currently going into service with SASEMAR in Spain, and other design/equipment contracts are in hand for India and other countries.

Some years ago the Ramform concept was introduced and several vessels built, mostly for seismic work. In plan view these were almost triangular and were said to resemble old-fashioned clothes irons. The concept has proved successful, and third-generation Ramform vessels are now under construction. Petroleum Geo-Services placed an order for *Ramform 7* with Aker Yards, Langsten, and has now exercised an option to build yet another vessel of the same sort, *Ramform 8*.

Compared with earlier vessels these will be 16m longer, will have a higher fuel capacity and power upgrade which will significantly increase the speed when surveying. These third-generation Ramforms will be able to deploy 22 seismic streamers, and the ships will have all they need for handling, deployment, retrieval, and maintenance of the in-sea equipment.

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Design & Construction of Floating Production Units

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Since their introduction in the mid '70s floating production units have proved themselves as cost effective viable technical solutions for many remote, deepwater and marginal offshore field developments. There are over 150 such units currently operating around the world. Over 60% of these FPUs have been based on mono-hulls, mainly converted trading vessels but increasing purpose-built hulls particularly for the larger fields with longer service life requirements. However, a diverse range of technical solutions including semi-submersible, Tension Leg Platforms (TLP) and spars buoys have been deployed as FPUs.

With the current high oil and gas prices and strong worldwide demand for energy, many more offshore fields are now becoming viable for development, and many will utilise or require FPUs. It has been forecasted that by 2008, world offshore oil production will increase by 43% and offshore gas production by a staggering 83%. The conference will provide an ideal opportunity for designers, builders and project engineers to learn about the latest projects and technical developments, and to exchange experience in this key offshore development technology. Papers are invited on all related topics including the following areas:

- Experience on specific design & construction projects
- Structural integrity and reliability
- Project management and integration
- Key components (swivels, bearing, riser & offloading system)
- Passive & active mooring systems
- Safety & risk evaluation

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Rapid prototyping for model production

A NEW technique known as rapid prototyping is now in operation at the Danish research centre Force Technology, based at Lyngby, following three years of use at subcontractors. For several years, Force has been using advanced 3D CAD systems as a basis for production of ship models on its large CNC-controlled milling machine, as well as for production of model propellers. Now, the centre's own in-house rapid-prototyping unit is in operation as a 3D design inside IBM CATIA software. Primarily, such systems are based on selective laser sintering (SLS) or Polyjet (3D printing) technology.

Typical examples of models produced using RPT technology: a propulsion pod housing and bossing, also a bracket for a twin-screw open-shaft arrangement.

The use of rapid prototyping technology – colloquially known as RPT – in production of models for testing is said to offer several benefits to clients, particularly in four areas:

- ability to model very complex structures
- 3D design documents can be forwarded to a client for reviews and comments utilising dedicated viewers
- changes to appendage designs; these can be made overnight and refitted on models the following day for repeated tests
- 3D design (STL format). Designs from clients can, in most cases, be used directly as input, thus reducing the time

Originally, RPT was planned for use in Force Technology wind tunnels for construction of complex land buildings and bridges. However, during the last two years the technique has increasingly been used for appendages and details on offshore platform and on ship models.

The organisation's own machine is an Objet EDEN 500 V-RPT printer (Polyjet technology), which should ensure very high quality of resulting components. This machine can produce very large elements, and units can be divided into sections connected with snap locks for easy mounting and fitting.

MAN Diesel and Wärtsilä unite in Hercules-B research project

More and more, maintenance of a set of 'green' credentials should be every shipowner's priority. Certainly, leading manufacturers and technical organisations are making every effort to make this a reality. Here, David Tinsley reports on some of the most recent initiatives, beginning with the Hercules R&D project.

PREMIER engine suppliers MAN Diesel (formerly MAN B&W Diesel) and Wärtsilä Corp have proposed a further, large-scale research project to follow on directly from the current Hercules initiative, with its ambitious targets for cutting emissions and raising the efficiency of marine diesel engines. The central objective in the envisaged Hercules-B endeavour is to hoist the efficiency factor for diesel propulsion systems to above 60%, and thereby achieve significant savings in unit fuel consumption and attendant reductions in carbon dioxide (CO_2) and other emissions. The scale of the task may be gauged from the fact that the highest thermal efficiency rating for modern marine engines to date is around 50%

The Hercules integrated project was set in motion on March 1 2004, and is expected to be completed by the autumn of 2007. It is anticipated that Hercules-B will be fully agreed during 2007, and thereby provide programme continuity through to 2011.

Hercules-A has 42 participating organisations from across the industry in Europe, and €17.8 million of its overall budget of €33 million is being publicly funded, to the tune of €15.0 million from the EC under the Sixth Framework Programme and with €2.8 million contributed by the Swiss government. Management of the multi-faceted project is in the hands of Uleme EEIG, an Augsburg-based subsidiary of MAN and Wärtsilä.

The enormous technical challenge of Hercules is to reduce emissions drastically from the next generation of marine engines, with parallel advances in engine efficiency, reliability, and life-cycle costs. The scale and complexity of the undertaking is implicit in its division into nine work packages (WPs), 18 tasks, and 54 sub-projects.

The areas of marine engine design in which innovations are being addressed include the following:

- engines with 'extreme' mean effective pressure (MEP) design parameters
- new combustion concepts
- 'intelligent' variable flow area, multi stage turbochargers
- 'hot'-operating engine, using a combined steam cycle
- marine engines incorporating water injection
- exhaust-gas recirculation (EGR) in heavy fuel engines
- new after-treatment methods for heavy fuel (including plasma technology and scrubbers)
- new sensors and emission measurement methods
- 'low-friction' engines
- 'adaptive' control of engines.

Like the present project, Hercules-B is foreseen as a cooperative study, drawing in a broad spectrum of technical organisations, institutes, and companies. The innovative content of Hercules-B would be very high, to the extent that a technological breakthrough is foreseen with regard to the reduction of fuel consumption and emissions for the next generation of marine diesel engines.

The potential environmental impact of the project is emphasised by its champions. It is argued that it would not only help facilitate marine industry compatibility with future, tougher regulations and controls on exhaust emissions, but would also strengthen the environmental argument for waterborne transportation. The project would deliver a number of 'technology demonstrator' engines, and some of the new technologies developed by the partners would be validated aboard newly-built ships.

Hercules-B is planned to run over a four-year period with a targeted budget of €60 million. Once the project has been agreed, the promoters plan to apply for partial funding support from the EC under the auspices of the future, Seventh Framework Programme.

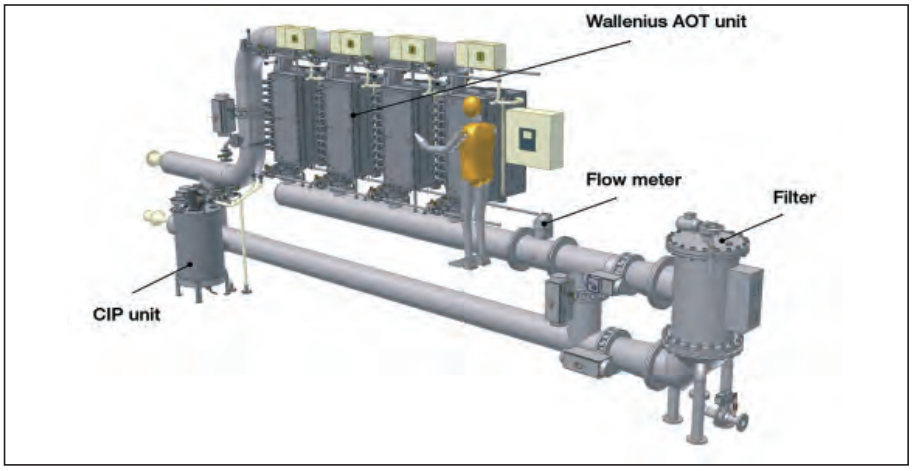
PureBallast: innovative technology to destroy micro-organisms

FOLLOWING laboratory pilot tests and a series of test installations on deepsea vehicle carriers, a chemical-free ballast water treatment system has been released by Alfa Laval to the commercial market well in advance of the 2009 activation of IMO regulations. The concept is actually the brainwave of a small Swedish company named Benrad, which approached the leading Swedish owner Wallenious to consider its AOT (advanced oxidation technology) technique – which was originally planned for land use.

Developed by the manufacturer in cooperation with Wallenius Water, the compact and fully-automated PureBallast system has been designed to remove potentially invasive species from ballast water in compliance with the exacting IMO requirements. In understanding shipowners' and shipbuilders' needs as to ease of integration – modules have been designed for operating efficiency, and simplicity has had a direct bearing on the arrangements and technology adopted. PureBallast incorporates patented Wallenius advanced oxidation technology (AOT), a process similar to that used in many of today's 'smart' products, whereby micro-organisms are broken down without the need for chemicals. Alfa Laval's goal is to have the first fully-approved, certificated ballast water treatment system ready in mid-2007, and confidence inspired by the trials and test results led the company to launch PureBallast officially in December 2006. Dispensing with chemicals was a key objective, not only for environmental reasons but also out of consideration of operational and ongoing cost factors, obviating the need for onboard stocking and handling. The PureBallast treatment plant has a small footprint and embodies a block structure, facilitating engineroom installation between the normal ballast water system components.

The formal name of the technology is actually Wallenius AOT. In this concept, the ballast water is taken on board and passed through a 316K

An AOT (advanced oxidation technology) unit from Alfa Laval for the destruction of micro-organisms in ballast water. Twenty ultra-violet lamps operate in association with titanium-dioxide catalysts; each AOT unit is capable of handling 250m³/h, so a ship wishing to pump 1000m³/h would need four such units.



Computer diagram of a typical arrangement for a Alfa Laval AOT ballast-water treatment plant with four units suitable for handling a total of 1000m³/h

stainless steel container fitted with 20 medium-pressure ultra-violet lamps (low-pressure lamps were originally used) and special titanium-dioxide catalysts; these generate radicals when struck by light, and it is these radicals – with a lifetime of only a few milliseconds – that breakdown the cell membrane of micro-organisms and destroy them. No residues result.

Each standard AOT unit is capable of processing 250m³/h of ballast water so a ship needing to process 1000m³/h would need four units. Each lamp is estimated to have a service life of approximately 1500hours, and of course, they would only be switched on when handling ballast. One AOT unit would require a 60kW electrical supply so naval architects and engineers planning a 1000m³/h ship would need to take into account the requirement for 240kW of extra generator capacity.

During ballasting, water travels through a pre-filter to remove larger particles and organisms. The water then continues to the AOT unit; this pre-filter stage obviates sediment build-up in the ballast tanks, and any backflushing water is returned to the sea directly at the ballasting location. When deballasting, water again passes through the AOT unit so as to kill any organisms that might have re-grown in the tanks during the voyage. The filter is bypassed, thereby avoiding filter backflushing and eliminating the risk of contaminating the deballasting site.

The whole chain is fully automated. An automatic cleaning unit has been integrated into the system to ensure that AOT performance is not affected by scaling from seawater contaminants.

Laboratory pilot tests with PureBallast, conducted by the Norwegian Institute for Water Research (NIVA) in 2006 under the supervision of DNV, have confirmed that the system meets the stringent IMO requirements. In addition, the programme at NIVA showed that the system leaves no residual compounds or toxicity after ballast water treatment. Accordingly, Alfa Laval submitted its application for Active Substance Basic Approval in April 2006, and set the complicated IMO approval process in train. Full-scale land-based testing has been assigned to NIVA, where investment has been committed to four new tanks of over 200m³.

A full-scale prototype of PureBallast has been operating on the Wallenius-owned PCTC *Don Quixote* since retrofitting in 2003, and has been used to test automation and operating reliability as well as biological efficiency. A PureBallast plant has also been incorporated in the 2006-commissioned *Aida*, and a third system has gone into a subsequent Wallenius PCTC new ship under construction.

SCR technique continues to excite Scandinavian owners

SELECTIVE catalytic reduction (SCR) technology has been shown to be by far the most effective solution for curbing NOx (oxides of nitrogen) emissions from a diesel engine, with the capability to achieve reductions of as much as 95%-98%. Nevertheless, SCR plant entails additional investment and operating costs, such that adoption has been predominantly among vessels intended for trades or services in waters subject to the most stringent environmental controls.

For instance, the Swedish Maritime Administration's system of environmentally differentiated fairway dues, which provides clear financial incentives to ships with low emissions, and imposes tougher charges on the heavier polluters, has stimulated usage of shipboard SCR plant. It is thought that the Swedish initiative could be emulated elsewhere. In addition, the Baltic Sea is now a SECA (SOx Emission Control Area), with implications for all operators sailing to that region.

A number of new deliveries into the Baltic trades during 2006, including three heavily ice-strengthened ro-ro ships of 13,800dwt for Stora Enso, and the high-speed ro-ro ferry *Gotlandia II* (*The Naval Architect* September 2006, page 120), have provided further platforms for the technology, as has Broström's innovative new generation of D-class 14,500dwt product tankers headed by *Bro Deliverer* (to be presented in the forthcoming 2006 edition of *Significant Ships*).

The Swedish-developed Munters system is characterised by low complexity, high efficiency, a compact design, and long service life, and is suitable for retrofit applications as well as newbuild projects. Having been designed to meet the most stringent NOx regulations to which shipping in Swedish waters has been subject since January 1 1998, the main benefit of the system is inreducing NOx to N_2 (nitrogen) and water. The plant also deals effectively with HC (hydrocarbons) and CO (carbon monoxide), which are oxidised to CO_2 (carbon dioxide) and water during the conversion process.

An oxidation catalyst stage after the SCR catalyst ensures that no emissions such as CO and ammonia increase over the converter. The system can be equipped with an integral silencer section, so as to achieve a total noise attenuation of 30dB-35dB. Typical figures achieved are:

NOx reduction.....85%-99%
HC reduction.....70%-90%
CO reduction.....50%-90%
Ammonia reduction.....<3ppm
Noise reduction.....30dB-35dB

The SCR converter is a multi-stage unit containing several different catalysts, a urea injection system and monitoring control arrangements. Because the urea injection system operates at low pressure, it enables the use of small-diameter pipes and small pumps, such that the entire emission reduction unit forms a compact, space-saving package. Urea is odourless, and is considered completely safe for handling onboard ship.

NOx is reduced through the injection of a small amount of a solution of urea and water into the hot exhaust-gas stream. The solution then vaporizes and contacts with NOx in a process of heterogeneous catalysis over the SCR catalysts.

The combined SCR and oxidation process does not produce any waste products, and the NOx reduction rate can be varied to meet different air pollution requirements by adjusting the urea injection rate between zero and 100%.

The consumption of urea solution is generally within 5%-8% (by weight) of the fuel consumption, depending on the desired degree of NOx reduction in relation to the base line emission level. The control metering unit receives load and rev/min signals from the engine, and these are used for controlling the urea injection flow, in accordance with the pre-set injection curve.

A milestone in the uptake of marine SCR technology was reached when the Munters system was specified for Broström's D-class

14,500dwt product carriers ordered from Jinling Shipyard. The contract signified a breakthrough for the latest exhaust-gas cleaning technology in the products tanker sector, and also denoted the first sale of a Munters SCR system in the Chinese shipbuilding market.

The first ships of the quartet made their debut in 2006, giving operational form to a design distinguished by engineering features aimed at meeting project goals relating to high levels of environmental compliance as well as redundancy, safety, reliability, and manoeuvrability.

The specification includes the unusual choice of twin azimuth thrusters, incorporating Rolls-Royce Azipull pulling propellers, for main propulsion. Munters SCR units are fitted to the exhaust lines of each ship's two MAN B&W 7L27/38 main engines and four 6L16/24 auxiliary engines. An integrated silencer section has also been chosen, in keeping with Broström's tough criteria governing noise levels.

Environmental considerations have been shaped by the intended use of the ships in littoral traffic adjacent to countries with high environmental expectations, not least Sweden and its environmentally-differentiated fairway charges, and by the fact that the vessels will spend about 50% of their time in ports and terminals adjacent to urban areas. Broström is expecting a NOx reduction of around 98%.

Power concentration

A complete outfit of Munters converters has also been applied to the two MAN B&W main engines and two Wärtsilä gensets of the *TransPaper*-class of three 13,800dwt ro-ro paper/freight carriers phased into Baltic duties during the second half of 2006 (these ships will be discussed in more detail in our February issue).

Distinguished by a high power concentration and 20-knot service speed, the series gives added dimension to Stora Enso's logistics system, and will ultimately maintain year-round services linking two of Finland's most northerly ports, Oulu and Kemi, with Gothenburg and Lübeck. Operator Transatlantic has also entered into a separate agreement with the paper and forestry products specialist to use spare capacity for third party cargoes, to be marketed and managed under the guise of TransLumi Line. The decision to employ SCR plant as part of broader measures to reduce environmental impact reflects a long-term view of the expectations of the shipping, trading, and industrial communities in northern Europe.

Earlier, Munters acquired ABB Fläkt Marine's business in the field of NOx emission control. The company also offers patented Humid Air Motor (HAM) technology, based on a technique of humidifying the compressed inlet air of the diesel engine, to curb NOx.

Cold-ironing aims to limit emissions in harbour

CONCERNS for the environment and the health of residents in port communities are expected to foster increasing use of the practice of 'cold ironing', whereby vessels shut down all power plant when in port, and draw electricity from the shoreside grid. Of course, not all ships are readily adaptable to employing a power supply system of this nature, especially those reliant on onboard machinery for cargo handling. Diesel-driven tankers are a case in point. However, cold ironing is emerging as a technically feasible, cost-effective way of cutting emissions in port for container ships and cruise liners, and potentially for other ship types which also make regular calls at a given terminal or berth.

The scale of the hotel load borne by a large cruise ship gives special merit to the concept, which can eliminate pollutants such as particulate matter, NOx, and SOx from the ship while alongside.

The ports of Los Angeles and Long Beach were the front runners in the provision of shoreside connections for commercial vessels. The first initiative relied on a specially-equipped barge to establish the link with the port power supply infrastructure, by way of transformer, switchgear, and high- and low-voltage cable management systems. Subsequently, NYK Line's containership *NYK Atlas* was claimed to be the first vessel to plug directly into shore power, without the use of a barge.

She incorporates an integrated onboard electrical system for cold ironing. Under the port's incentive scheme, NYK has received substantial reimbursements from the Los Angeles Board of Harbour Commissioners for costs associated with shore power capability. However, cold ironing is to be put on a statutory footing in California, against the backcloth of the development of a new generation of shoreside facilities with fast plug connections and seamless load transfer.

It is understood that a new regulation envisaged by the California Air Resources Board will require vessels visiting the state's ports to reduce air pollution from auxiliary installations through the use of cleaner marine distillate fuels or equivalent emission controls, including the use of shoreside electrical power.

The Cavotec cable reel on the new 7024TEU container liner *Hatsu Shine*, specially installed so that the ship can switch to shore electrical supplies in sensitive ports, such as those on the US West Coast.

Cold ironing is also set to become an issue for ships calling at ports elsewhere in North America, while steps to provide shore power for regular callers have been taken at various ports in Germany, Japan, and elsewhere.

Baltic Marine demonstrator

A concrete outcome of the New Hansa environmental research project, undertaken by 18 partners throughout the Baltic, was the commitment to the pilot installation of a ship-to-shore power interface in Lübeck-Travemünde, which will also serve as a demonstrator for the Baltic marine industry as a whole. Reflecting the situation in many port towns and cities, research had shown that ferries and other ships together represented the main source of nitrogen oxide and sulphur dioxide emissions at Travemünde, while noise and vibration from vessels alongside was also cited as an area of local environmental impact which needed to be addressed. A fully integrated ship-based system, complete with cable management system, shore connection panel, transformer and shore incoming panel, has been adopted in container ships by a number of operators, including Mediterranean Shipping Co (MSC) and Evergreen subsidiary Hatsu Marine – as illustrated in our January 2006 article on the new S-class *Hatsu Shine*, as well as NYK Line and others.

Other solutions offered by suppliers include semi-fixed and all-in-one removable containers. Cavotec's semi-fixed system holds the shore connection panel and transformer, while the cable management system can be placed either directly on the ship or inside the container. The idea is to carry the shore power unit aboard while a vessel is engaged in the US West Coast trade.

Among the developments on the Pacific seaboard, Cochran's marine division has designed a transformer substation which allows visiting ships to hook-up easily to shore power, and cover

the entire onboard hotel load during a sojourn in port. Two of leading cruiseship 'brands' and a ro-ro trailer ship operator are using these arrangements.

Although there is as yet no global technical standard governing ship-to-shore connection points, IMO has called on the International Standards Organisation to develop a formula, and it is anticipated that work could be completed in 2008 or 2009.

'Those wishing to wait for a standard system to take shape.....are advised to make sure that the technology will be easy to implement on their newbuilds,' counselled Germanischer Lloyd, in a review of implications for the container ship sector. At the time, in early 2006, it reported that quotations from yards for retrofitting ships had been in the order of €900,000. 'Fitting costs can be kept to a minimum by installing an upgradable power control panel and providing a special base for subsequent installation of the container housing the shore power unit. This container will hold most of the extra equipment required, such as the switchgear or cable reel,' observed GL.

For its part, Lloyd's Register warns that ship safety and environmental benefits must be given equal Weight when examining issues and practicalities relating to cold ironing. To address the potential hazards, this society has developed draft rules for onshore power supplies, in consultation with a wide variety of stakeholders. It has also been asked to contribute to ongoing industry discussions and to working groups tasked with devising uniform standards for such arrangements. 'The aim is to harness best practice to mitigate the risks posed by the significant change to port operations that cold ironing represents,' pointed out LR.

Fuel cells: future technology coming closer

ENDEAVOURS by marine industry players to bring the prospective environmental benefits of fuel-cell technology to bear on ship operations have been endorsed by a €1 million research grant from the EU. The allocation will be used by a Wärtsilä-coordinated study consortium charged with developing and validating methanol-consuming fuel cells to provide onboard electrical power.

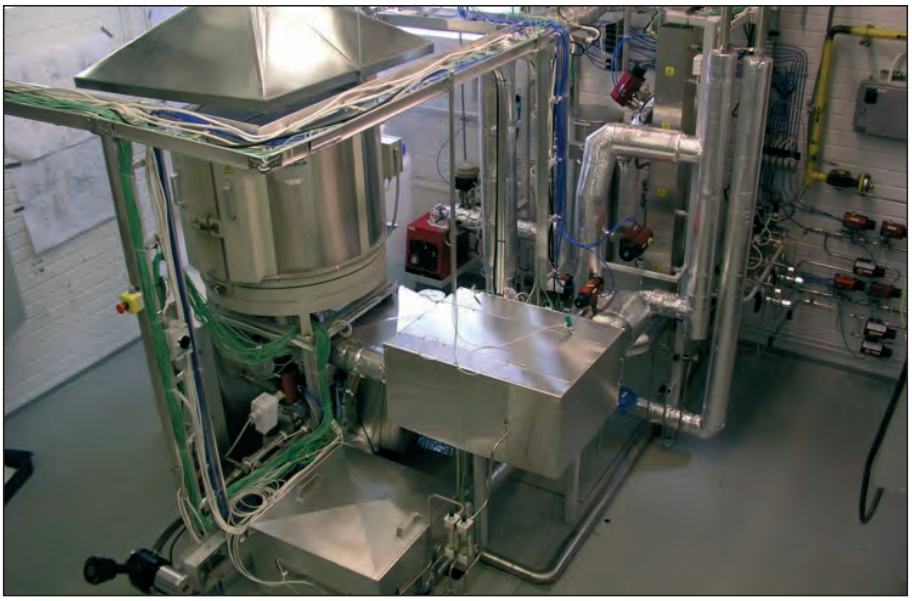
The project is known as METHAPU ('Validation of a renewable methanol-based auxiliary power system for commercial vessels') and has an overall budget of €1.9 million to cover a study period of two-and-a-half years. One of the key aims of the research consortium is to lay the technical groundwork to support the introduction of the requisite regulations to allow the use of methanol as a marine fuel. The specific components of the technology to be validated are methanol fuel bunkering, distribution and storage, and a solid oxide fuel cell (SOFC) designed to operate on methanol.

The partners will carry out research on the marinisation, safety, and reliability of a 250kW fuel cell unit. As a trial, a 20kW unit is to be installed aboard a Wallenius-owned pure car/truck carrier (PCTC), following factory and laboratory tests and the necessary approvals. The results of the validation phase with the 20kW fuel cell will provide vital data for the second part of the research, spanning the development, compatibility and performance of the 250kW unit.

'The construction and operation of this research unit running on renewable methanol will open up attractive opportunities for using sustainable fuels for fuel cell-based distributed generation and auxiliary power units in large ships,' said Erkko Fontell, Wärtsilä's general manager for fuel cells.

Besides Wärtsilä and Wallenius Marine, the shipmanagement and technical arm of Wallenius Lines, parties to METHAPU include Lloyd's Register, Det Norske Veritas, and the University of Genoa. From its own resources, Wärtsilä has been pursuing R&D work on fuel cells since 2000, with a view to applications in both the distributed power generation and marine markets. An important milestone was reached in June 2006 when a 20kW prototype employing SOFC technology was transferred to the group's fuel cell laboratory in Espoo, Finland.

The aims of the METHAPU project dovetail with Wärtsilä's own strategic objectives in giving life to its first commercial demonstration units in the 20kW-50kW power class during 2007-2008, and in bringing commercial products in the 50-250kW power range into being by 2010. Besides methanol, fuelling possibilities for the proprietary fuel cells will be natural gas and biogas.



Equipment set-up for the fuel-cell study being made by a consortium coordinated by Wärtsilä.

Wärtsilä's target markets for marine fuel cells include ferries on short crossings, cruise ships, and vehicle carriers. 'With fuel cells progressing from theory to practice, it is time to formulate a consistent approach to the assessment of the safety and dependability of not only fuel cells, but systems, machinery, and equipment onboard vessels making use of new or novel technologies,' said Ed Fort, of Lloyd's Register's R&D department.

With the introduction of fuel cell systems operating on fuels not traditionally associated with marine power generation - indeed, not currently recognised by marine legislation - comes a variety of considerations.

Fuel cell arrangements

The storage and distribution arrangements for FC fuels will need to recognise associated safety and cleanliness requirements not normally identified with oil fuels for traditional marine machinery. Other areas that will need to be addressed include the location of fuel cells and related equipment and attendant ventilation arrangements.

While a small SOFC unit is to be trialled at sea under the METHAPU project, a full-scale demonstrator of a marine power plant based on fuel cells is planned for 2008 by north European participants in the pan-industry research initiative known as FellowSHIP. FellowSHIP is a three-year project, tasked with developing and testing marine and offshore power solutions using molten-carbonate fuel cells (MCFC) and solid-oxide fuel cells (SOFC), and has public financial sponsorship from the Eureka programme, the network for European collaboration in R&D. The pilot seagoing application will be an auxiliary power unit.

Led by DNV, the FellowSHIP initiative includes Eidesvik Offshore, MTU CFC Solutions of Germany, Wärtsilä Automation Norway, and Norwegian ship design consultancy Vik-Sandvik. The opening phase also involved Wallenius Marine and Wärtsilä.

Besides its project management role, DNV's responsibilities under FellowSHIP embrace safety and reliability issues and environmental analysis. DNV was also entrusted with providing an information flow from two earlier, EU-sponsored marine fuel cell research projects, FCSHIP and NEW-H-SHIP, as well as several EU projects on hydrogen. In the FCSHIP study, DNV participated in the safety module, working together with three other European-headquartered classification societies to develop basic safety requirements for fuel cells in ships.

Wallenius leads the way in being 'green'

UPTAKE by the shipping industry of advances in environmental engineering trends has tended more often than not to be legislation- or regulation-led. However, many owners and operators are now taking a proactive approach to such investments, appreciative of the interrelationships between good environmental credentials and operating efficiency, safety, dependability, and market reputation. An overarching culture of environmental responsibility, furthermore, is associated with a number of industry names, notably vehicle carrier specialist Wallenius Lines.

One of the latest initiatives has seen Wallenius Marine, the technical and shipmanagement arm of this Swedish group, enter into an agreement with Wärtsilä for the adoption of an emissions reduction technology in 40 auxiliary engines throughout the fleet. The method to be used, the WetPac Humidification System, is expected to reduce NOx (oxides of nitrogen) formation by 30%, and thereby cut NOx emissions to some 7g/kW/h-8g/kW/h across the fleet.

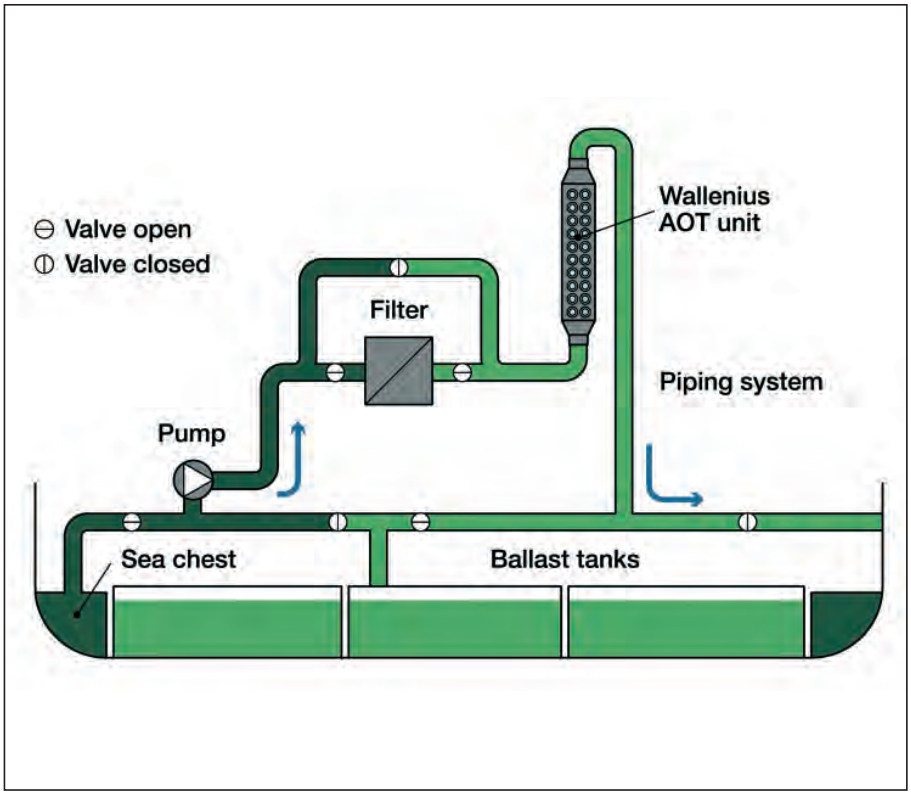
A total of 17 vessels are encompassed by the accord, which runs to the end of 2008. The selection of WetPac for the generator engines underscores Wallenius Marine's strategy in emissions reduction of primarily choosing engine-internal measures, or 'upstream' solutions, in preference to aftertreatment methods.

The WetPac system targets the temperature peaks in an engine's combustion chamber by humidifying the scavenging air. Through the injection of water mist into the chamber, temperatures can be lowered, thereby suppressing the formation of NOx.

Wallenius indicated that the agreement signalled the start of a deeper cooperation entailing several phases. The link between the Swedish and Finnish organisations in terms of environmental technology is also expressed in the planned validation of a Wärtsilä 20kW fuel cell aboard a Wallenius PCTC under the auspices of the METHAPU research project (discussed elsewhere in this feature).

Wallenius Marine is engaged in a number of environmental projects at various levels in the ship operations field, as reported in various issues of *The Naval Architect*, particularly September 2006, page 3. Since 2003, the company has been primarily using low-sulphur bunker fuels, and runs shipboard auxiliaries on MDO (marine diesel oil) in port so as to reduce the local atmospheric impact of its activities. In 2005, the company's Swedish-flag vessels had an average bunker fuel sulphur content of 1.12% - claimed to be a world record.

Through Wallenius Water, the Swedish group is a pioneer in ballast water treatment, and has developed the recently-launched, chemical-free PureBallast system in conjunction with Alfa Laval (see separate article in this feature). Incorporating Wallenius AOT technology, a full-scale prototype of PureBallast was fitted aboard the Wallenius PCTC *Don Quixote* in 2003. Commissioned in 2006, the 6700 unit-capacity PCTC Aida also has a PureBallast installation, representing one of a wide range of environmental protection measures conferring very high green credentials. In fact, *Aida* introduced the 'Green Passport' concept to the fleet, applying a standard in environmental responsibility to the ship's entire lifecycle. The aim is to have every vessel meeting Green Passport criteria.



A diagram illustrating the operation of a ballast system on a Wallenius car/truck carrier, showing the inclusion of a Wallenius/Alfa Laval AOT unit for destruction of micro-organisms. Two ships in the fleet already have these fitted, and more will follow.

New rules to beat water-ballast invasive species

THE problem of invasive aquatic species, transported globally in ships' ballast water and shown to have detrimental ecological and economical effects, was first raised at IMO in 1988. Quantitative data shows the rate of bio-invasions is continuing to increase at a high rate, in many cases exponentially, and that the impact is widening in terms of geographic areas. Given the continuing growth in seaborne trade, the problem may not yet have reached its peak.

Now, the issue has finally been addressed by way of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, which was adopted by IMO in February 2004. Once the necessary number of states with the required minimum tonnage have ratified, ballast water treatment systems will have to be used on both new and existing vessels, in accordance with a phased Schedule and depending on keel laying and total ballast water capacity for each ship. The first target date is 2009, in relation to smaller new vessels.

Phase-in of requirements for ballast water treatment is as follows:

Newbuilds
From 2009.....Ballast water capacity of less than 5000m^3
From 2012.....All new ships
Existing vessels
From 2014.....Ballast water capacity between 1500m^3-5000m^3
From 2016.....All existing vessels.

In addition, the convention will require all ships without an approved ballast water treatment system to perform ballast water exchange as of 2009.

Ballast water exchange involves flushing the tanks at sea, which in theory reduces the chances of organisms surviving in the ballast tanks. Because of perceived shortcomings and concerns over the process of ballast water exchange, it is anticipated that many owners and operators will choose to install a treatment system before they are actually required to do so.

To be approved by IMO, a treatment system must be able to reduce the number of viable organisms contained in ballast water to a maximum number per unit of volume. The future performance standard D-2 requires that ships conducting ballast operations discharge no more than 10 viable organisms of 50-microns/m^3 or more, and less than 10 viable organisms of between 10microns/ml and 50microns/ml of ballast water.

The IMO certification process involves testing using two types of water differing in salinity and turbidity. Both land-based and onboard tests of biological performance must be undertaken, all of which must be conducted at full-scale and with a minimum ballast water capacity of 200m^3/h.

Fully automatic treatment system from RWO

FOLLOWING three years' development and test work, Bremen-based RWO Marine Water Technology has unveiled a modular ballast treatment system distinguished by its dimensioning for very high sediment loads. RWO's focus on effectiveness in operation in waters laden with silt and other material reflects its appreciation that most ballasting takes place in harbours, estuaries and tidal-influenced coastal areas, and that organisms 'hidden' in sediments are protected against disinfection.

Known as CleanBallast!, the fully-automatic RWO solution does not use chemicals and consumables. It employs electrolytic disinfection and continuous monitoring of viable organisms in the effluent, and has been engineered to give high flow rates for heavy duty operation in harbours and areas subject to substantial concentrations of sediment.

Advanced disc filtration has been adopted in preference to other methods in the belief that it achieves a more far-reaching mechanical separation during the intake of ballast water, removing suspended solids, sediments, and a large number of organisms. The disc filter technology in RWO's compact design is widely used for filtering sea water, especially on cruise liners and offshore, and in other industries, acting as pre-filters serving reverse-osmosis desalination plants.

The disc filtration process is claimed to remove most sediment before it can accumulate in the ballast tanks, reducing abrasive wear and raising operating efficiency, and enhancing the effectiveness of the subsequent disinfection phase. The small fraction of remaining, very fine particles will be swept out of the ballast spaces during regular discharge.

The cleaned filtrate is treated by in-line disinfection, using electrolysis rather than chemical additives. Through the advanced electrolytic process, various disinfectants, such as hydroxyl and oxygen radicals, are produced directly in the pipe, affording protection against the diverse range of marine organisms. RWO attaches particular importance to this aspect of CleanBallast!, whereby the system is suited to all global water qualities and also to river water without any loss in disinfection effectiveness.

A newly developed monitoring device, for which a patent is pending, is incorporated to scrutinise the purified effluent continuously and measure its remaining content of viable organisms, control treatment efficiency, and guarantee compliance with the future IMO performance standard D-2. The nature of CleanBallast! and its disinfection arrangements mean that an owner does not have to consider the handling, dosing, and supply logistics associated with using and storing chemicals onboard.

High demand for refined BilgeMaster concept

BUOYANT demand for its BilgeMaster processing system, to meet internationally-mandated quality standards for bilgewater discharge, has led Westfalia Separator to refine and expand the equipment series. The upgrading process has increased the options and level of customisation available to shipowners and shipbuilders, whereby the original offering of three sizes at 1500-litres/h, 3000-litres/h, and 6000-litres/h capacity has been superseded by a range spanning nine models from 1000-litres/h to 7000-litres/h. In addition, the three basic types of self-cleaning separators have been converted from gearwheel drive to belt drive. The change has engendered speed increases in the order of 20%-30%, with a correspondingly higher centrifugal force, resulting in more efficient separation and better performance.

The D range covers the requirements of passenger ships and other commercial vessels with installed diesel engine ratings upwards of 5000kW. Furthermore, smaller ships and craft can be fitted with the BilgeMaster 200 model. Incorporating the non self-cleaning WTC2 separator, offering capacity throughputs up to 200-litre/h, this product effectively represents the 10th member of the BilgeMaster family.

BilgeMaster has proved its effectiveness in allowing shipowners to meet IMO's limit value of 15ppm residual oil content in discharged bilgewater. In fact, by incorporating a downstream adsorption filter, a residual oil content of less than 5ppm is achieved in more than 95% of cases. By such means, the system has been 'future-proofed' to meet any further tightening in the regulations.

Since May 2005, Westfalia Separator has also secured approval from the US Coast Guard, which specifies even more stringent standards than those set by IMO. An additional US requirement is that separators have to demonstrate a capability for reliable operation at an incline, reflecting high wave conditions. Furthermore, certification has been obtained from the German Seamen's Accident Prevention and Insurance Association, which also set very demanding criteria.

While the technological merits of the system are the overarching factor, BilgeMaster confers a 'visible' benefit in that the treated bilgewater discharge to the sea is clear and colourless. The optical advantage is regarded as particularly important to cruise-ship applications. Westfalia claims that flotation separating processes with settling tanks do not yield clear bilge water, even if they meet the separating threshold of 15ppm.

One of the other attributes of the system is that its relatively compact nature facilitates retrofits as well as newbuild installations.

Technological solutions for three cruise ships

The technical services provider, Imtech, has announced that it has received orders worth over €50 million for a variety of equipment for three cruise ships to be built in Germany. Meyer Werft, in Papenburg, has just placed an order with Imtech for three of its newest projects; each of these post-Panamax ships is over 315m in length, with a beam of 36.8m, and offering space for over 1425 passenger cabins for two or more persons.

Imtech will be responsible for the advanced air conditioning and climate control package. The order was booked by Imtech Schiffbau-Dockbautechnik (part of Imtech Deutschland), in Germany. The first ship will be completed in 2008, followed by the second in 2009, and the third in 2010.

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New pipestoppers available range of diameters

The pipestoppers division of Huntingdon Fusion Techniques Ltd has launched a new range of aluminium pipe stopping plugs suitable for use in shipbuilding, and shiprepair applications. Such plugs are used for sealing pipes, blocking them, testing for leaks, and to prevent entry of unwanted foreign material. They are also sometimes used in the marine industry as scupper plugs.

This new range comprises 12mm as well as 25mm sizes to ensure that every pipe and tube diameter between 38mm and 152mm has a plug that will seal to full pressure and leak tightness. They are equipped as standard with a natural rubber seal but can be delivered with nitrile, neoprene, viton, or other synthetic rubber seals to allow use at high temperatures. They can also be used with harmful or corrosive chemicals and fluids.

In addition, this new range of aluminium drain plugs makes use of a tough wing nut with a friction-free washer underneath to make plug tightening easy. Other mechanical plugs for pipe sizes up to 2000mm diameter are also available from the company.

Contact: Huntingdon Fusion Techniques Ltd, Stukeley Meadow, Burry Port SA16 OBT, UK. Tel: +44 1554 836 836. Fax: +44 1554 836 837. E-mail: hft@huntingdonfusion.com www.huntingdonfusion.com

New Azipull order for tanker

The application of Rolls-Royce Azipull thrusters as a main propulsion system has been extended with the contract for a pair of thrusters for a 7500m^3 gas carrier to be built in Poland, for The Netherlands shipowner Anthony Veder (see page 26 of the *Gas Carriers* supplement, which accompanied our October issue).

This vessel is the first of a new breed, being designed to carry liquefied natural gas (LNG), liquefied petroleum gases (LPG), or ethylene. On completion in 2008, it will go on long-term charter to Gasnor, carrying gas along the coast of Norway.

Rolls-Royce is supplying the complete power and propulsion package.

Two AZP120 thrusters with FP propellers and classed to Bureau Veritas ice standard 1B will be driven by frequency-controlled motors in a gas/diesel-electric system. Two gas-fuelled gensets and two diesel gensets, from Bergen Diesel, will provide the primary power. The main thrusters will be assisted by a bow tunnel thruster, also to be supplied by Rolls-Royc.

The shipowner selected the Bergen solution against dual-fuel or triple-fuel alternatives, while the Azipull thrusters were chosen to provide the manoeuvrability, course stability, and propulsion efficiency required by this 117m-long ship.

Contact: Rolls-Royce, PO Box 160, N-6065 Ulsteinvik, Norway. Tel: +47 70 01 42 17. Fax: +47 70 01 40 05. www.rolls-royce.com

First extinguisher for cruise-ship balconies

Following a fire which recently broke out on the cruise ship *Star Princess* (covered in the News section of *The Naval Architect*, June 2006), Germany-based Minimax has released what is claimed to be the first fire extinguishing system for ship's balconies. Up until now, and despite comprehensive fire protection regulations, balconies on passenger liners have remained unprotected.

The Minimax Competence Centre for Marine Studies carried out a number of trials to investigate how the fire spread through the balconies, and as a result was able to develop a claimed highly effective fire protection solution. A number of full-scale replicas of the ship's cabins went up in flames at Minimax's own fire protection research centre in Bad Oldesloe. Minimax used the full-scale fire tests to demonstrate the effectiveness of its own development of a fire extinguishing system for ships' balconies. An independent report from the Rostock Institute for Marine Safety confirmed the reliability of the fire protection, and the system has been approved by Germanischer Lloyd.

The Minimax extinguishing system proved itself in two different test scenarios. In the first test, it prevented a cabin fire spreading outwards - even with the external door open. In the second test the system's two nozzles quickly and reliably extinguished a large fire on the balcony. The high extinguishing performance prevented the fire spreading to the upper and neighbouring cabins, as happened on *Star Princess*.

During the tests, which were also observed by representatives of leading yards and cruise liner companies, Minimax stuck closely to the requirements set by the standard for sprinkler tests IMO Res. A 800 (19). This forms the basis for the approval of sprinkler systems.

Contact: Minimax GmbH & Co KG, Industriestraße 10/12, D-23840 Bad Oldesloe, Germany. Tel: +49 4531 803 495. E-mail: eilitzb@minimax.de www.minimax.de

These new aluminium pipe stopping plugs from Huntingdon Fusion Techniques are suitable for a range of marine applications.

Equipment contracts won at Gdynia Shipyard

Swedish cargo equipment manufacturer TTS Ships Equipment AB has recently received two orders from Gdynia Shipyard, Poland, for ro-ro equipment with a total weight of almost 14,000tonnes. The orders cover the supply of equipment for a total of eight vessels.

The first new order covers the supply of equipment for two 2100-unit PCTC vessels; hull numbers 8245/5 and 8245/6, at Gdynia Shipyard (*Thames Highway* class). The equipment consists of quarter and stern ramps, internal ramps and covers, liftable car decks, and doors. TTS will deliver the design and parts, and supervise the

installation. Equipment is scheduled for supply by June and August 2007, with the vessels expected to be completed for delivery to the owner in 2007-2008.

The second order involves the supply of equipment for six vessels, hull numbers 8168/21-26, at the same shipyard. The equipment consists of quarter and side ramps, internal ramps and covers, liftable car decks, doors, and hatch covers. TTS will deliver the design and parts, and supervise the installation. Equipment is scheduled for supply between August 2007 and October 2008, with the vessels expected to be completed for delivery to the owner during 2008-2009.

All the equipment is designed to adhere to the rules of Det Norske Veritas, and will also comply with all of the relevant safety conventions for such vessels.

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E-mail: info@tts-se.se

Automation and navigation packages for Hanjin Philippines ships

A contract to supply advanced integrated automation and navigation systems for six new-design 4300TEU container ships has been secured by German company SAM Electronics GmbH. The ships have been ordered by the French operator CMA CGM from Hanjin Heavy Industries & Construction and will be built at this company's new yard at Subic Bay in the Philippines (*The Naval Architect* October 2006, page 32).

Each package will comprise MCS2200 modular monitoring and control assemblies for integrated management of all main ship machinery, in addition to extensive alarm functions, also sections for reefer container monitoring (using AMS RMS 2200 equipment). Intelligent outstations will act as fully independent processors linked by a common network for continuous exchange of data. In addition, all six vessels will have NACOS Series 5 integrated navigation command systems, featuring radar-based steering and track control, Ecdis, and other sensors, including those for automatic identification and voyage data recording.

Contact: SAM Electronics GmbH, Behringstrasse 120, 22763 Hamburg, Germany.
Tel: +49 40 8825 0.
Fax: +49 40 8825 4000.
www.sam-electronics.de

LED technology for new emergency lights

A new emergency wall or bulkhead-mounted luminaire, the Nexled, has been launched by UK lighting specialist Chalmit Lighting. Specially engineered for extreme environments, these units are claimed to provide instantaneous bright white light, to use low volumes of power, and not to be affected by temperature extremes. They offer safe alternatives to traditional fluorescent and HID emergency lights; the output of light-emitting diodes (LEDs) is claimed actually to increase under low temperatures, whereas fluorescent types are said to diminish their brightness.

The new luminaires are enclosed in die-cast, corrosion-resistant, marine-grade aluminium units with toughened glass covers, silicone rubber gaskets, and stainless steel fittings. These are designed in accordance with requirements for ATEX Category 2 and Zone 1 and 21 areas; they are also certified by independent laboratories for use in environments where explosive gasses may be present intermittently. Lifespans of approximately 50,000 hours are claimed.

Nexled lights come in two models: 1W with two lamps or 1W with eight lamps. Both can be fitted with battery packs for emergency lighting, providing 3h and 90min illumination respectively. If required, a directional decal kit can be fitted to sign the way to emergency exits.

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www.chalmit.com

Software for hydrostatic analysis of floating structures during their design

Last year, Patrick Couser wrote a series of articles for *The Naval Architect* (April, May, and July/August editions) to try and help ship designers select a suitable software package for hull definition. Now, he has compiled a new review of software to aid analysis of hydrostatics; an introduction appears in this issue. Detailed reviews will follow in future editions.

AS a follow-up to the series of articles which appeared in *The Naval Architect* during 2006, which examined ship design and fairing software, this article considers some of the hydrostatic analysis software available to naval architects. Again, there is a very wide range, some is primarily aimed at hydrostatic analysis during vessel design and other systems for use onboard during service. In this article, we will consider only software for use during design. Also, since the vast majority of naval architects use personal computers with Microsoft Windows operating systems, we shall only look at software that will run on those platforms.

The following software has been included in this review:

GHS	Creative Systems Inc
HST	Wolfson Unit for Marine Technology & Industrial Aerodynamics (WUMTIA)
Hydromax	Formation Design Systems Pty Ltd
Hyss	M Huss Naval Architect
PIAS	SARC BV (Scheepsbouwkundig Advies en Reken Centrum)
RhinoMarine	Proteus Engineering.

This is by no means an exhaustive list but does cover the range of available software: from systems such as RhinoMarine, which is fully integrated into the hull modelling software, to extremely capable, dedicated stand-alone, hydrostatic analysis products such GHS and PIAS, which include probabilistic damage analysis. This broad spectrum gives an idea of the software available to suit a range of users: from the enthusiast naval architect through to medium-sized shipyards and design consultancies employing an entire design office. It should be noted that the majority of software can be tailored to specific requirements and budget by careful choice of modules and/or version (see accompanying pricing table).

A reasonably high-end computer from mid-2004 was used for the review (Asus P4CG800-E; Intel Pentium 4 with Hyper-threading running at 3.0GHz; 2 GByte DDR SDRAM, dual-channel RAM; 160 GByte SATA hard-disk drive; nVidia GeForce FX 5700 video card with dual 17in LCD screens at 1280 x 1024; Microsoft XP Professional). This system was sufficiently powerful to run all the software tested without difficulty.

Pricing structure

The prices for various modules/versions of the software reviewed are given in Table 1. In some cases these have been converted to Euros from the quoted currency. These prices should be used as a guide only, and it is always worth obtaining a quotation for your precise requirements, especially when purchasing multiple licences, since these are often offered at a significant discount. Depending on the country of origin (given in brackets) and country of purchase, VAT may or may not be payable.

Program	Available from	Cost	Notes
GHS	**Creative Systems Inc (USA)**	€6240 (US$8000); additional modules at €721 (US$925) each	Main design package for naval architects. Can be tailored with additional, optional modules
GHS/Salvage			Additional capability for salvage calculations
BHS		€4368 (US$5600)	Budget version with reduced capabilities
HST	**WUMTIA (UK)**	€1554 (£1050) +VAT	Hydrostatics, stability and tank capacities. Free on-going technical support and software updates
HST Loading		€1850 (£1250) +VAT	Additional module for weights and loading, longitudinal strength, maximum KG intact stability criteria, and inclining experiment (requires HST)
HST Damage		€1850 (£1250) +VAT	Additional module for damage stability and floodable lengths (requires HST)
Hydromax	**Formation Design Systems (Australia)**	€4317 (Aus$7915)	Main design package for naval architects. Annual fee approximately 10% for support and software updates (not charged in first year)
Hydromax/S		€1317 (Aus$2195)	Budget version for intact upright hydrostatics and stability (no criteria or tanks)
Hyss Pro	**M Huss Naval Architect (which country?)**	€600 + VAT	Main design package for naval architects
Hyss Intact		€240 + VAT	Intact analysis only
Hyss Basic		€120 + VAT	As for intact but at reduced precision
PIAS	**SARC BV (The Netherlands)**	€60,000 + VAT (should this be 6000???)	Typical 'professional' package. The full PIAS suite consists of around 90 modules and these vary in cost from about €250 to €8210. It would be unusual for a company to purchase all modules. Fee includes installation and training as well as on-going support and updates.
Typical 'entry level' package		€16940 + VAT	This is a typical basic installation.
RhinoMarine (plug-in for Rhino)	**Proteus Engineering (USA)**	Hydrostatics €350; All 4 modules €1685	Four modules available: Hydrostatics, stability and sections; Hull design & fairing; Performance analysis; Model management.
RhinoMarine Student		Hydrostatics: €140; All 4 modules €560	As above, non-commercial student licence
Rhinoceros NURB modeler		€895 – commercial €195 – educational	Rhinoceros is required to run RhinoMarine

Table 1. Summary details and guide prices for the software tested.

Background to hydrostatic analysis software

The underlying principles of hydrostatic analysis are essentially very simple, especially with the advent of modern computers, where analysis can be done from first principles without the need for the approximate methods required for hand calculations. Put simply, the vessel geometry below the waterplane is integrated to obtain areas, volumes, and centres. Iteration of the vessel orientation may be required so that one or more of the following equilibria are met:

1. Displaced volume – vessel mass (force equilibrium, sum of all forces = 0)
2. Centre of gravity – centre of buoyancy (moment equilibrium, sum of all moments = 0)

Analyses of greater complexity can be derived from these simple calculations (for example, grounding, probabilistic damage and calculation of maximum vertical centre of gravity that satisfies specified stability criteria). Of importance are the method in which the vessel is represented digitally and the explicit and implicit assumptions that the representation method makes.

1. At the highest level, the vessel is defined by a complete mathematical model of the hull surface(s). With such a model it is possible to calculate any point on the hull to whatever level of precision is required.

2. The next level is a surface mesh made up of simple geometric facets (typically triangles and possibly planar quadrilaterals). In most cases, the implicit assumption is that the surface is linear between the data points thus, for highly curved areas of the hull, a higher density of facets is required (the actual assumption depends on

the integration method used, but in most cases the integration is linear – some CFD codes use higher-order schemes).

With this type of mesh the full 3D hull is explicitly defined. The surface mesh representation is often directly connected to a surface model (see 1) where the mesh is used as a simplification of the geometry for (hydrostatic) computations. Where the full surface model is available, the surface mesh can be refined to whatever level of precision is required (though the number of facets in the mesh will impact on the speed of the computations).

3. Another common representation is that of planar sections through the hull. Computations on such a representation are typically done in a two-stage process: the first consists of calculating the section properties; the second stage integrates the section properties along the length of the hull to obtain the overall vessel properties. Implicit in the longitudinal integration scheme is an assumption for the longitudinal connectivity of the sections. In some situations (discussed below) it is also necessary to attempt to reconstruct the 3D hull geometry from the section. Although this is relatively easy for a simple monohull vessel, this quickly becomes a non-trivial task as the complexity of the vessel increases. The interested reader is directed to the literature on medical imaging and 3D medical reconstruction for further information on the reconstruction of 3D surface models from 2D section data.

The section method is probably the most commonly used amongst hydrostatic analysis software, though the surface mesh method is also used by some hydrostatic software and also in CFD applications. These two methods are discussed in greater depth below.

Method 1: Sectioning approach

The vessel is divided into a number of (transverse) planar sections. Each section is then intersected with the waterplane and the immersed area calculated by integrating the area of the section below the waterplane. The immersed volume is then calculated by integrating the immersed section areas along the length of the model. The waterplane properties are obtained by appropriate integrals of the waterplane beam at each section.

The sectioning approach has been in use for many years and stems from hand calculations using Simpson's rule. It is effective and fast for the majority of hullforms. Computers allow a significantly larger number of sections to be used compared with hand calculations providing greater accuracy.

In its simplest implementation, there are a number of drawbacks of the sectioning approach. In practice, these can be overcome (to a greater or lesser extent). To do this, the software must first identify that a special case has occurred and then take suitable action. The detection and treatment of these special cases can add significant complexity to the software which is undesirable and can make the software more prone to errors. Some of the most important cases to be considered are described below.

The immersed wetted surface area is typically obtained from integrating the section girths along the length of the vessel. It should be noted that this method is slightly inaccurate due to the longitudinal curvature in the hull. This is true even if an infinite number of sections are used. For example, consider the surface area of a sphere. This is given by $4xxr^2$, where r is the radius of the sphere. It may be shown that the surface area for the same sphere calculated from longitudinal integration of section girths is, in the limit of using an infinite number of sections, given by xx^2r^2. Thus the true area is 4/xx times the area obtained by integrating girths, or about 27% greater.

For most ship forms the error is much less because of the reduced longitudinal curvature. The problem can be overcome, to some extent, by finding the angle between corresponding points on adjacent sections and making a suitable adjustment to the integration length (though detecting the corresponding section points is not always an easy problem to solve).

Another potential problem with the sectioning approach is that it is not possible to determine the exact forward and aft extents of the waterline because they are generally between two sections. This problem is generally insignificant if there are a sufficiently large number of sections defining the hulls and there are no longitudinal discontinuities in the hull shape – or if these discontinuities are identified in some manner (this is often done by placing two sections at the discontinuity). Alternatively, the problem can be overcome by interpolating new sections between the defined sections. However, there is an implicit assumption of the vessel shape between the defined sections, which is dependent on the interpolation algorithm used.

Potentially, the sectioning method can also have problems if the vessel trim angle is very high (90deg) where the sections become parallel to the waterplane (in practice, depending on the section spacing, this trim limit is quite high, around 70deg to 80deg for many vessels). Again, the problem can be overcome by interpolation of the vessel geometry between the section immediately above and below the waterline.

Sectioning methods normally use linear (trapezoidal) or parabolic (Simpson's-type) integration schemes. Often, it is preferable to use the trapezoidal integration because discontinuities are much more easily taken into account. Parabolic integration is only useful if there are few sections defining the hull and the vessel hull is smooth everywhere.

By using a large number of sections, trapezoidal integration can easily be sufficiently accurate without any special care required to model discontinuities (for example, chines or longitudinal steps). The problems of non-linear integration and discontinuities can be solved by detecting the discontinuities and only performing non-linear integration on the slope-continuous portions of the vessel between the discontinuities.

It should be noted that not all section-based hydrostatic software apply the refinements, and corrections described above and may suffer from these problems.

Method 2: Direct surface integration

This method works on the principle of direct integration of the surface hydrostatic pressures to calculate the immersed volume. Because a full surface model is used, the wetted surface area is calculated directly and it is also easy to find the exact waterplane. In practice, a numerical integration scheme is used whereby the surface is divided into triangles (and possibly planar quadrilaterals) and a numerical integration over this mesh is performed. Calculation accuracy depends on the mesh refinement (number of triangles and quadrilaterals used) – especially in areas of high surface curvature. The triangulation of the surface gives a linear integration scheme; although higher order methods have sometimes been used in CFD codes, they are uncommon.

The key advantage of the direct surface integration approach is that the special cases, noted above, for the sectioning method, do not occur. Hence, no special treatment of these situations is required, leading to less complexity in the algorithms. Thus, complicated geometries are often handled more easily (provided that the outside envelope can be found and that it contains no holes – see below); and that the hydrostatic properties are accurate at any vessel orientation (eg, trim of 90deg).

Sectioning versus direct surface integration

To summarise, the sectioning method works well for a wide variety of hull forms, including multihulls, but can have problems with some structures or some analyses, for example semisubmersible platforms. The direct surface integration approach can work well for more complex models and works equally well at any trim angle (even 90deg). These limitations of the sectioning method can be overcome but this adds significant complexity to the software and implicit assumptions regarding the longitudinal connectivity of the sections.

The section method can be very useful when modelling an existing vessel for which no surface model is available. Sections from the body plan can be digitised and input directly into the hydrostatic analysis software. Where the direct surface integration method is used, a surface model would first have to be generated to fit the section data before the vessel could be analysed (this is a difficult task for all but the simplest hull forms, especially if a NURB surface model is required).

One key issue for both methods is that the vessel must be unambiguously defined and correctly interpreted by the software. This generally means that the watertight envelope must be uniquely defined. For software that uses the sectioning method, this means that transverse sections through the hull must be made up of a number of non-intersecting, closed contours (openings may be allowed but in most cases these are automatically closed by the algorithm, normally with a straight line.)

If the contours are open or intersecting, it is difficult - if not impossible - to intersect with the waterplane and calculate the immersed part of the section that should be integrated. For the surface integration method, there should be no holes in the model and the integration should be done only on the outside perimeter of the model (which should be closed when intersected with the waterplane).

In practice, when using direct surface integration, small gaps between surfaces can be ignored without too large an impact on the

accuracy of the hydrostatics. Gaps will generally cause fewer problems with a surface-based integration method (they can be simply ignored) than with a sectioning method (where the gaps need to be reconnected in a meaningful manner). However, it is normally easier to identify if and where these modelling errors occur for the sectioning method since, by inspection of each section in turn, it is relatively easy to verify that the contours are closed and non-intersecting.

It can be much harder to detect holes in the surface model or parts of surfaces inside the vessel perimeter that should not be included in the integration. This can become even more difficult when sections and surfaces are offset to account for shell thickness.

There are many subtle differences between the different methods of model representation and integration. In some cases, one method will prove to be more accurate than another; but then in another situation it may be less accurate. However in most cases, with sufficiently detailed models, the differences are of the order of less than 1% and, in many instances, are likely to be less than the convergence tolerances for the hydrostatic equilibrium conditions to be met. So discussing these subtle differences and trying to say that one method is better than another method is somewhat moot.

Having said that, there are certain advantages in being able to model a hull accurately, but with a small amount of data: it will significantly reduce the analysis time, this can be very important for complex analyses such as probabilistic damage that can take many hours to run. It has been reported that using a Simpson's-based method, accurate results can be achieved with only 40 to 50 sections; to achieve the same level of accuracy from surface integration, several thousand triangles may be required.

So one method is not significantly better than another and for simple vessels, there will probably be only very small differences in the calculated hydrostatics. What is important is that the user understands the limitations and assumptions of a particular method and its specific implementation in the hydrostatic analysis software that is being used. This becomes of increasing importance as the complexity of the hull geometry and vessel compartmentation increases.

How to choose the right software

This review can only be a starting point. Each user's needs will be unique, so individuals will have to evaluate the software themselves, too. Here are a few points to consider when you are doing this.

Definition of requirements

Define your requirements and base your decision on this, rather than simply counting up the bullet points on vendors' 'feature lists' and choosing the software with the most features. Equally, it is not worth spending more on a system that has probabilistic damage or grain heeling analysis, if you are only working with small fishing boats. If you have a specific type of analysis that the software must be able to perform, which does not appear on the feature list, there may be 'workarounds' so ask vendors if you are unsure. Workarounds are often possible when the software can be customised or programmed using macros.

Table 2. Principal features of the 'full' versions of each programme. Continued overleaf.

Geometry and data input	GHS	HST	Hydromax	Hyss	PIAS	RhinoMarine
Primary	section data	section data: manual or digitiser	Maxsurf NURB surface model	3D model defined by longitudinal curves	section data: manual or digitiser	Rhino surface model
Alternatives	section data in number of formats, including SHCP, DXF, and IMSA	section data in number of formats, including GHS, DXF, and IMS	none	section data	Fairway surface model or import of section data	NURB surface model
Load conditions	✓	✓	✓	✓	✓	
Damage conditions	✓	✓	✓		✓	
Tanks	✓	✓	✓	✓	✓	
Sounding pipes	✓	✓	✓		✓	
Compartments	✓	✓	✓		✓	
Flooded areas	✓	✓	✓		✓	
Margin line definition	✓	✓	✓	✓	✓	
Deck edge definition	✓		✓		✓	
Critical points	✓	✓	✓	✓	✓	✓
Model representation	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
Section based	✓	✓	✓	✓	✓	
Surface based					✓ Fairway model	✓
Integration method	linear	linear or parabolic	linear	sections: linear; longitudinal: partial polynomial	parabolic	surface integration using triangular and planar quad elements

The software industry so-called 'MoSCoW' method of requirements specification can be useful. This defines requirements as:

'must have features'; software without these is of no use
'should have features'; the software should contain these features, but if absolutely necessary they can be omitted
'could have features', but not necessary
'would be nice to have' features but can easily live without them.

Some requirements to consider are listed below:

- data input method – eg, sections, digitising, or surface model
- analysis modes:
  - upright hydrostatics
  - stability/GZ
  - maximum VCG
  - floodable length
- stability criteria evaluation
- probabilistic damage
- other features: including inclining experiment analysis, longitudinal strength, grounding, docking, and launching
- report generation: stability book
- integration: Microsoft Office (or other software) Images, data, graphs
- customisability: including stability criteria for local authorities, report templates, and reporting language
- customisability: macros, interaction with other software eg, VBA (visual basic for applications)
- cost – consider also cost of technical support and software updates over the expected life of the software
- quality of technical support, user documentation, demonstration material and samples.

Shortlist

Create a shortlist of the software that fulfils your requirements and investigate further. It may seem obvious, but all software that has all the 'must have' features should be on the shortlist. Any software that does not have these features should not! If this is not the case, then you may need to review your 'must have' requirements.

Examine your common tasks and determine the software that will lead to the greatest productivity gains. Some particular areas to consider are:

1. Hullform definition and data entry. Fast, accurate entry of hull and tank/compartment geometry is essential, and factors such as the format of the original hull data may affect the ease of data entry and model definition:

tables of offsets
physical lines plans
digital lines plans
surface model (digital)
point clouds from laser scanners/digitiser or photogrammetry.

2. Other model and condition data.

tanks and compartments
tanks with complex boundaries

non-flooded areas within flooded compartments – eg, tank in engineroom
permanently flooded areas such as jet ducts, thrusters, and moon-pools
load conditions
damage conditions
margin line, deck edge
key points (such as down-flooding or embarkation)

3. Analysis capabilities

stability book production (probably the most common task for many naval architects)
inclining experiment analysis
docking, launching
emergency response; salvage operations (such as damage stability, or grounding)
'what if …' user-defined analyses using macros, eg, as part of a hullform optimisation system.

4. Consider level of integration with other commonly used software eg, Microsoft Office and AutoCAD.

5. Automation; scripting interface eg, COM for automation of repetitive tasks and custom analysis.

Automation

Because hydrostatic analysis often requires repetitive tasks, or analysis of a large number of conditions (for example, in the preparation of a stability book), it is worth reviewing some of the technologies available to automate these procedures and define custom analyses. There are two methods for this: the first is scripting from within the hydrostatic analysis program; the second is scripting from an external program (such as a VBA macro in Microsoft Excel or Microsoft Word).

Scripting from within the program may result in faster analysis, because there is no data transfer between applications (which can be slow). However, scripting from an external program such as Microsoft Excel or Microsoft Word can be more versatile, since the results data obtained from the hydrostatic analysis can then be processed for presentation or more complex analyses.

A technology which is gaining popularity for providing external access to software is Microsoft's COM interface (Component Object Model). COM-enabled software can be accessed from most common programming languages (such as VBA, C++, and C#). Thus, if a hydrostatic analysis program has a COM interface, a VBA macro in Microsoft Excel or Microsoft Word can be written to perform an analysis and then extract, process, and format the results as required.

Related to scripting is the ability to define custom templates for results presentation. This capability will help to produce standard reports (such as stability books) more efficiently.

Analysis modes	GHS	HST	Hydromax	Hyss	PIAS	RhinoMarine
Upright hydrostatics, form coefficients	✓	✓	✓	✓	✓	✓
Cross-curves	✓	✓	✓	✓	✓	
Floodable length	✓	✓	✓		✓	
Equilibrium	✓	✓	✓	✓	✓	✓
GZ curve	✓	✓	✓	✓	✓	✓
Limiting VCG	✓	✓	✓	✓	✓	
Launching	✓				✓	
Docking	✓					
Tank calibration	✓	✓	✓	✓	✓	
Longitudinal strength	including torsion	✓	✓	✓	including torsion	
Inclining experiment	✓	✓			✓	
Bonjean		✓			✓	✓
Tonnage	✓				✓	
Loadline freeboard					✓	
Heel about arbitrary axis	✓				✓	
Heel about minimum stability axis	✓					
Stability of hopper dredges (incl. spilling of cargo)	✓				✓	
Criteria evaluation	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
Common sets eg, IMO and others	✓	✓	✓	✓	✓	
Customisable user sets	✓	✓	✓	✓	✓	
Different sets for intact and damage conditions		✓	✓		✓	
Grain heeling	✓	✓			✓	
Water on deck	✓				✓	
Arbitrary heeling arm		✓	✓			
Freeboard	✓	✓	✓		✓	
Damage	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
Lost buoyancy	✓	✓	✓	✓	✓	
Stages of flooding using added mass	✓	✓	workaround possible by partially filling tanks	workaround possible by partially filling tanks	✓	
Progressive flooding through openings	✓				✓	
Sealed and vented tanks	✓					
Probabilistic damage	✓				✓	
HARDER/SOLAS 2009 (harmonised probabilistic)	✓				✓	
Analysis options	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
Free surface	✓	std	std. and IMO	std	✓	
Fluid shift	✓	damage only	✓	✓	✓	
Spilling from tanks					✓	
Grounding	multiple points incl. heel		1 or 2 points, zero heel		single point incl. heel	
Wave form	sinusoidal, trochoidal, or stokes, any direction	longitudinal only	sinusoidal or trochoidal; longitudinal only		sinusoidal or trochoidal; longitudinal only	
Multiple body interaction	✓					
Crane simulation	✓				✓	
Output	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
Report	✓	html	rtf	via MS Excel	printer, rtf	html
Tabulated results	✓	html	interactive window	via MS Excel	rtf	via MS Excel and html
Data selection			✓		✓	via MS Excel
Table orientation			✓			via MS Excel
Graphed results	✓	static	interactive window	via MS Excel	✓	via MS Excel
Language options	✓	user defined	English	user defined	English, German, Dutch, French	English
Report templates	user defined			user defined in MS Excel		
Vessel visualisation	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
Line drawings	✓	hidden line removal	✓	wireframe and std 3-view linesplan	✓	shaded, ghosted, wire-frame, hidden line removal
Container plan					✓	
Tank top plan	✓				✓	
3D Rendered view			✓		Fairway model required	✓
View updated during analysis			✓		✓	
Final vessel orientation	✓		✓		✓	✓
Programming	**GHS**	**HST**	**Hydromax**	**Hyss**	**PIAS**	**RhinoMarine**
COM interface	✓		✓			
Scripting	✓					✓

Reliability

Is the software stable? Does it crash? The software tested by the author was found to be stable, with no significant problems encountered. It is also important that the software is well-supported by the vendor. In all cases, the technical support for the software tested was responsive and helpful.

Although vendors often cite classification society and/or marine authority approval, in many cases these bodies only approve software that is used onboard vessels (and often the requirement is that the software reproduces the stability book data). In most cases, design software (used in the drawing office) is not normally given approval. Of course, there are some exceptions to these

generalisations. It is also worth remembering the nature of software – a small change can have a huge impact. Thus, to be valid, the approval should really be done for every new version of the software.

Feature summary

Table 2 shows the principle features in the 'full' versions of each program. In many cases, these features are only included when additional modules are purchased.

Glossary

avi A file format that is used to save video.

CFD Computational Fluid Dynamics.

COM Component Object Model: a technology that allows COM-enabled applications to be accessed from other applications such as VBA macros in Microsoft Excel, C++, JAVA and C#.

CPU Central Processing Unit: the heart of a computer, where all the number crunching takes place.

dual-core Some of the latest CPU chips effectively have processors on them. Software which can use both cores simultaneously can potentially run twice as fast.

FAQ Frequently Asked Questions: typically, a web-based list of commonly occurring questions and their answers.

HSC IMO High-Speed Craft (code).

html Hypertext mark-up language: A file format compatible with web browsers and compatible with most word processors and spreadsheets, including Microsoft Word and Microsoft Excel.

hyper-threading Most modern CPUs (less than two-three years old) are hyper threading. This provides two virtual CPUs on one physical chip. This can enhance multi-tasking or allow software that can run in multiple threads to execute up to twice as fast as software running in a single thread.

IS IMO Intact Stability (code)

NURB Non-Uniform Rational B Spline: a numerical representation of splines and surfaces.

rtf Rich Text Format: a file format compatible with most word processors and spreadsheets, including Microsoft Word and Microsoft Excel.

tree-control A user interface control, such as Windows Explorer, which allows items to be grouped in folders and sub folders.

VBA Visual Basic for Applications: an easy-to-use programming language often used for macros in Microsoft Word and Microsoft Excel.

Fluent Version 2 for CATIA V5

IN December, Version 2 of its Fluent software suite was launched by Fluent, a wholly owned subsidiary of Ansys, for use with Dassault Systèmes' CATIA V5 package. This new simulation-driven software extends the range of fluid flow simulations that can be accomplished within the V5 PLM environment and includes enhanced automation for rapid performance-based evaluation of design alternatives.

The new version continues the strong focus on full product lifecycle management (PLM) integration and aims to provide V5 PLM users with fully generative bi-directional 'associativity' between 3-D modelling and analysis. Enhancements in the new release provide further automation, efficiency, and alignment with the V5 analysis process.

Model building options have been extended to include Dassault Systèmes' hexahedral meshing tools and the ability to convert to polyhedral meshes within the Fluent solver. All meshing options can be used alone or combined within the same model, improving efficiency of the overall simulation and yielding faster turnaround for many important design analyses.

The Version 2 release also includes a significantly expanded set of capabilities for handling complex flow scenarios. Fluid flows that involve time variation, rotating equipment, compressibility, and mixed convection thermal modes can now be considered. These new capabilities are critical for addressing important applications such as pumps, fans, blowers, full HVAC systems, electronics cooling, engine system components, thermal transients, and many more. Finally, support for full 64-bit memory addressing under Microsoft Windows XP 64 has been added, enabling simulation of larger models.

Friendship-Framework – integrating ship-design modelling, simulation, and optimisation

Most ship design teams have used CAD tools for many years and quite a few have already gained good experience with computational fluid dynamics (CFD) to guide them in their design effort. Often however, CAD and CFD display a friendly co-existence instead of sharing a life of true symbiosis. The German consultancy Friendship Systems, specialising in hydrodynamic optimisation of functional surfaces (*The Naval Architect* April 2006, page 48), has now released its new environment for the integration of modelling, analysis, assessment, optimisation, and constraint management. This system, named Friendship-Framework, was presented in September at the SMM exhibition, in Hamburg. Friendship Systems' Claus Abt and Stefan Harries summarise the concepts and merits.

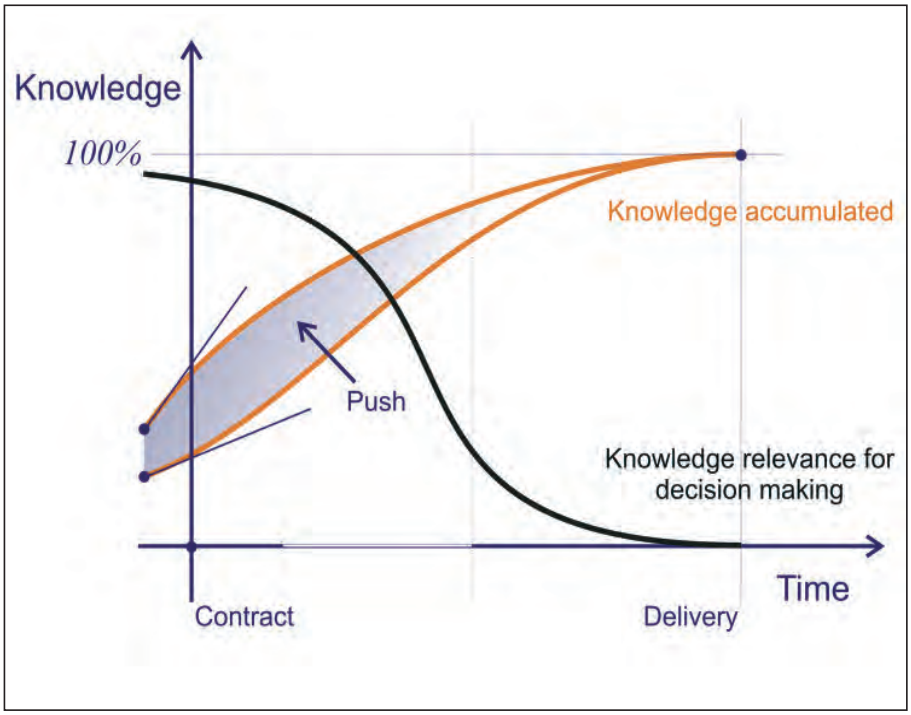

Fig 1. Knowledge accumulation and relevance for decision-making.

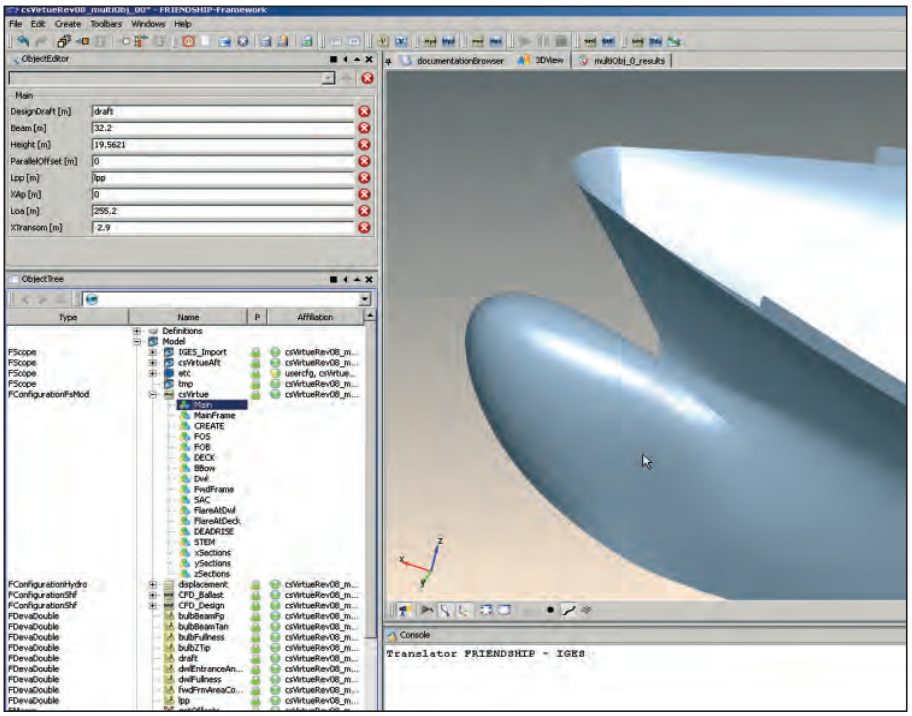

Fig 2. Close-up of imported geometry along with object tree and object editor.

WHILE the time-to-market constantly decreases, new ships must out-perform both predecessors and competitors. In order to meet rising expectations and to diminish the risk associated with newbuilds, particularly novel designs, the development of hull forms today often comprises extensive numerical studies, in addition to comprehensive towing tank testing. Naturally, any experimental work requires considerable time and financial resources. Therefore, many design teams have started to fine-tune their shapes prior to any test campaign, thus reducing lead time and budget. However, integrating disparate software for CAD and CFD still constitutes a major bottleneck in the process.

Many teams dispose of one commercial or in-house hull definition package and one or more commercial or custom-made simulation programs. Often, data transfer between various tools is difficult and requires additional manual work. Frequently, tools are so complicated to run – often due to the complexity of the actual problem but sometimes also due to cryptic syntax and file handling – that several specialists are called for to close a single design loop fully.

Each new design variant then takes several days to consider instead of hours or just minutes to model and analyse. Furthermore, ship design is typically governed by numerous constraints that all need to be observed. Evaluating a complex constraint might take tangible effort (for instance, simulating the hydrodynamics for an off-design point) but also constraints that entail less computational burden (such as hard points that must not lie outside the final shape) are difficult to oversee if there are many.

Based on a thorough assessment of this situation and building on the experience gained from many optimisation studies, see [1, 2, 3, 4], Friendship Systems has developed a new software product for the integration of modelling, simulation and optimisation. The software was called Friendship-Framework – a framework being a computer-aided engineering (CAE) system that offers the flexible integration of tools available in the individual design environment. It enables naval architects to undertake CFD calculations, systematic form variations and automated optimisations without any need for scripting or programming.

The ultimate goal of the Friendship-Framework is to facilitate advanced hydrodynamic design, thus pushing the knowledge gained during the early design stages up until the lines' freeze as illustrated in Fig 1; for details see Ref 4. This will help all parties involved (shipyards, consultants, model basins etc.) and all members

of a team who contribute to the success of the design (such as managers, naval architects, CAD specialists, and CFD experts) to develop a better insight at a time when the freedom for decision-making is still appreciable and the impact on performance and costs is highest.

Key features

Unique features of the new Friendship-Framework are:

- the efficient variation of hull forms via partially parametric modelling capabilities on data being imported from offsets, panel meshes and IGES (Initial Graphic Exchange) files (Fig 2).
- the facilitated plug-in of CFD tools for typical design assessments such as non linear potential flow codes for wave resistance simulation and non-viscous codes for seakeeping calculations (Figs 3 and 4).
- the incorporated post-processing, comparison and reporting of project data in tables, figures and flow visualisations (Figs 4 and 5).

Furthermore, the system was developed to:

- provide fully parametric modelling techniques for the design of functional surfaces
- support the design team in setting up and monitoring complex hydrodynamic design tasks including constraint management
- allow the direct application of sophisticated design engines such as a Design-of Experiment, deterministic search strategies and genetic algorithms.
- permit the coexistence of both manual and automatically driven variants
- encapsulate simulation tools to avoid erroneous application due to infrequent usage or complicated handling
- circumvent the need for scripting or programming
- assist the tailor-made extensions for the specific needs of different working environments.

Application example

In order to illustrate some of the system's functionality, a reduced yet representative example was worked out: investigate the calm-water hydrodynamics of a container carrier for two trim-draught situations (here design and ballast draught) at their respective target speeds. The CFD code of choice for this example was the widely used SHIPFLOW code by Flowtech.

Fig 2 shows the close-up of a container carrier's forebody as imported via an IGES file. The object tree can be seen in the lower left window, displaying the parameters of the chosen forebody model, along with several of the design variables defined by the users for their investigation. Fig 3 depicts results from a multi-objective design engine (here NSGA II) which can be readily monitored at run time. The table summarises essential information on objectives, constraints, free variables and further data as compiled by the designer. Constraints, for instance, are presented according to their current state to allow a quick overview of critical situations. (Note that a typical design problem utilises some 10 to 30 free variables and sometimes up to 20 constraints. For clarity the simplified example features just three design variables and one inequality constraint, namely initial stability at design draft which can be found in the right-most column of the result table.)

Figs 4 and 5 present snap-shots of the browser capabilities which can be utilised for competent decision-making on the basis of the all variants produced either manually or automatically. Results from any computation instance can be displayed in configurable windows either on their own or together with any other design, eg, the baseline or a favourite variant. In Fig 4, the top view of wave patterns for two variants are shown at design draught (upper window) and ballast draught (lower window), respectively.

In both visualisation windows, the upper wave patterns stem from the baseline while the lower wave patterns are associated to the current favourite design. The reduction of the free wave systems can be nicely seen. Fig 5 displays the pressure distribution on two selected hull forms at either draught. In each visualisation window the baseline is found on the right side. For concurrent examination of details, the scenes of various windows can be connected to the same interactive view to allow the simultaneous rotation and close-up for different design variants.

More information on the Friendship-Framework along with an elaborated example for SWATH vessels can be found in Ref 5. It comprises wave resistance analysis on the basis of Nu-Shallo by HSVA and seakeeping calculations with SEDOS by MTG. Further interfaces to other flow codes are available, under development or can be supplied on request.

Conclusion

The Friendship-Framework is a new CAE system for integrating modelling, simulation and optimisation in ship design. It facilitates the work flow at shipyards, design consultancies, model basins and research institutes at the crucial stage of hull form development. It offers integrated constraint management and supports the consistent and systematic generation and assessment of form variants.

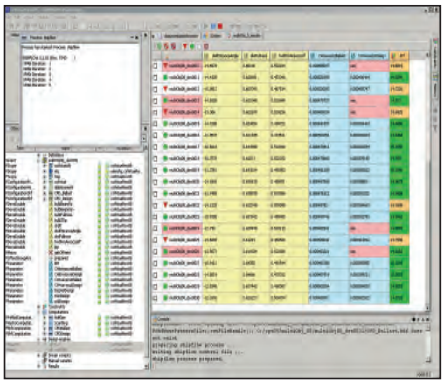

Fig 3. Monitoring of variants and design progress.

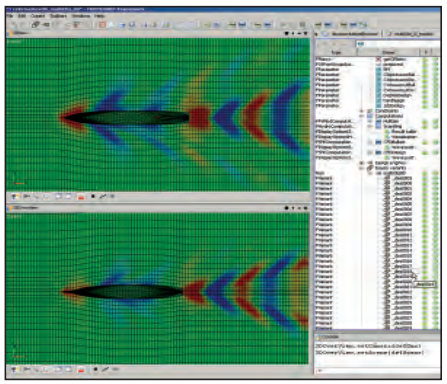

Fig 4. Comparison of selected design variants generated by a multi-objective design engine.

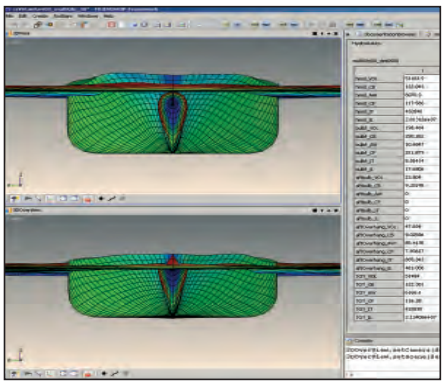

Fig 5. Detailed assessment of selected variants at different operating conditions along with comparison to baseline performance.

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The references below are made available for download at www.friendship-systems.com.

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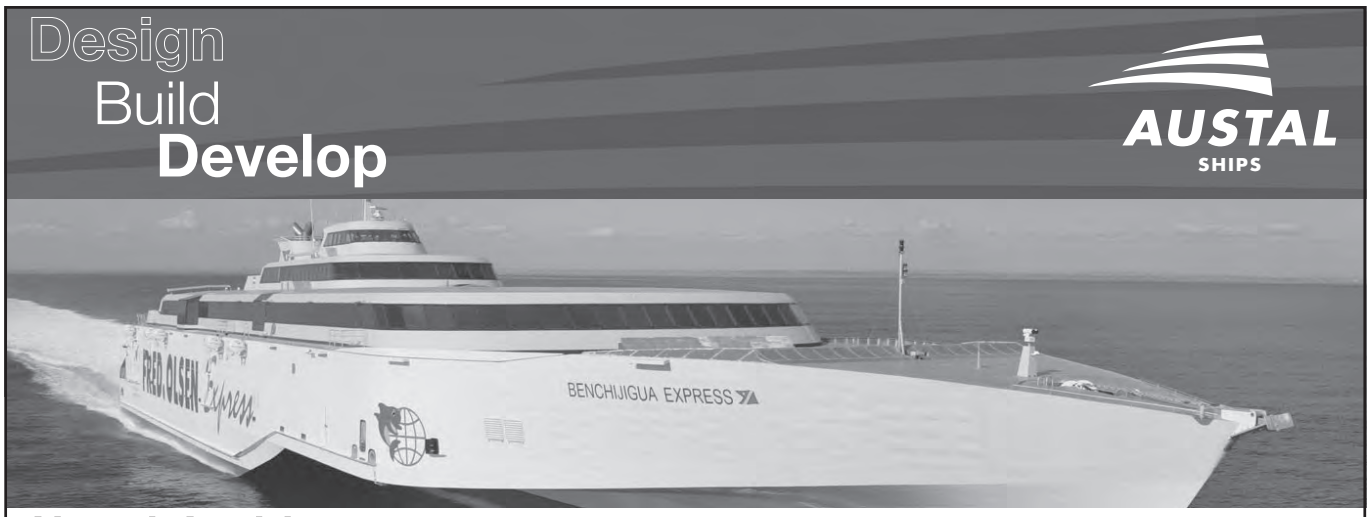

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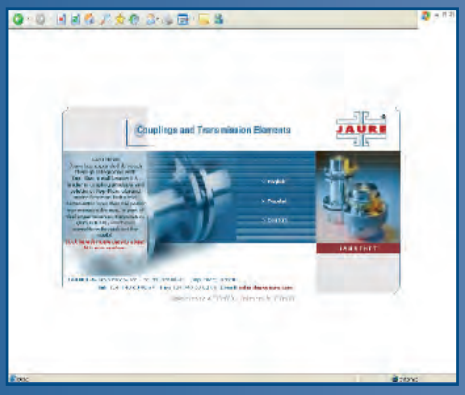

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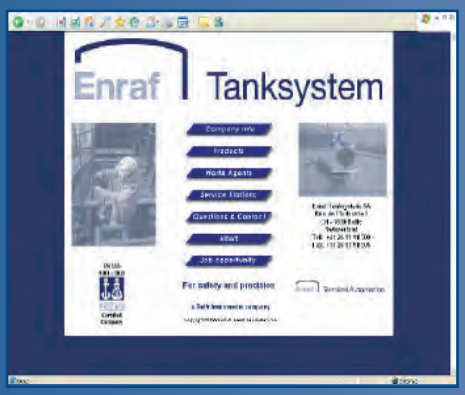

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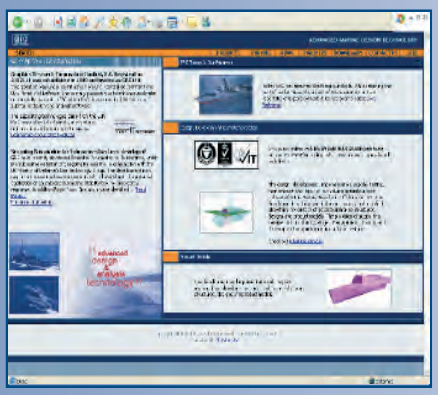

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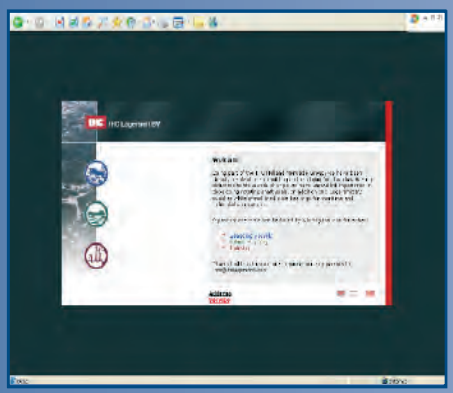

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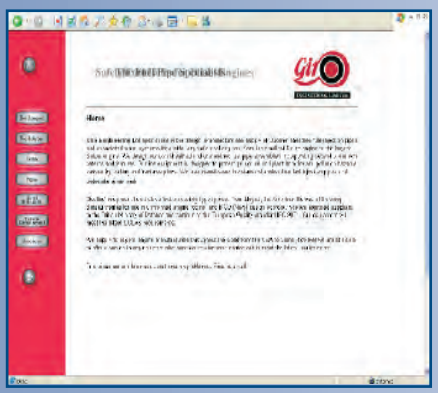

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