

THE NAVAL ARCHITECT



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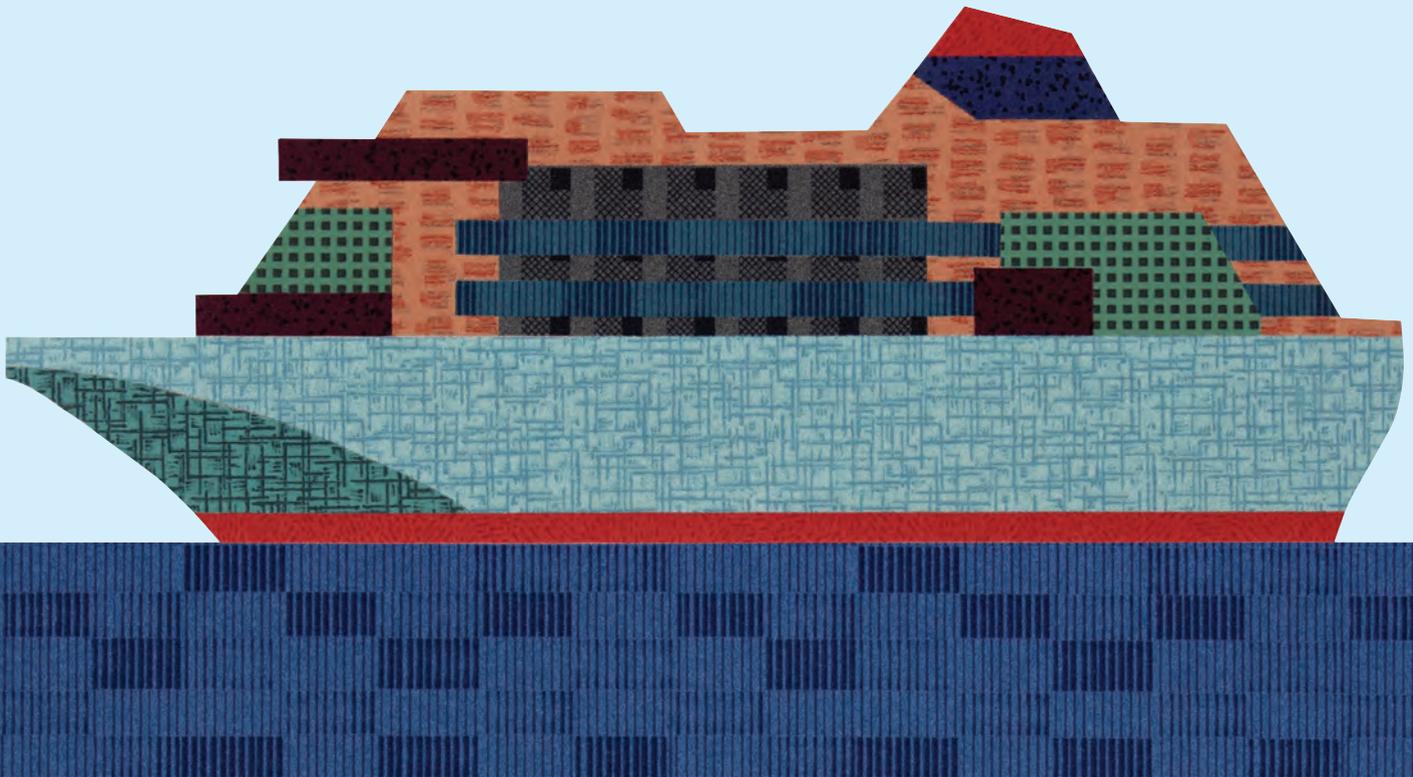
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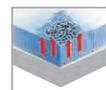
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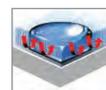
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THE NAVAL ARCHITECT



As China's shipbuilding industry expands at a tremendous rate, ever-more complex ships are being ordered there. This 16,000gt ro-pax ferry, newly delivered by Jiangnan Shipyard to China Shipping, although for a domestic owner, is indicative of tonnage under construction there today. The new ferry will mark a major improvement to services across the Bohai Strait (Yantai to Dalian); a new pair of train ferries for this route is also being built at Tianjin Xingang Shipyard. More details of this country's activities appear in our special feature on China, which begins on page 14.

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Human interface - still an essential element

METICULOUS naval architect preservers of loose leaflets inside journals and magazines will have found the editions of *Alert!*, The Nautical Institute's human element bulletin sponsored by Lloyd's Register (now being included four times a year with this journal) to be of great interest. This bulletin highlights once again the continuing difficulties of introducing humans into the day-to-day life of the design, building, and operation of a ship.

In previous columns on this page, we have emphasised the everlasting need to maintain dialogue between naval architect, shipbuilders, and owners, and the importance (sadly more or less non-functional, at least in the UK) of sending all naval architects to sea as part of their professional development. Recognising today's demands and pressures, this practice should be for a period long enough for them to gain a good appreciation of the product of their work, ie, the ship, in its true environment. Ideally, this should also be when the ship is being operated commercially, rather than on sea trials.

The problems of the human element in marine affairs have been discussed on two occasions at international conferences run by The Royal Institution of Naval Architects, most recently in February 2005, but clearly they are still a deep issue. In the July/August issue of *Alert!*, a writer refers once again to 'those irritating design errors, some of which may not be readily identified until sea trials, but which could so easily be rectified before commissioning....' According to that writer, much of this stems from the now largely and sadly abandoned but well-established and excellent practice of having senior crew standing by a new ship during construction.

Amazingly, the same writer even claims that 'a substantial discount is offered (by shipbuilders) to purchasers who surrender this right'. Yes, it is true that many ships - particularly more or less standard workhorses - are being turned out in large series at ever higher speeds. It is probably also true that in the mammoth Far East yards of Korea, Japan, and China, delays to a schedule by owner's sea staff requesting alterations (for what ever reason, but hopefully only

because of errors by the yard or subcontractors) will be seen as a major irritant, where production schedules are timed to the last day and perhaps even to the hour.

Furthermore, it must also be a regrettable fact of life today that many ships are often designed and overseen by remote agencies on behalf of an owner far away. Nevertheless, the fact that an owner can actually agree to such a surrender to examine his own ship seems incredible.

Unfortunately, much of this boils down to the disappearance - in many parts of our industry - of the traditional shipowner with his large permanent technical staff, and in its place the subcontracting of vital projects and tasks to management companies or to a shipyard. At a time when many increasingly complex ships are being built in the Far East at yards - as noted in our China report in this issue - whose names have never before appeared on the international scene, the need for a firm grasp on technical matters from the owner's side must, this journal believes, be imperative. An active owner's representative - ideally from the owning company itself - on the steelwork production line, in the paint shop and pipe shop, and at the outfitting quay must be an essential of today and tomorrow's shipbuilding scenario.

At least one company seems to be enlightened in this field - Captain Bill Harvey, from Graig Shipping, reports in *Alert!* that he successfully petitioned for a deck cadet to help him during a recent commissioning in Shanghai. At the same time, he notes, on the same theme as above, that even yards building for his prestigious company do not always appreciate the interference of sea-going staff during a newbuilding construction project! What a pity that some sea-going staff did not interfere more strongly on the case of the small engineroom starter panels discussed in an adjacent article!

The June 2005 edition of The Nautical Institute's journal *Seaways* throws a further spotlight onto the human dimension (mainly relating to bridge equipment). In a long article, Margareta Lützhof reports on the difficult relationship between navigating staff and modern wheelhouse equipment. She concludes, after extensive research, that more work still needs to be done to inform designers and manufacturers about seamen's needs. Clearly, we are not out of the maze yet. 

This impressive console, with mimic displays, is on the new icebreaker/offshore support ship *Fesco Sakhalin* (featured in *The Naval Architect* July/August 2005). Installed in the wheelhouse for controlling the Rolls-Royce Marine bulk cargo system, it is typical of modern marine consoles, but it would be interesting to report on the crew's experience with it.



Two important ferry contracts for Aker Yards

GOOD news for Aker Yards is the signing in August of two new contracts. The first, worth €111 million, is for yet another ferry for the expanding Estonian Tallink group, which includes an option for a sister. This passenger/vehicle type will be of a new and innovative design, able to carry 1900 passengers, with 2000m of ro-ro space, on services between Helsinki and Tallinn. A very fast service speed of 27knots is envisaged, which will allow the ferry to complete a trip in 1h 50min. The new ship will be built at the covered Helsinki site for delivery in Spring 2007. Aker's Rauma yard is currently building a third cruise-ferry for Tallink, which will be delivered in Spring 2006.

Aker's second new contract involves a ro-pax ferry for the French operator Brittany Ferries, worth €80 million (£55 million). Again, this contract - which is subject to final financing confirmation - includes an option for a sister vessel. This ship will also be assembled at Helsinki although sections will be fabricated at Rauma. Up to 120 lorries on 2200m of ro-ro space will be able to be carried on routes between the UK, Cherbourg, in France, and Santander, in Spain, at a service speed of 23knots. A total of 120 cabins will be installed for passengers. The hull will have a length of 165m and a breadth of 26.80m.

ASBESTOS PROBLEMS IN JAPAN -

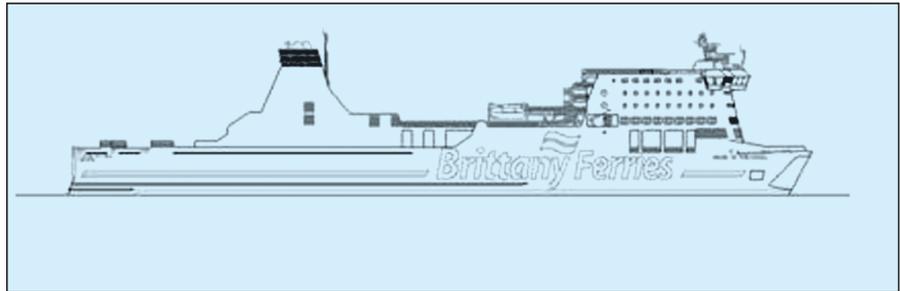
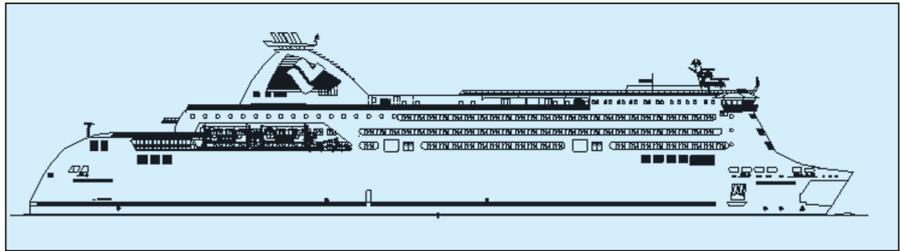
Although asbestos-related health problems are a well-known and regrettable feature of shipbuilding and similar industries everywhere, they have recently come under the spotlight in Japan, where the Shipbuilders Association of Japan (SAJ) is to carry out new research. Previously, problems were dealt with on a company basis but the SAJ believes that there is a need for the association to examine these problems throughout the country.

Incubation periods for asbestos-related illnesses can be very long - up to 40 years, but although spraying in Japan ceased in 1975 and asbestos products are no longer used, this could be an on-going problem for another 10 years. Amongst SAJ members, 71 people are known to have been affected, with 58 fatalities (including 51 from cancerous mesotheliomas). Nevertheless, no claims are known to have been submitted by families or by retired people, nor by residents living near shipyards. The SAJ will continue to monitor and study the situation.

NEW SHIPS FOR TRASMEDITERRANEA?

The leading Spanish ferry operator Trasmediterranea is close to placing an order for two new pure ro-ro ferries, designed to increase capacity on its long-haul Spain-to-Canary Islands service. This company is experiencing a big growth in the number of lorries carried on all routes (compared with only 2% growth in passengers).

An impressive service speed - for freight ferries - of 25.5knots will make these ships faster than existing ones and will allow some to be released for service elsewhere; however, the



Profiles of the two new ferries ordered at Aker Yards in Finland: the new 27knot passenger/vehicle ferry for Tallink (top) and the new ro-pax trailer design for Brittany Ferries (bottom).

hulls will still have the same design draught (around 7m). Tenders have been sought from yards throughout Europe (not in the Far East because full order books there mean that those yards cannot meet the required 2007 delivery date).

As reported in our July/August special supplement *CLT: A Proven Propeller for Efficient Ships*, it is possible that Sistemar CLT propellers may be selected, following successful trials with retrofit propellers of this type on the Trasmediterranea passenger/vehicle ferry *Fortuny*. Useful power savings of up to 10% for the 40,000kW propulsion plant could be possible for the new ferries on their 700-mile voyage. Trasmediterranea is further considering application of the new technique of silicone-based hull coatings to reduce friction. The shipyard winning this order will design the new ferries to the owner's specification and will also be required to carry out model tests.

At the same, another potential contract for Sistemar is looming, since the Spanish Navy could well specify soon a CLT propeller for its new tanker/supply ship *Cantabria*, which is to be built by Navantia in a joint effort by its Puerto Real yard and the nearby one at San Fernando. Navantia is the name of the new company set up to operate the mainly military side of the former IZAR organisation.

The new supply ship, known by the letters BAC - *buque de aprovisionamiento de combate*

- and somewhat similar to the navy's existing *Patiño*, will have a double hull, a displacement of 19,620tonnes, and a deadweight of 9820dwt, being capable of carrying up to 10,8550m³ of liquids and 6790m³ of dry cargo. Every effort will be made to comply with modern environmental standards.

She will be built to the standards of Lloyd's Register: +100A1, Double Hull Product Tanker (F.P.>60°C), LMC, UMS, CG, CL, PL, FAS, MD, RAS, and although she will have a maximum sustained speed of 20knots at 85% MCR, the economical speed will be 13knots; with these two different speed ranges, *Cantabria* will be an ideal candidate for a CLT propeller. The diesel-mechanical propulsion train will comprise two 10,890kW engines coupled through a reduction gearbox to a single CP propeller of approximately 5.70m diameter and running at 120rev/min.

DOUBLE CHRISTENING AT HDW -

Two new 2500TEU container ships, *Carolina E* and *Andres E*, were christened together recently at the HDW yard in Kiel, Germany. They are the third and fourth of four vessels for MPC Münchmeyer Petersen Steamship. *Carolina E* will be operated by NSC Schiffahrtsgesellschaft and will sail under the name *Maersk Narbonne*. Total container capacity is 2490TEU, of which 958 are carried in the hold, and 1532 on deck. Service speed

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will be 22knots. More news on shipbuilding in Germany can be found in our special feature in this issue.

NEW CRUISE LINER FOR CELEBRITY

- The Celebrity division of Royal Caribbean Cruises has signed a letter of intent with the leading German builder of passenger vessels, Meyer Werft, for a new 117,000gt cruise liner, which will be of an innovative next-generation type, as well as being the operator's first 'wide-bodied' (post-Panamax) ship.

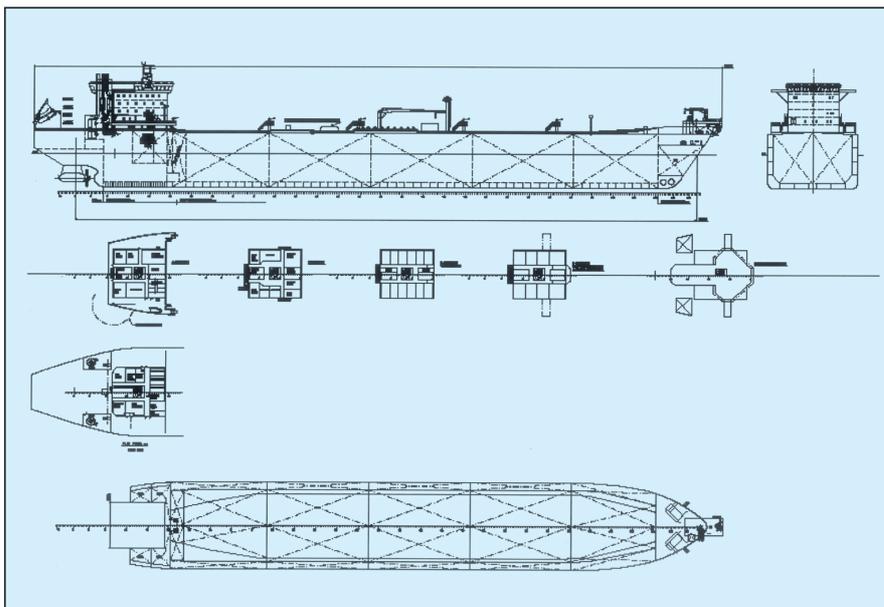
Hull dimensions will be 314.85m length and 36.88m breadth, and more than 90% of the 1425 cabins will be outside types, and more than 90% of these will have balconies. Total passenger capacity with double occupancy is 2850, and the crew will number 1250. Standard cabins will be much larger than normal at around 19.97m² on average. Delivery is planned for autumn 2008, and there is an option for a second ship, which has to be exercised by March next year. All-in costs for the new vessel are reckoned to be approximately US\$225,000/berth.

FIRST FREEDOM-CLASS LINER AFLOAT

- The first of Royal Caribbean's mammoth *Freedom*-class cruise liners has been floated out of the dock at Aker Yards' Turku complex. The 158,000gt *Freedom of the Seas* - the largest liner yet built - will be able to accommodate up to 3600 passengers and around 2000 crew. Handover is expected in April next year; she will be followed by two further vessels, to be delivered in spring 2007 and 2008.

FINNISH DESIGN FOR NEW RUSSIAN TANKERS

- Confirmation has been received that Aker Arctic Technology, in Helsinki, will design the new 70,000dwt Arctic shuttle oil tankers recently ordered at Admiralty Shipyards in St Petersburg by Sevmorneftegaz. In our July/August edition (page 3) we illustrated a preliminary design proposal submitted by the Finnish ice specialist, but at that time no contract had been agreed. Aker Arctic Technology has also signed a licence agreement and will supply a classification package for these important new vessels. They will be of the Aker/ABB



Updated general arrangement plans of the new 70,000dwt Arctic shuttle tankers to be built at Admiralty Shipyards, St Petersburg, to a design from Aker Arctic Technology. They will be of the Finnish double-acting type - able to turn their Azipods 180deg and travel stern-first into ice.

double-acting type, with an overall length of 260.00m, a breadth of 34.00m and a draught of 13.60m.

Although capable of worldwide operation, they are specially planned for operation between an offshore platform and a transhipment terminal in Murmansk. The tankers will fly the Russian flag and will be constructed to Russian regulations (almost certainly including classification to Russian Maritime Register of Shipping standards although at the time of writing this had not been confirmed), to meet JIU6 ice class.

Twin 8.5MW azimuthing pod drives will be fitted, supplied by a diesel-electric power plant comprising four 6250kW diesel-alternators, together with dynamic positioning equipment, a helicopter platform, and bow loading gear. Admiralty Shipyards is already well experienced in Arctic tankers, having built the 20,000dwt *Astrakhan* type

(*Significant Ships of 2000*) but these new designs will give the yard - and Russia's marine industries generally - a great boost.

TANKER DAMAGE STABILITY RULES

- Class society ABS is urging tanker operators to start preparations as soon as possible to ensure compliance with the new MARPOL Reg 1/37.4, which comes into force on January 1, 2007. This rule, which applies to all tankers of more than 5000dwt, calls for ships to have access to shore-based computerised damage-stability and residual structural-strength calculation programs. The reason for the urgency is that ABS estimates that the necessary computer modelling for an existing tanker could take in excess of 100h. Since many owners have indicated that they will seek assistance from class societies, the backlog of engineering work could be very large. Ⓢ

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New superyacht designs encompasses style and comfort

MONACO-based McFarlane Ship Design has a number of superyacht projects ongoing at present. The 85.0m Classic-Steamer design was developed for a client two years ago, but was never realised, however, new interest on this project has recently been shown by several new parties. Another 85m project is the Elegant motor yacht. This is one of the company's most recent designs and has been developed for a potential client that is interested in a modern but very conventional type of larger yacht. The ship has very clear and smooth lines, and a large volume.

A third venture is UK MCA-compliant, commercial *Force 1* motor yacht, which is also available as a SOLAS-compliant passenger ship for up to 36 guests. This vessel has been designed with dominant 'eccentric' features, an unusual circular forward superstructure and swept-down windows, and rounded forms.

Although this yacht has a long and relatively low exterior profile, it also has a high amount of interior space. There is no walk-around exterior deck, which means the full beam has been extended on all but the small upper deckhouse. This gives a large area of 1200m² of guest spaces.

The private owner's suite is 150m², with an attached lounge of 85m², while all guest cabins have been positioned away from noise sources. Traditional public spaces are located aft on three decks opening out onto the open aft decks. There is a circular room forward on top of the bridge, for panoramic viewing, and this also has a large skylight. A health spa and beach club area are connecting to the aft beach platform.

A special feature includes a 'garage' with lifting beams for 13m tender boats, on either side, while tender boarding platforms are located port and starboard, providing secure embarkation. An opening transom platform creates a beach area complete with sun beds and two Jacuzzis.



The 85m *Force 1* superyacht is a most interesting new speculative concept from McFarlane Ship Design.

TECHNICAL PARTICULARS *FORCE 1* DESIGN

Length, oa.....	85.00m
Length, wl.....	75.00m
Breadth.....	15.00m
Depth.....	6.50m
Draught.....	4.00m
Air draught.....	22.00m
Displacement.....	2000tonnes
Speed.....	18.00knots
Range at 15.00knots.....	3500nm
Fuel capacity.....	150m ³
Main engines.....	Caterpillar 3516C
Output.....	2 x 2400kW
Propellers.....	2 x five-bladed, 2200mm diameter
Auxiliary diesel-generators.....	2 x 350kW, 1 x 125kW
Guest accommodation.....	20
Guest cabins.....	10 cabins
Crew.....	30
Crew cabins.....	16

There is a large helicopter platform, along with a special wave-breaker feature for protection forward of the bridge, and day-lounge/office-space on the top deck. It is possible to use SOLAS-approved rescue/lifeboats, with stored energy davits.

Propulsion is via a classic twin-screw propulsion train featuring high-speed diesel engines and reduction gearboxes. The main engines exhaust underwater, while the generator engines exhaust in the traditional manner. The vessel is also equipped with a bow thruster, and twin high-lift rudders. Advanced engine monitoring and automation systems permit a periodically unattended machinery space, and a central air conditioning unit has individual cabin temperature controls.

To ensure best-possible passenger comfort, a rounded bilge hull form, plus fin stabilisers, was chosen for this superyacht. It has large fixed bilge keels, which are placed out of line of the fin stabilisers to reduce interference, and five chord lengths clear of the stabilisers. Stern lines are intended to give good water flow to the propellers, with a smooth wake and sufficient transom immersion to avoid wave

slamming when at anchor, while bow lines use a moderate V in combination with a bulbous bow.

The bulbous bow serves several purposes in that it brings the centre of buoyancy forward, which reduces pitching; it also separates the centre of buoyancy from the centre of floatation, which also reduces pitching. In short waves (typical of the Mediterranean) it can help reduce pitch and bow accelerations, as well as shrinking power requirements (but it is accepted that it is of minor importance at the expected speeds). Finally, the bow allows the collision bulkhead to be moved forward (half the length of the bulb), which increases usable interior volume.

The long keel has several important contributions. It helps reduce rolling, due to entrained mass, and it can allow integration of a simple stiff hull construction. It is easily reinforced to simplify drydocking and can reduce damage from minor groundings. The yacht has also been designed with topsides that have a continuous curve, with no parallel mid-body, which is both aesthetically pleasing and easier to fair. 



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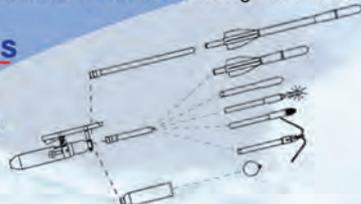
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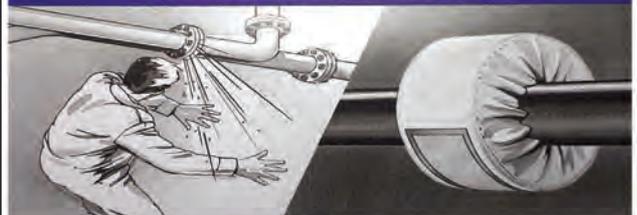
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Diamond concept brought to the Handysize market

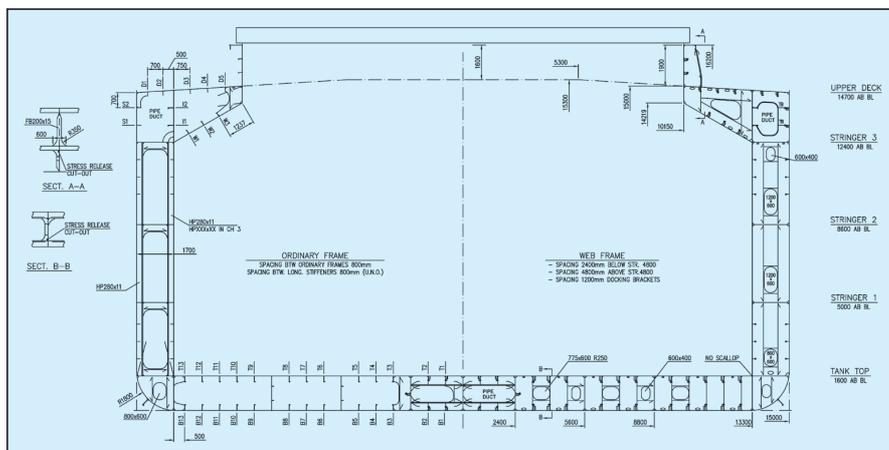
Cardiff-based Graig Group has given added dimension to its business offering by unveiling a 34,000dwt bulk carrier design developed jointly with Danish technical consultancy Carl Bro Marine, reports David Tinsley.

It is anticipated that the extension of Graig/Carl Bro's innovative Diamond double-hull bulk carrier concept to the Handysize sector of the market will soon be vindicated by a contract for a series of the new type from internationally-emergent Vietnam Shipbuilding Industry Corp (Vinashin). The geared, wide-hatched, shallow-draught Diamond 34 perpetuates the key features and perceived long-term operational and structural benefits that have generated around 30 firm sales to date for the first member of the family, the Diamond 53 Handymax (*Spar Lyra*, presented in *Significant Ships of 2004*).

The versatile new 34,000dwt type offers 45,500m³ of cargo capacity in five holds, bounded by a double side shell and double bottom, affording increased safety and allowing structural arrangements which make for smooth, obstruction-free, and squared-off hold spaces. Although there is no mandatory requirement for new bulk carriers to incorporate double hulls, as had seemed likely when the original Diamond 53 design project had been implemented, the Graig/Carl Bro solution has proven to have wide appeal because of its perceived, long-run operational as well as safety merits.

Graig's success in demonstrating that a full double-hull class can be obtained at no cost penalty over a standard single side-skin design of comparable capacity has had a signal bearing on market interest and sales to date. The company's choice of Asian yards, and the nature of the agreements and project management, has been pivotal to the whole concept.

The Diamond double-hull configuration presents a second barrier to accidental water ingress, and permits the bulkhead framing and



Steel structural details proposed for the hold midship section of the Diamond 34 bulk carrier.

side frames to be arranged outside the holds, and within the inter-shell spaces. This makes for flush surfaces in the cargo spaces, facilitating and speeding discharge and cleaning, and potentially also providing maintenance benefits. In a conventional, single side-skin bulk carrier, the strength members are exposed within the holds, which tend to call for more exacting unloading operations with certain types of cargo, and an increased cleaning task. The water ballast tankage so formed by the inter-shell spaces in the new Diamond 34 is protected by an epoxy paint formulation.

The double side-skin ensures safe access for close-up survey of the complete hull structure, even when the vessel is loaded. Furthermore, green water protection afforded by the raised forecandle and the fore-and-aft underdeck passageway contributes to the safe operation of the ship. In addition, all piping and service lines have been placed in the underdeck tunnel, making for an unobstructed main deck, reduced exposure of fittings to the elements, and potentially reduced maintenance.

The robust Diamond 34 is suited to a very broad range of bulk commodities including coal, grain, ore, cement, alumina, bauxite, mineral sand, fertiliser, steel products, scrap iron, logs, packaged timber and certain dangerous cargoes. Underlining the trading scope of the new class, typical loading conditions could include a heavy grain or heavy ore cargo deadweight of 32,200tonnes, with a 1800tonne departure deadweight, at the 9.75m scantling draught, and with holds 2 and 4 empty in the case of ore.

Strengthened for steel coils

An added merit of the design, and reflecting its increased tanktop strength, is the suitability for up to two tiers of 20tonnes steel coils of 1.5m length to be stowed on timber dunnage across all holds, providing a full coil cargo carrying capability. The heavy tanktop structure also imbues long-term protection against the rigours of grab discharge. The holds have been specified with two levels of lashing points, while the upper deck will incorporate timber sockets and lashing eyes so as to secure deck stows of logs and packaged timber.

Self-sustaining qualities in cargo working are conferred by an outfit of four high-stooled, level-luffing deck cranes of 30tonne capacity, plumbing all five holds. A suite of end-folding, hydraulically-actuated, double-skin hatch covers with double cross-joint sealing has been specified, incorporating grain/cement feeder openings. The hatchways serving Nos 2-5 holds in the 30m-wide vessel are of generous proportions, measuring 19.20m length by 20.80m breadth, while a somewhat smaller opening has been provided to No 1 hold.

The design affords flexibility as to the choice of two-stroke main engine, with both Sulzer and MAN B&W marques. The draft specification foresees a de-rated installation producing a maximum continuous output of 7600kW, with an attendant heavy fuel oil consumption of 170g/kWh. Extrapolation to the 6100kW continuous service rating for a vessel speed of 14knots at the scantling draught evidently results in a main engine consumption of 26.40tonnes/day, coming down to 24.90tonnes/day when operating at the design draught. To minimise the risk of oil spillage in the event of an accident, all heavy fuel oil and diesel oil will be stored in coffered tanks in the engine room.

It is envisaged that the first of the Diamond 34s will make her seagoing debut in mid 2007, underscoring the early delivery positions obtainable in Vietnam. In the meantime, a further tranche of Diamond 53 contracts is in the offing, realisation of which would take the worldwide tally of orders for the Handymax design beyond 30.

Feedback from the five Diamond 53 ships delivered to date by Chengxi Shipyard and New Century Shipbuilding, in China, and in service with Norway's Spar Shipping and the Turkish operator Densan Shipping, has indicated that power requirements for the requisite service speeds are lower than expected. Masters have also commended the class for its manoeuvrability, reducing the need for tug assistance in harbour, and for the benefits in loading, discharge and cleaning times conferred by the nature and configuration of the cargo section.

TECHNICAL PARTICULARS DIAMOND 34 BULKER

Length, oa.....	180.00m
Length, bp.....	172.00m
Breadth, moulded.....	30.00m
Draught, scantling.....	9.75m
Deadweight.....	34,000dwt
Cargo hold capacity.....	45,500m ³
Deck cranes.....	4 x 30tonnes
Main engine power.....	7600kW
Service speed, at 9.75m draught, 80% MCR, 15% sea margin.....	14.00knots
Endurance.....	approx 18,000nm
Classification.....	Det Norske Veritas +1A1 Bulk Carrier ES(D), Nauticus (New Building), BC-A (Holds No 2 and 4 may be empty), ESP, EO, GRAIN-U, IB(+), DK(+), HA(+), TMON, BIS, FUEL



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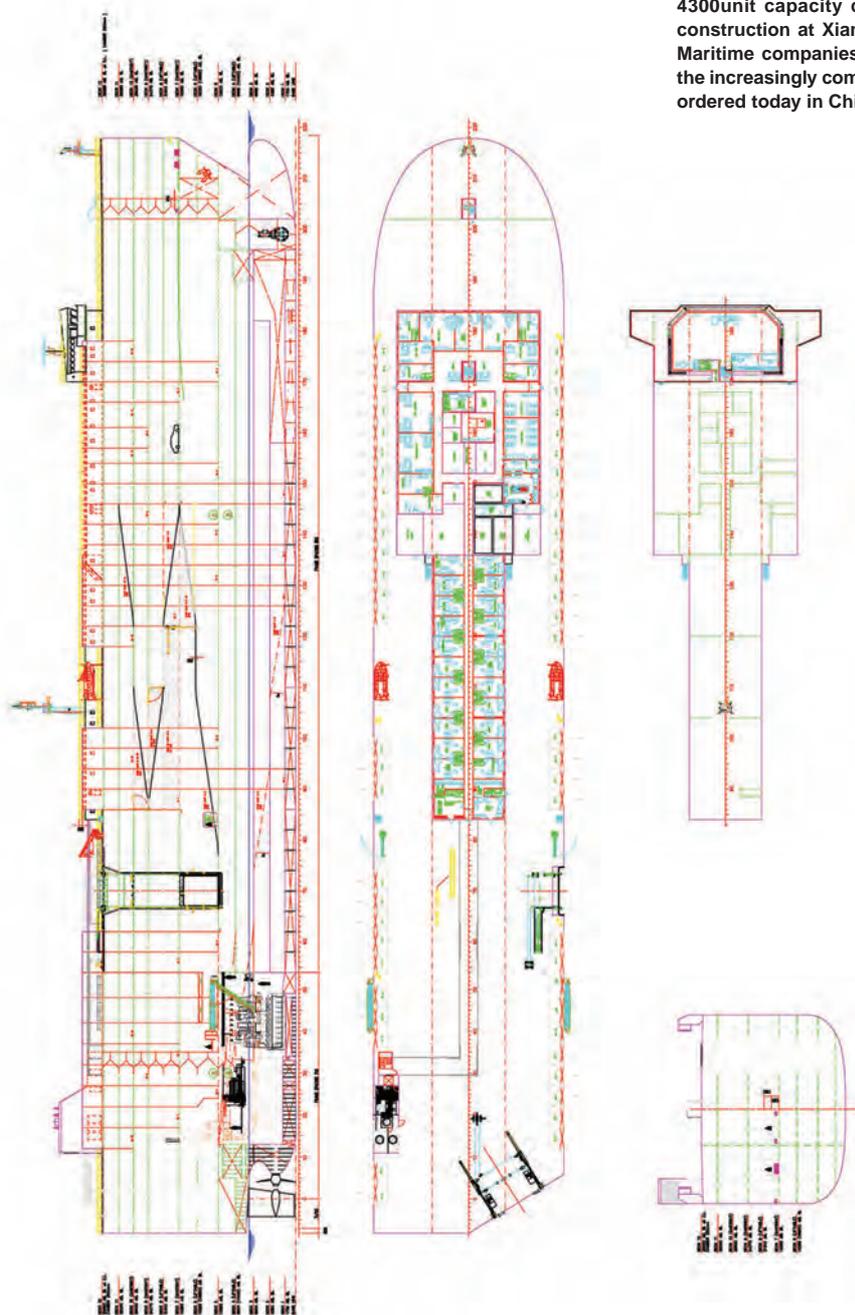
Chinese shipbuilders on the way to the top

CHINA, today ranked only behind South Korea, and Japan in terms of newbuilding output, is well on its way to becoming the world's leading shipbuilding nation, a target which the country's government has said it expects to be reached by 2015, if not before. In 2004 the country's shipyards delivered 8.5 million dwt of new ships, 40% more than in 2003. A further increase to around 10 million dwt is forecast for 2005, which would give China approximately 18% of the world market.

The continuing and amazing expansion of China's booming shipbuilding yards and supporting industries is recorded by Clive Woodbridge, who visited the country recently specially for *The Naval Architect*.

A series of large-scale investments are being made by the two leading state-owned

shipbuilding groups, CSIC and CSSC, to increase China's shipbuilding capacity. The biggest single project currently underway is construction of the new Jiangnan Shipyard on Changxing Island in the Huangpu River near Shanghai, which will create the country's largest shipyard so far by 2008. In addition, there are major new yard developments at Longxue, in Guangzhou, which includes the construction of two 300,000dwt drydocks that will be able to build over 2 million dwt a year, as well as at Qingdao, for the Beihai Shipyard. The latter project includes two graving



General arrangement plans of a series of 4300unit capacity car/truck carriers under construction at Xiamen Shipyard for Zodiac Maritime companies. This is an example of the increasingly complex ships that are being ordered today in China.



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An artist's impression of Jiangnan's massive new yard at Changxing, where ships up to VLCC size will be constructed.

docks, of 300,000dwt and 500,000dwt size, and will eventually create a yard capable of building 2 million dwt annually

Much of this additional capacity will come onstream between 2008-2010, when many industry experts predict there will be a downturn in global ship ordering activity from its current high level. This could present a huge challenge to the Chinese shipbuilding industry, and put downward pressure on pricing. However, the requirement for new tonnage for Chinese shipping companies alone will probably be sufficient to sustain a reasonably strong orderbook for the yards until 2010, and possibly well beyond.

The focus of most Chinese yards today is still very much on the building of long series of relatively standard container ships, bulk carriers, and tankers. However, Chinese yards are also now securing more orders for relatively sophisticated vessels of types that have, up to now, been ordered primarily from South Korean or Japanese yards.

An example is Xiamen Shipbuilding, which has picked up orders for a total of six 4300-car-capacity pure car and truck carriers (PCTCs) for companies associated with Zodiac Maritime. The first of this series will be delivered later this year, and the sixth in early 2008.

These DNV-classed vessels will be powered by a MAN B&W 9S50MC-C main engine, from Hyundai in Korea, and will have a service speed of 21knots. Equipped with both stern and side ramps, the emphasis of the design is on flexibility, with three liftable car decks, out of the total of 11 car decks, onboard. Xiamen Shipbuilding has undertaken production design for this series itself, while detailed design work was carried out by a Norwegian design consultancy.

Another yard that is also building car carriers is Nantong-based NACKS, a joint venture between

Cosco and Kawasaki, of Japan, this time for K Line. These are rated at 5000-car capacity and are the largest vessels of this type under construction in China, as explained elsewhere in this feature.

Contracts for superlarge container liners

More orders for very large container vessels are similarly being placed in China, albeit mainly by Chinese owners. The biggest vessels contracted to date are four 10,000TEU liners ordered by Cosco at the NACKS yard, while Hudong-Zhonghua is building ships of around 8500TEU size for China Shipping.

Perhaps the most significant diversification into more technically demanding vessels is the impending start of LNG ship construction in China. So far, Hudong-Zhonghua has firm orders for two LNG vessels, for Chinese owners, and every prospect of signing contracts for three more in the near future. Other contracts, for at least 10 more LNG carriers, are expected to be shared between Hudong-Zhonghua, Dalian New Shipbuilding yard, NACKS, and Jiangnan.

Developing domestic infrastructure

Another key trend is the development of a domestic support infrastructure for the Chinese shipbuilding industry, which continues apace, with European-based manufacturers in particular setting up joint venture operations that will supply key components manufactured locally. Over the past few months, Wärtsilä Corp, of Finland, has established a number of new ventures to manufacture marine components in China. In June, the company inaugurated Wärtsilä Propulsion (Wuxi), which is the group's first wholly-owned production venture in China and which will focus on the manufacture of Lips-brand transverse thrusters.

The next step will be to build auxiliary generating sets in China, through Wärtsilä Qiyao Diesel, a joint venture with Shanghai Marine

Diesel Engine Research Institute. This plant will manufacture Wärtsilä-designed Auxpac packaged generating sets, and production is expected to commence in the summer of 2006.

Wärtsilä recently delivered the first Finnish-built Auxpac units, both of six-cylinder configuration, to Shanghai Zhenhua Port Machinery. These are destined for installation on a new 4000dwt heavy-lift vessel being built at the Jing Jiang Eastern Shipyard for Guangzhou Salvage Bureau, and which is scheduled for delivery in April 2006.

MAN B&W Diesel and CSIC have recently agreed to cooperate more closely on the development and production of large diesel engines. A framework agreement signed this June also provides for close co-operation in the purchase and production of components, personnel training and the production under licence of MAN B&W turbochargers.

CSIC will further be supported by MAN B&W in the establishment of its own crankshaft manufacturing facility in China. This is an especially significant development, as almost all crankshafts for major shipbuilding projects in China have to be imported, and a current shortage of crankshafts (as a result of bulging orderbooks throughout the Far East) is inhibiting the development of Chinese shipbuilding output.

The first domestically-produced crankshaft in China was completed and delivered in January 2005 by CSIC, and has been installed in a MAN B&W 6S60MC-C engine for Weihei Shipyard. CSIC has indicated that it plans to raise crankshaft production from around six units in 2005 to 40 a year by 2007.

In another significant development, Cosco International and Jotun have set up a joint venture, Jotun Cosco Marine Coatings. This will manufacture marine coatings for newbuildings in China, with a particular focus on those ships being built for the Cosco group. 



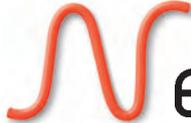
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Changxing project opens up new opportunities for Jiangnan yard

BY early 2008, Shanghai's Jiangnan Shipyard will be moving to new facilities now being constructed on Changxing Island, a greenfield site a short distance by ferry from Shanghai. The new yard, which will occupy an area of around 5.3 million m², will be China's largest, with an annual production capacity of around 4 million dwt.

This is around twice the capacity of Shanghai Waigaoqiao Shipbuilding, currently the country's largest yard, and eight times the annual capacity of the present Jiangnan yard in central Shanghai. The total investment in this phase of the development of facilities on Changxing Island is estimated to be around US\$1.43 billion.

Jiangnan is moving because its existing shipyard area will be used for the World Expo 2010 that is taking place in Shanghai. In addition, the decision to move is in keeping with the long-term local government strategy of moving heavy industry out of the city, while another consideration is the limited scope for further expansion of the existing yard.

The new Jiangnan yard will incorporate two production lines, each having two drydocks. One of No 1 production line's drydocks will measure 520m x 76m, and will be equipped with one 600tonne capacity goliath-type gantry crane, while the other will be 510m x 106m in dimension, and will be served by two 600tonne gantry cranes.

The first production line will incorporate two surface preparation lines, three part-assembly lines, four flat panel lines, and a number of environmentally friendly, enclosed painting shops. In addition, there will be five, VLCC-length outfitting quays in this sector of the yard.

The second production line at Changxing will have one drydock measuring 580m x 120m and another of 365m x 82m. Between them, these two docks will be equipped with three 800tonne capacity gantry cranes. Other facilities include two surface preparation and part assembly lines, two flat-panel lines, paint shops, and four VLCC length outfitting quays.

Jiangnan expects that the first production line will be operational towards the end of 2007, and

that the two docks will be completed, simultaneous with the launch of the first ship at the new yard, in September 2008. If all goes to plan, the first vessel will be delivered there towards the end of 2008, while the second production line should deliver its first vessel around one year after that, in late 2009.

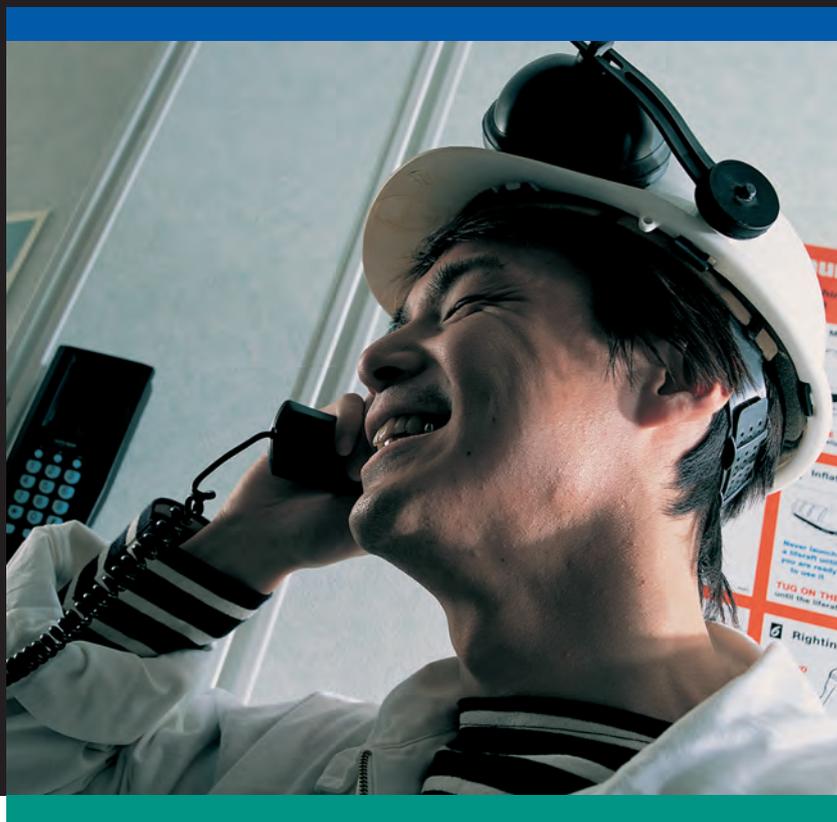
The new yard will give Jiangnan the ability to build much bigger vessels than it can at its existing facilities. As well as the larger drydocks, Changxing Island offers deepwater access. As a result, the yard's intention is to focus more on larger ship classes, including VLCC and Aframax crude oil tankers; very large ore carriers (VLOCs) and Capesize bulk carriers; also large container ships up to 10,000TEU capacity, and LNG carriers. In addition, Jiangnan will continue to build the series of Panamax bulkers and chemical tankers that have been a key part of the existing yard's success.

It is expected, though not yet confirmed, that the first ships to be built at the new site

The 16,400dwt *Stenberg* is one of four product/chemical tankers being built by Jiangnan for the Norwegian owner Stenersen.



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will either be VLCCs, which will be constructed using a tandem approach in Dock 1, or VLOCs, probably for Chinese shipowners. Jiangnan is also optimistic about securing a share of the significant number of LNG ships which are expected to be ordered by the Chinese government to meet its import requirements over the next few years. The yard has a technical assistance agreement with Kvaerner Masa, and could build LNG carriers using the latter's Moss-type containment technique, at the new yard.

The 140-year long history of shipbuilding at Jiangnan's Shanghai yard will come to a close in early 2008. The last vessels built here will be launched by February of that year, and will then be towed to the new shipyard for final outfitting.

Like all Chinese yards, Jiangnan is busy, and the yard's current orderbook includes 10 76,000dwt Panamax bulk carriers for Bocimar, of Belgium, IRISL, of Iran, and domestic owners, which are of an optimised design, featuring a more efficient hull form and an ability to carry more cargo than previous Panamax bulkers built at the yard. In addition, Jiangnan is building four 16,400dwt product/chemical tankers for Stenersen, of Norway, six vessels of the same type for AP Möller, and two 16,500m³ LPG carriers for Formosa Plastics.

Demonstrating its versatility, the yard has recently delivered the second of a pair of 16,000gt ro-pax ships for China Shipping. This vessel, like its sister, is now deployed on the route between Dalian and Yantai.

SDARI expands its horizons

THE Shanghai Merchant Ship Design and Research Institute (SDARI), which celebrated its 40th anniversary last year, plays an important role within the Chinese shipbuilding industry. As far as the merchant ship sector is concerned, SDARI is one of the biggest design offices in China, employing 400 people in total, 280 of which are ship design specialists. The company offers a full design service, from project development up to detailed design, and also sometimes provides production design in conjunction with third parties.

Bulk carrier design is one of SDARI's strengths, and in recent years it has produced a full range of new designs, the largest being a 175,000dwt Capesize type. SDARI also points out that it is now updating all its bulk carrier designs in accordance with the new IACS rules, and is furthermore working on the development of even larger sizes, including designs for 230,000dwt and 300,000dwt iron ore carriers for Chinese owners. The 230,000dwt type recently underwent model tests at the SSPA model basin in Sweden, with reportedly good results.

Hu Jin-Tao, vice-president and technical director at SDARI, comments, 'The feature of this new design is a high tonnage capacity within a relatively limited overall size, and a low fuel consumption. We hope that vessels of this type will soon be ordered in China'.

Container vessels represent another significant focus for SDARI. As well as a series of feeder vessels, the company has independently developed the design of the 3500TEU capacity series now being built at Shanghai Shipyard and Zhejiang Shipyard, which are understood to be the biggest container ships built to date, where the full copyright is owned by a Chinese company. *MSC Queensland*, the first of a series of 12, was delivered in June last year, and others will be completed at regular intervals through to 2007.

SDARI has also developed a 5000TEU container vessel design as well as a post-Panamax 6500TEU version. 'We have this

design ready to go', says Mr Hu. 'This size is very popular now and a number of Chinese yards are preparing building slots. We will have to see what the market wants, but we believe there will be a higher demand for vessels in the 5000TEU-6500TEU range than for very large container carriers in the next few years'.

SDARI has also developed a 16,000gt ro-pax ship design, with capacity for 1428 passengers and 81 lorries or 193 cars. Two of these vessels were recently delivered by the Jiangnan yard for China Shipping, and this pair represented SDARI's first entry into the ro-pax market, although it has in the past designed pure ro-ro ships for Finn carriers and Finnlines, together with a Finnish consultant (Deltamarin); these were the *Finnmaster* type constructed at Jinling Shipyard and presented in *Significant Ships of 2000*.

SDARI also designed the new train ferries for the Yantai-Dalian service, which are currently being built at the Tianjin Xingang yard (*The Naval Architect* February 2005, page 88).

Work on conversion projects

Despite this level of activity, the past year has been a relatively quiet one for SDARI in terms of newbuilding design work. Mr Hu explains, 'The reason is that the yards are all heavily occupied with long series. It is a strong sellers' market, and yards are only taking orders for existing designs, which, of course, presents us with a challenge'.

Owners may not be able to find building slots in the short term, but some are looking at the conversion market as a means of getting the tonnage they want in a limited time frame. As a means of complementing its newbuilding work, SDARI is now looking to support this trend, and has been working on a number of conversion projects.

One has involved the conversion of two 250,000dwt single-hull VLCCs into 230,000dwt ore carriers for HESCO, a Chinese shipowner. The first of these is now operating on the Brazil-China trades, while a second is now at the preparatory stage. *continued*

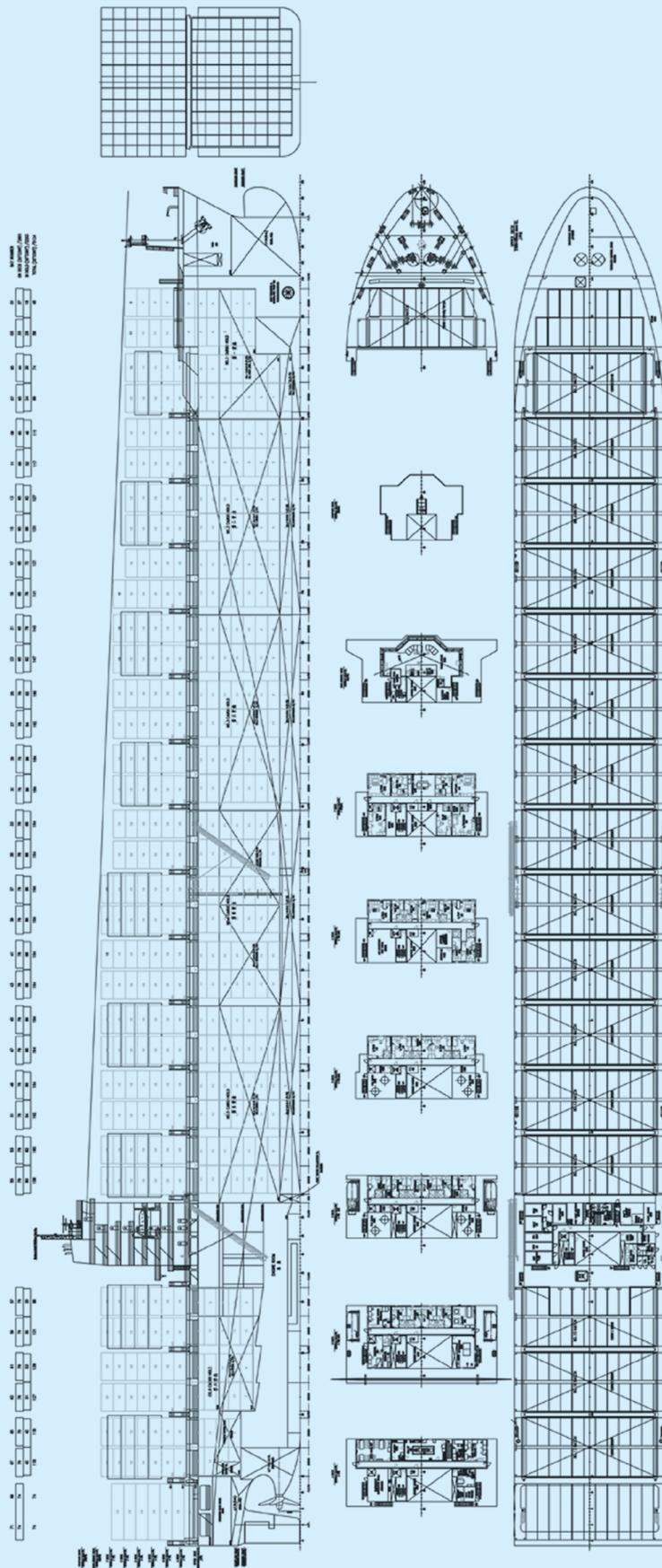


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General arrangement plan of a 5000TEU container ship designed by SDARI.



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MSC Queensland, a 3500TEU container ship designed by SDARI.



SDARI undertook all the design and engineering work for these conversions. According to Mr Hu, 'These ships were quite challenging. They were more difficult in some respects than newbuilding design, as we had to utilise the existing structure'.

Another conversion project was undertaken by SDARI in connection with the transformation of an old Panamax bulk carrier into a self-loading/unloading bulker for Canada Steamship Lines. The existing cargo

areas were cut away, leaving just the engineroom, while the new cargo areas that were constructed have been designed by SDARI. This work is being undertaken at the Shanhaiguan and Chengxi Shipyards, and the first of the three is due to be re-delivered at the end of 2005.

SDARI is also now looking to export its newbuilding design services overseas. Over the years, SDARI has developed a number of container feeder ship designs, many for

German shipowners, and this year SDARI has received enquiries from Tsuneishi in Japan and also some Korean shipyards. As a result, Mr Hu reveals that SDARI has secured a contract to design a 900TEU capacity feeder vessel for Tsuneishi, while a design of 1100TEU capacity for Korean yards is under negotiation. SDARI is part of the China State Shipbuilding Corp (CSSC). Currently between 20-30% of its workload is for CSSC yards, with the remainder for other yards across China. ⚓

High-value strategy pays off for Yantai Raffles

THE privately-owned Yantai Raffles yard in the north of China is very much the 'odd man out' in the Chinese shipbuilding scene. While the majority of Chinese yards concentrate on building long series of relatively standard vessel types, Yantai Raffles' focus is on short series, or even 'one offs' of relatively complex designs. As Yantai Raffles' majority shareholder, and chief executive officer, Brian Chang, states, 'We are very different to other yards in China as we are not looking for mass production, but high added value'.

An example of the success of this strategy is the yard's contract to build a semi-submersible yacht carrier for the Dutch heavy-lift operator, Dockwise. Steel cutting started in July this year and it is expected that delivery will take place in December 2006. This will be a custom-built prototype vessel, designed specifically for the yacht transportation market, and represents the



Yantai Raffles has an unusual production technique, fabricating hulls on land and then launching them using barges which, with the aid of rollers, pull the vessels into the water.

first time ever that a dedicated vessel for the ocean transportation of luxury yachts has been ordered.

Designed to load yachts using a 'float-on/float-off' method, the new vessel will have a length of 208m overall, a breadth of 32.2m and a design

draught of 5m. Yachts, and other heavy-lift cargo, will be accommodated between spray covers in the dock bay, which measures 165m by 31m, giving a total deck space of 5115m². One of the features of the design is that the aft caissons are longer, and thinner, than on conventional heavy-



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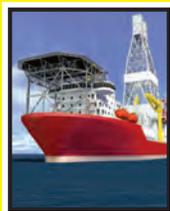
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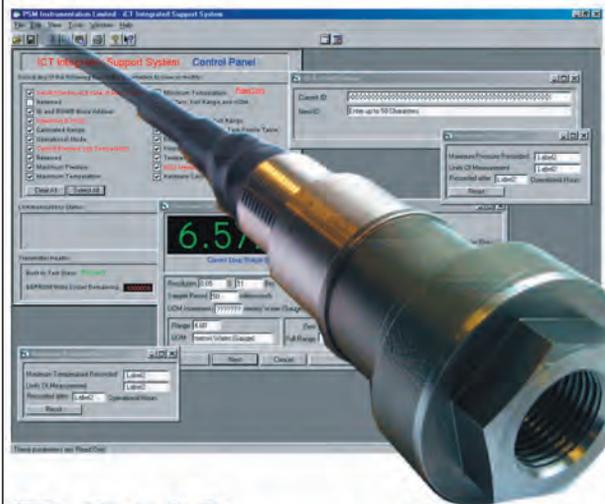
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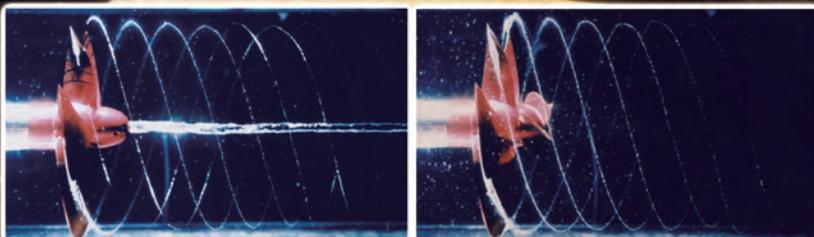
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A computer-generated image of the large semi-submersible yacht carrier which Yantai Raffles is building for Dockwise.

lift vessels, in order to maximise the number of yachts that can be taken onboard, within a relatively compact space.

Another feature of the vessel is its relatively fast service speed of 18knots. Dockwise believes this will allow the journey time from the Mediterranean to Florida or the Caribbean to be reduced from 15 days with current-generation ships to eight days. One of the keys to achieving this high speed is the relatively low depth to the main deck of 8.5m, which, Philip Schreven, project director, suggests, makes the vessel 'like a big surf board'.

A diesel-electric propulsion system has been selected for the yacht carrier, and this will be provided by a joint venture between Wärtsilä and the Dutch contractor Imtech. This is the first time that Yantai Raffles has subcontracted such a large part of the project - worth around 25% of the contract price - to an outside supplier. Wärtsilä will supply the main engines, bow thruster, steering gear and hydraulics, while Imtech will deliver the navigation, electrical, automation and communications systems. Delivery will be undertaken by an integrated project team set up by Wärtsilä and Imtech.

For the main engines, Wärtsilä will supply two 8700kW 12V38 models, featuring common-rail technology, and two 6L20 auxiliary engines. Advanced soot prevention systems, similar to those found on cruise ships, will be

incorporated, to protect the high-value yacht cargoes. Main propulsion will be by two Lips azimuthing pulling thrusters each of 5100kW, which are believed to be amongst the largest pulling thrusters available on the market.

A number of design challenges had to be overcome, stemming from the semi-submersible nature of the vessel, and this included how best to ventilate the thruster room. This issue has been solved by having all ventilation and electrical systems running from bow to stern in enclosed corridors, says Mr Schreven.

The vessel will carry DNV's RP notation, which recognises the high degree of redundancy of the propulsion system. It will be possible for the vessel to run on one engine and thruster and still travel at 14knots.

Compared with more conventional heavy-lift vessels, there is also more accommodation, of a very high standard, onboard, and this will allow Dockwise to provide space for extra riders wishing to accompany a yacht during the voyage. In all, there is space for 50 passengers in the accommodation block, located forward, which also features an atrium, a pool, and a bar area.

Aside from the yacht carrier, Yantai Raffles is busy with a number of other interesting projects, most of which are oil industry-related. The company is, for instance,

building the first 'round-shaped' FPSO, the SSP 300, for Sevan Marine, of Norway. On delivery this will be destined for an 11-year lease with Petrobras in the Pira Nema field.

Yantai Raffles developed the concept together with the owner and believes it offers an number of advantages compared with conventional FPSO arrangements. According to Mr Schreven, 'There are benefits in terms of the characteristics of the FPSO's behaviour at sea, the available deck space, and the weight/storage capacity ratio, while there is also an 85% reduction in the amount of cargo and ballast piping on the vessel'. The 300,000barrel capacity FPSO features 12 L-shaped ballast tanks, five cargo tanks and three slop tanks, and there is one central shaft, with one central ring line to the main deck.

Construction of this FPSO is now well underway. The process plant is being built in Norway and will be shipped this December for integration with the main structure in Yantai. It is planned to deliver the FPSO in March 2006. Yantai Raffles is also building a FSO for Modec with a 350,000tonne storage capacity, a series of four 93m long, diesel-electric platform supply vessels for BP, and two anchor-handling tugs for Tideland.

Yantai Raffles has an extensive in-house engineering and design department, that employs around 120 staff. This team utilises



the CATIA CAD/CAM system developed by IBM-Dessault, supported by the EROVIA data handling system. As Mr Schreven points out, 'We need a department of this size to manage the various complex projects that we have'.

Yantai Raffles, which occupies an area of around 750,000m², has two drydocks, one capable of accommodating vessels up to 500,000dwt, and another covered dock for ships of 35,000dwt. However, the drydocks are not extensively utilised for newbuilding work. Yantai Raffles instead uses a relatively unusual newbuilding technique, undertaking construction work horizontally within a large open fabrication area, and then launching finished structures with barges.

A change to the way of working at the yard is now at the planning stage, however. A site at Penglai, 70km from Yantai, has been acquired and will be used for block construction. As a result, the Yantai yard will become more assembly-orientated in the future. 

Another special feature at this yard is its 2000tonne pedestal crane, used for lifting large ship sections.

LR gears up for growth

TODAY, China is, not surprisingly perhaps, the fastest growing newbuilding market for Lloyd's Register (LR) worldwide, and it has built up a significant share within this sector. The group estimates that it is the nominated classification society for around 22% of the total tonnage ordered, under construction or delivered from China in the 12 months to end-March 2005, a figure which puts it slightly ahead of its closest rival, Germanischer Lloyd (GL).

LR's current order book in China covers more than 160 vessels on order or under construction, with a total of more than 4 million gt. These include projects at 26 shipyards countrywide. LR is particularly strong in the oil tanker sector in China. Of the 68 vessels of this type under construction in China as of July this year, 22 are being classed by LR. This includes a long series of Aframax and VLCC tankers on order for AP Möller at Dalian New Shipyard, as well as

series of 35,000dwt tankers for various owners at the nearby Dalian Shipyard. The company has also recently secured an order for two Aframax tankers at Shanghai Waigaoqiao Shipyard (SWS) for Singaporean interests.

LR believes it can start to challenge GL's current dominant position in the container sector in China, particularly for the larger vessels where LR has significant corporate experience. This optimism is supported by the fact that orders for container ships continue to be placed in Chinese yards at a healthy rate.

The company's strategy includes working closely with local design institutes at the pre-contract stage. In this context, LR reports that it is currently providing assistance in the development of 1300TEU and 1700TEU feeder designs.

LR is one of the leading class societies for LNG ships worldwide, and hopes to build on this experience within China. While the only

confirmed LNG vessel order placed with a China yard to date, two 147,000m³ ships at the Hudong-Zhonghua yard, will be classed by ABS, there are plans for the Chinese government to order at least 13 more LNG ships over the next few years. LR is closely monitoring developments in this sector, with a view towards participating in these future projects.

Newbuilding is not the only focus of LR's marine business division in China, and it has handled a series of notable conversions /major repairs over the past two years. In addition, LR has experienced a significant growth in the volume of periodic surveys to existing ships carried out in China. Overall, in the 12 months to the end of April 2005, LR carried out 1431 periodic surveys, compared with just 568 in the preceding 12-month period.

LR further notes that it is beginning to secure class for an increasing number of existing

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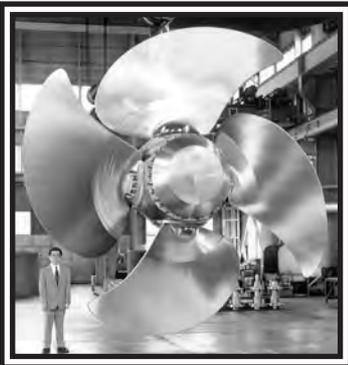


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vessels for Chinese owners. These currently number around 80 ships, totalling approximately 2 million gt, doubling the LR-classed, Chinese-managed fleet over a 12-month period.

To handle the significant expansion in workload that it is experiencing, LR has increased its staffing levels in China from 120 at the end of 2004, to 177 at the end of July this year. This includes an appreciable increase in the number of surveyors and

plan approval engineers on the ground. The plan approval capability is being strengthened, LR notes, by bringing in experienced expatriates to train up local staff.

Support services to the Chinese shipbuilding industry are being strengthened. LR highlights the introduction this year of a pre-contract department to assist yards and design institutes in China, while a suite of training packages, specifically

for shipbuilding clients, has been drawn up and these will be made available to leading Chinese shipyards in September this year.

As a result of the increase in its local workforce, LR has outgrown its present head office accommodation in Shanghai and will be moving to new premises in the city this November. Outside of Shanghai, LR's main offices are in Dalian and Guangzhou, and these are supported by further satellite offices in Nantong, Nanjing, Qingdao, Xiamen, Mawei, Wuhan, and Yichang. Ⓢ

Diamonds glitter in China

CHINESE yards may once have been criticised for having old designs, but when a radical new one is provided, they have shown how they can adopt it with success. The Graig/Carl Bro Diamond 53 Handymax double-hull bulk carrier design, launched in 2003, represented a major step forward in bulk carrier design, and a departure from accepted practice in many areas. To date, 36 of these ships have now been ordered, including 19 from two Chinese yards, New Century and Chengxi. So far, five of them have been delivered (*Spar Lyra*, the first, was presented in *Significant Ships of 2004*), three from Chengxi and two from New Century, and feedback from the ships in service is said to be 'excellent'.

The five ships in service are now trading for Norway's Spar Shipping and Turkey's Densan Shipping. Reports from the masters indicate that power requirements for service speeds

are lower than expected, and fuel consumption is better than predicted. At the same time, masters report excellent manoeuvrability, which has led to savings on tug costs, cargo friendliness, helping to cut loading and discharging time, and major time savings in terms of cargo hold cleaning.

The masters of *Spar Lynx* and *Spar Lyra*, both delivered from Chengxi, reported after their maiden voyages that the vessels were a significant improvement on other newbuildings that had recently joined their fleets. Both masters highlighted the slow-speed manoeuvrability and power response as critical in enabling them to save time berthing and on river transits, and both quoted occasions when the manoeuvrability enabled them to berth without tug assistance, saving time and money. They also highlighted the well laid-out bridge as a key factor.

Michael Schmidt, Diamond project manager for Carl Bro, said that particular attention had been paid to the design of the after body and rudder arrangement. The large rudder combined with the slim after body gave very good waterflows and so control at low speeds.

Masters also report that the double-hull configuration with no frames inside the holds made cleaning much quicker and easier. The same sheer sides and flat bulkhead arrangement also cut down on time needed for stowing cargo.

Overall, the assessment after the first months of service is that the new design is a step forward for Handymax bulkers. It proves that the double skin offers significant savings in cargo handling and hold cleaning time, while power requirements and manoeuvrability are not compromised. A new Graig/Carl Bro design, the Diamond 34 Handysize bulker, is discussed in a separate article in this issue. Ⓢ

DF-Marine increases design activity



A split hopper barge, *L'Aigle*, designed by DF-Marine and FKAB for Jan de Nul, leaving for sea trials recently.

A JOINT venture between FKAB, of Sweden, and Chinese interests, DF-Marine has been in operation since 2001. In that time, the Dalian-based company has established itself as an important vessel designer in the country, assisting small to medium-sized yards in China with the development and delivery of a variety of specialised vessel types, and providing support services to overseas owners, especially those based in Scandinavia.

Vessels delivered recently that have been designed by DF-Marine together with FKAB include two diesel-electric 18,200dwt product/chemical tankers for Donsötank Rederi; two 973TEU container vessels for Tropical Shipping; two 6400dwt bitumen carriers for Nynäs Petroleum, and three oil/chemical tankers for Furetank and Alvtank, all of which were built at Shanghai Edward; and four 17,600dwt general cargo vessels for B&N Nordsöfrakt, constructed at Mawei Shipyard.

DF-Marine and FKAB now have a wide range of vessel types under construction in China, and these include a 19,500dwt box type general cargo ship for Donsötank, at Shanghai Edward; a series of eight

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174,000dwt double-skin bulk carriers for Transmed Shipping, of Cyprus, being built at the Bohai Shipbuilding yard; three 6400dwt split hopper barges, a 5700dwt split hopper dredger, and a cutter suction dredger, for Jan de Nul, all of which are being built at the Tianjin Xinhe Shipbuilding facility; and two 6800dwt bunkering tankers, with an option for two more, that are under construction at the Fu Ning yard for Gea-Alpha, of Singapore.

In addition, DF-Marine has signed its first design contract for vessels that are being constructed outside of China. Two 8300dwt ice-class product tankers are being built to the company's design at the RMK Marine Shipyard in Turkey, for Rederi AB Brevik, of Sweden.

Furthermore, DF-Marine has a number of interesting vessel types at the design development stage. This includes an upgraded

version of its Capesize bulk carrier design, which complies with IACS S17, S18, S20 and S25 rules, and has an optimised double-skin arrangement, freefall lifeboat, and improved operational performance in accordance with PMA.

DF-Marine is also working with the Bohai Shipbuilding yard on a 1400lane metre, 1200 passenger capacity ro-pax ferry. This will utilise a twin-screw propulsion system and will be able to operate at speeds of up to 22knots.

To enhance its local design capabilities, DF-Marine and FKAB are currently investing in the Nauticus Early Design and Intelliship systems developed by DNV, which will give the companies 3D design tool capacity for the first time.

Chief executive, Peter Rosholm, says, 'We will now be able to work on the same

projects in both Europe and China and see what the other party is doing. This represents a significant investment for us, but will save time will generate better drawings and will minimise production problems'.

In January this year, DF-Marine opened a branch office in Shanghai, and this has proved a great success. Already some 13 of the 32 people employed by the company in China are based at the new office, which is in the Pudong area of the city. The idea is that the Shanghai and Dalian offices will be complementary, the former handling concept and basic design, while the latter will focus on production and detailed design work. The Shanghai office also represents the Callenberg group's marine electronics and ventilation division, as well as the UFAF precision industries business, in China. 

Busy times for Hudong-Zhonghua

IN terms of the number of vessels delivered in 2004, Hudong-Zhonghua (HZ) Shipbuilding in Shanghai was China's busiest yard. The company (a union of two yards on opposite banks of the Huangpu river) delivered 23 vessels in 2004, with a combined deadweight of 1.03 million tonnes, a 56%

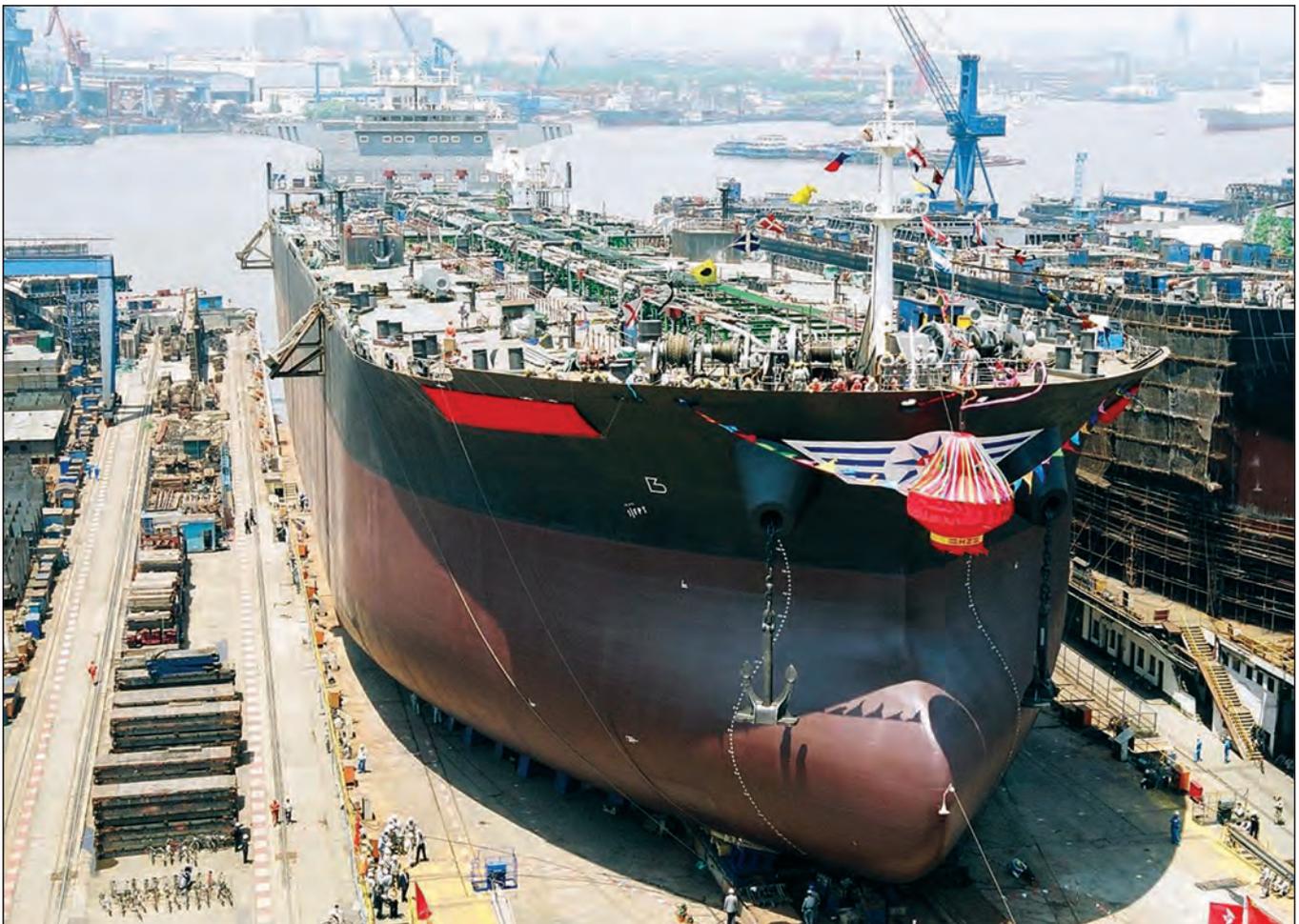
increase compared with 2003. HZ also delivered more vessels than any other yard in China in the first half of 2005, with the 12 ships handed over in that period amounting to around 632,000dwt.

Currently the yard is fully booked through to the end of 2008. Depending on market

conditions, the company indicates that it may start taking orders for 2009 delivery in late 2005.

Panamax bulk carriers make up a large proportion of HZ's output, and the yard is currently building a long series of 74,500dwt bulk carriers. In total, some 44 vessels of this

Hudong-Zhonghua has two conventional berths, one for ships up to 70,000dwt and the other for vessels up to 100,000dwt.



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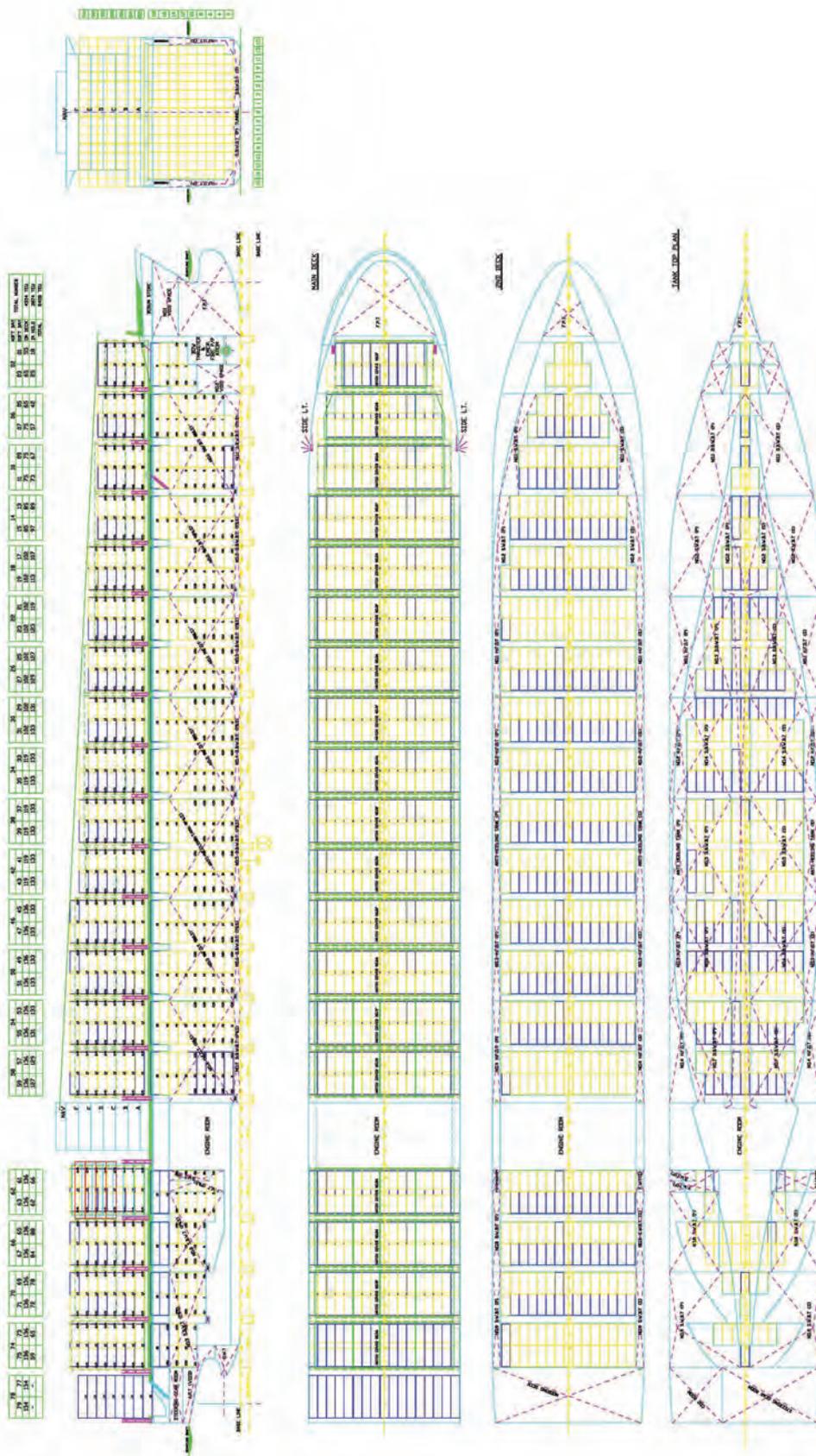
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General arrangement plans of the 8500TEU container liners that Hudong-Zhonghua will build for China Shipping.



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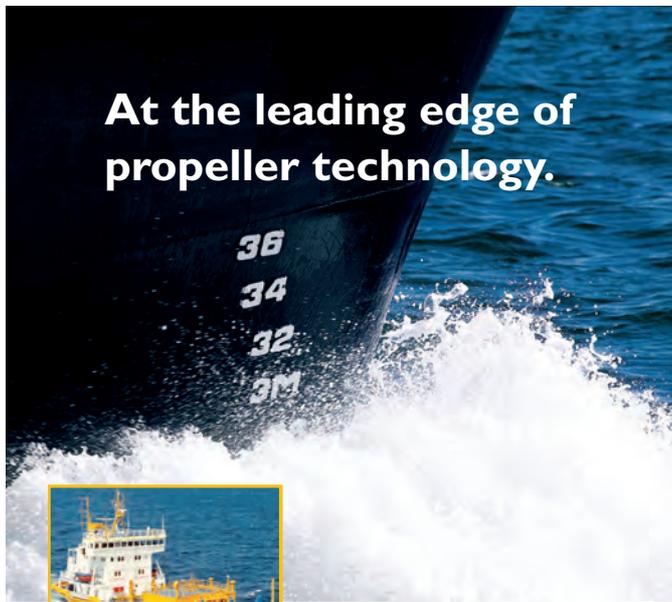


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The newly completed construction dock at Hudong-Zhonghua can theoretically accommodate ships up to 300,000dwT.

type will be delivered between early 2000 and the end of 2007, to owners in Greece, Hong Kong, China, and Italy.

Also on HZ's current orderbook are a series of 72,000dwT product tankers, for Greek and Italian owners, and two 110,000dwT crude oil tankers, which will be delivered to Valles

Steamship Co in 2005 and 2006. In addition, HZ is building four 17,300dwT multipurpose vessels for the Dutch owner, Wagenborg, for delivery in 2007.

Large container vessels make up another important product line for the yard. In this case, the key customer is the China Shipping

Co, which will take delivery of three 4250TEU capacity vessels and three 5688TEU units in 2005.

HZ is now gearing up to start production on what will be the largest container vessels produced at the yard to date. The yard will design and build four 8530TEU, 313m-long

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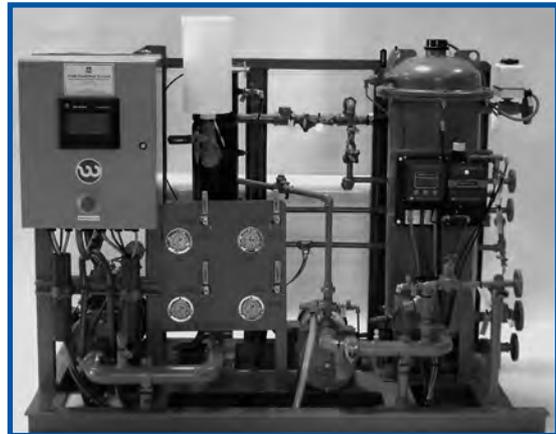
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post-Panamax hulls, again for China Shipping, and these are scheduled to be delivered in 2007. However design work is now in progress, the yard reveals, on even larger vessels, up to 10,000TEU size.

Entering the LNG sector

Perhaps the most important project for HZ at the present time, though, is its entry into the LNG construction market, following a contract for two 147,000m³ membrane-type vessels, plus an option for one more, signed last year with a consortium

that includes China Merchants and Cosco. Technical support for the building of these vessels, which are scheduled to be handed over in late 2007 and early 2008, will be provided by Chantiers d'Atlantique, of France. These vessels will be used to deliver LNG to the Guangdong import terminal.

In addition, HZ is confident that it has won the tender to build two similar LNG carriers for the Fujian import terminal project, again for a consortium of Chinese stakeholders. No firm contract has yet been signed for these ships, however.

Considerable investment is now being made by HZ to add facilities for the LNG construction project. This includes construction of a number of dedicated workshops close to the yard's new graving drydock, which measures 360m x 97m.

Also on the HZ site are two slipways, one of which can build ships up to 100,000dwt, and another to 70,000dwt. These tend to be used, however, for smaller vessel production work, and will for example be utilised to construct the 17,300dwt multipurpose series. 

China equipment strategy for Sumec

ALTHOUGH Nanjing-based Sumec Marine no longer owns its own shipyards, the company is still heavily involved in the domestic shipbuilding industry as an intermediary. 'We act as a contract co-ordinator', explains Mr Tian Ming, vice-president. 'We can take responsibility on behalf of the owner for the technical and financial aspects of the contract'.

Sumec has project management teams in a number of yards, to assist with quality control and management of the newbuilding schedule, and the company can also handle the purchasing of key items of equipment. On the financial side, Sumec Marine can take responsibility for opening letters of credit and can arrange refund guarantees, for instance.

Over the past year, Sumec Marine has been involved in a number of significant newbuilding contracts, offering one or more of these services. These projects include a series of seven Panamax 74,000dwt tankers on order at the New Century Shipyard for Greek, Singaporean and Italian owners; two 1100TEU container ships ordered by Hartmann at the Dayang yard; a 3600dwt

IMO Type II chemical carrier for Ka Shipping, of Turkey, built at the Advance Shipyard; and four 7000dwt product tankers building at the Shenghua Shipyard for Chemoil.

One of the most significant elements of the Ka Shipping tanker, delivered in May 2005, and the Chemoil vessels, the first of which will be delivered in 2006, is that all of the major equipment items, with the exception of the radio, radars, purifiers, pressure-vacuum valves, and paint, were supplied by Chinese companies. These five tankers will, for instance, feature a main engine supplied by Ningpo CSI, and cargo pumps that were supplied by Huaiying Pump. 'This is an important step', says Mr Tian, 'Using Chinese-manufactured components is a way to help Chinese yards stay competitive'.

Sumec's role in these projects was extensive, as the overall contractor acting on behalf of the foreign shipowners. The company upgraded the specification of the design, originally developed for Chinese shipowners, to minimum international requirements, and its in-house technical team optimised the design. In addition, Sumec selected the major equipment suppliers, and

inspected the equipment prior to delivery to the yards. A project management team was then stationed in the yards to co-ordinate the supply of drawings, materials and equipment and to provide quality control.

There are a number of issues that have to be overcome with regard to the use of Chinese marine equipment items on vessels for international trades, Sumec accepts. 'Getting spare parts worldwide can be a problem, fuel consumption can be higher, and also components can be larger than overseas-made alternatives', comments Mr Tian. 'However, for some owners, and vessel types, these issues are not so significant, and securing cheaper vessels, with a certain level of quality, can be preferable'.

Sumec indicates that it is now seeking to promote the concept of 'all-Chinese' vessels on the world-wide market. According to Mr Tian, 'With this strategy, I believe we can develop new markets for Chinese yards. It will be a long march, but if we want to enter the international market, we have to make a start. Sumec's role will be to check quality and provide detailed specifications, and also to educate local manufacturers so that they can meet international standards'. 

Sinopacific establishes design centre

SINOPACIFIC Heavy Industries Group is a relatively new, private entity organisation within the Chinese shipbuilding industry. The group, established by a French-Chinese businessman, Simon Leung, now operates yards in three locations - in Dadong and Dayang, which are located between Shanghai and Nanjing, and Zhejiang in Ningbo.

Since being acquired by the group, these yards have all been upgraded. An additional slipway has been constructed at Zhejiang Shipyard, for example, and this is being used to build Aframax tankers. At Dayang the facilities have been extensively renovated, additional workshops constructed and the quay areas strengthened.

Sinopacific has also set up its own design office, Shanghai Design Associates (SDA), to provide design and technical support to shipyards in the group. One of the issues identified by Sinopacific was a lack of skilled people in the yards, and the concept is that,

through SDA, the company will be able to centralise and consolidate available professional expertise. According to David Wang, vice-president, SDA, 'Our yards in China need technical support and not just consultancy. We can provide the help needed to manage the production process'.

The company is, however, independent and can do work for other yards. According to Mr Wang, 'Our aim is to develop a wider customer base, and not just in China. SDA is able to offer a good solution for overseas companies, especially for design-optimising work, where the relatively low labour costs in China can be advantageous'.

SDA now employs more than 80 design staff, and this is expected to rise to around 100 by the end of this year. Mr Wang observes, 'Around a third of our staff are university educated. We are actively recruiting very high quality people'.

To support its design development work, SDA has invested in sophisticated computer

software, including the ShipConstructor suite from the Canadian company, Albacore Research. Indeed, SDA is now the designated training centre for ShipConstructor software in China. Mr Wang comments, 'We evaluated several options, but decided the ShipConstructor system gives us better levels of control, a high degree of reliability, and is relatively easy to use'.

Since being established in 2004, a number of new designs have been produced by SDA for the Sinopacific group yards. These include a 4250TEU container ship type, six of which are now being built at the Zhejiang Shipyard for the Conti Group. These GL-classed ships can carry 2800TEU of containers homogeneously loaded to 14tonnes, and have a service speed of 24.5knots, provided through a MAN B&W 8K90MC-C main engine. The vessels, the first of which will be delivered towards the end of 2007, also feature a relatively high reefer container intake capacity of 550FEU. 

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SWS makes its mark

CHINA'S biggest shipyard at the present time, Shanghai Waigaoqiao Shipbuilding (SWS), is a relative newcomer, having delivered its first vessel only in mid-2003. Already, however, it is a major player on the world stage.

Up until mid-2005, the yard has completed a total of 19 vessels of three types - 175,000dwt Capesize bulkers, 105,000dwt Aframax tankers, and FPSOs. During 2005, it is expected that the yard will deliver a total of 13 vessels, with a total deadweight of around 2 million tonnes.

These three product lines will remain the focus of the yard until 2009. SWS then plans to develop additional vessel types, including 300,000dwt VLCCs, as well as large container vessels.

SWS is today one of the world's leading builders of Capesize bulk carriers. Its current order book included contracts for Bocimar, Cardiff Marine, Cosco, NYK, Oak Maritime Canada, Poseidon Shipping, Geden Lines, and Wah Kwong Ship Management. K Line has also recently ordered a vessel of this type, for delivery in 2008, and this marks the first time that this Japanese shipping company has ordered a bulk carrier in China.

SWS has recently upgraded its Capesize bulk carrier design, and future deliveries will be rated at 177,000dwt. This will also be a more environment-friendly design, featuring tin-free coatings and low exhaust emissions, and will also include an optimised ballast

tank arrangement. The design will furthermore fully meet new IACS rules on bulk carrier design.

The yard currently has orders for a total of nine 105,000dwt Aframax tankers in hand. These include contracts for Greek and Italian interests.

To date, SWS has completed two FPSO newbuilding projects, one of 150,000dwt and another of 170,000dwt, both for China National Oil Co. The yard is now working on a 300,000dwt FPSO for Conoco Phillips China, which will be the largest built so far in China. This project is expected to be completed in 2006, when the FPSO will start operating in the Bohai Bay area.

The second phase of the yard's development was completed in May this year, and this has taken SWS' annual production capacity up to around 2.6 million dwt annually. Facilities now include two drydocks, one measuring 480m x 106m, and another of 360m x 76m, which are equipped with 600tonne gantry cranes, and a 300,000dwt capacity outfitting quay. Other facilities include a 400tonne NC ship frame bender, an automatic profile cutting production line, a 220tonnes, 21m roller type bender, eight NC plasma cutting machines, profile and steel plate pre-production lines, and a block panel production line. Further increases in production capacity at SWS are planned by the CSSC group, in line with demand levels.

Jinling rolls on

THE Jinling yard in Nanjing is one of the most experienced builders of ro-ro tonnage in China, having completed the *Finnmaster* and *Finnpulp* series of vessels since 2000, as well as *Ville de Bordeaux*, an unusual and very challenging vessel, custom-built to carry parts for the Airbus aircraft, which was completed in 2004 (*Significant Ships of 2004*). The yard has now received a further order, from Macoma Shipping, a UK-based company linked to Nordic Holding, for a pair of 11,300dwt ro-ro vessels, which will be long-term chartered by DFDS, of Denmark.

These vessels, designed by Jinling with assistance from SDARI, will incorporate 3343lane metres of deck space, and will be used primarily for the transportation of paper products. They will operate on the North Sea, and will be capable of speeds of up to 20knots, powered by twin MAN B&W 48/60-series main engines. The first of the two ships is due for delivery towards the end of 2007, and the second in early 2008.

An inland, riverside yard with transverse-launching berths, Jinling is currently busy building a series of 1100TEU container vessels for German, Dutch and Russian owners; 37,300dwt chemical tankers for

Swedish and German owners; 14,300dwt chemical tankers for a Swiss-based company; and 40,000dwt tankers for Nanjing Tanker, of China. The yard indicates that it has confirmed orders through until 2008, although there are some building slots still available in that year.

At present, Jinling is capable of building vessels up to around 50,000dwt, but is limited by the size of the Nanjing Changjiang Great Bridge which has to be passed under by vessels leaving the yard. This constraint could however be overcome by plans to build a new drydock at the former Yichen Zhenjiang shipyard in Jiangsu, about 100km from Nanjing, which would be capable of building vessels up to 100,000dwt. This site, which covers around 1 million square metres in total, would be operated by Jinling Shipyard as a second, complementary facility, and could be operational by 2007. At present, the Jiangsu site builds hull sections for Jinling, and also features a piping workshop.

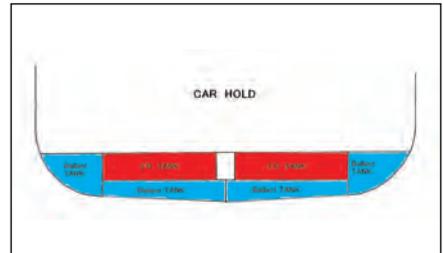
The project is awaiting approval by the China Changjiang National Shipping Group, of which Jinling is a part. It would require substantial investment, but is the only way that Jinling could expand its newbuilding portfolio beyond vessels of 50,000dwt size.

Innovative K-Line car carriers from NACKS

NANTONG COSCO KHI Ship Engineering Co Ltd (NACKS) has completed the first of a series of car carriers for K-Line, in what is the Japanese company's first newbuilding project in China. The 5000-car capacity, 15,000dwt *Shanghai Highway*, will be followed by two sister ships, *Tianjin Highway* and *Guangzhou Highway*.

The new Chinese-built PCTCs feature some significant new features designed to improve safety and environmental protection. For example, the fuel and bunker oil tanks have been situated within a triple-bottom structure in order to afford a higher level of protection in the event of damage to the ship's hull. This is the first time that K-Line has incorporated this design feature into one of its car carriers.

Shanghai Highway also represents the first time that the company has made use of an environment-friendly main MAN B&W ME-type engine. By controlling the fuel injection timing and the timing of the opening and closing of the exhaust valves with electronic

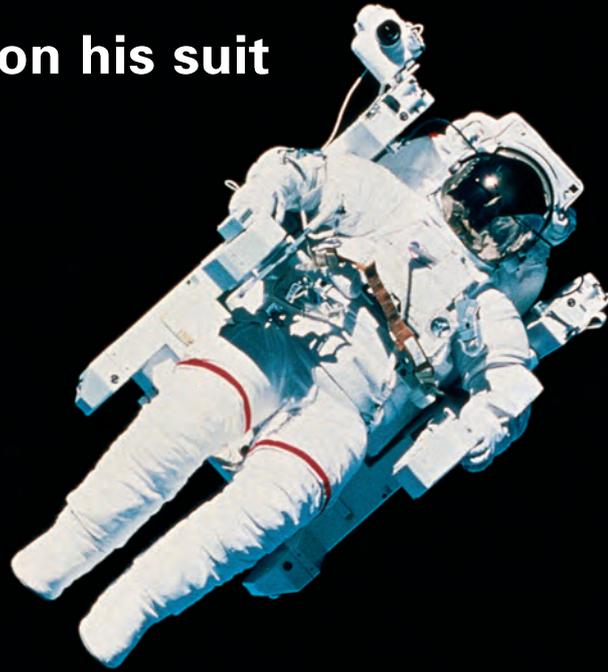


A cross-section through *Shanghai Highway's* hold, showing the interesting triple-bottom arrangement to give extra protection to fuel tanks.

signals, K Line expects to gain a number of benefits. These include a reduction in NOx emissions, as a consequence of optimised fuel injection timing; a reduction in particulate matter (PM) emissions in low load operations, as a result of high-pressure fuel injection, which improves combustibility; a reduction in CO₂ levels, as the optimised fuel injection timing also reduces fuel consumption in low load operations; and improved ship manoeuvrability, owing to enhanced reverse startability and reduced minimum engine speed.

In addition, *Shanghai Highway* is equipped with a soot removal system to remove particulates in the exhaust gas. Working with NGK Filters, K-Line has modified devices sold for onshore use to make them suitable for shipboard application. Using ceramic filters, particulates are collected in a tank under the filter, while every 75 seconds high-pressure air is used to clean the filter to prevent clogging. K-Line claims the soot removal system has a very high efficiency rating, of around 99%, and can capture very small particles.

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Benchijigua Express: world's first ro-pax trimaran in service

In this article, Guy Anderson details *Benchijigua Express*, the first ro-pax trimaran, on which the author recently experienced sea trials. The Austal-built trimaran hull form offers the first significant increase in an operational seakeeping envelope since the introduction of the high-speed light-craft ro-pax ferry 15 years ago.

IN 2000 Fred Olsen SA identified some limitations in terms of capacity and especially passenger comfort when operating high-speed ferries in rough seas. Thus the company embarked on a two-year cooperation agreement with Austal and carried out extensive research into solving this problem.

A design brief was accepted by Fred Olsen SA in early 2003, putting Austal's naval architects and engineers on their final circuit of the design spiral. This included resolving High Speed Craft Code 2000 and SOLAS compliance issues, plus the detailed design work on hull resistance, sea keeping, and structure. Less than six months later, the design was complete and construction of Austal's yard number 260 was under way.

Despite the exposure to risks presented by interpretations raised by class and flag authorities and shipyard logistics attending this unique design, Austal confidently accepted a very demanding build schedule. Launch was set for September 2004, allowing just 15 months for construction.

Propulsion and manoeuvring

The slender main hull presents adequate volume for propulsive machinery but a serious lack of



The recently delivered *Benchijigua Express*, is the world's first ro-pax trimaran.



Benchijigua Express has been fitted with four MTU 20V800 main engines and three Renk gearboxes, arranged in two engine rooms. Seen here are the aft units driving the steerable wing waterjets; the shaftline for the booster jet passes between them. Multi-disc steel membrane couplings and composite drive shafts were supplied by Vulkan.

TECHNICAL PARTICULARS *BENCHIJIGUA EXPRESS*

Length, oa.....	126.7m
Length, wl.....	114.8m
Beam, moulded.....	30.4m
Hull depth, moulded.....	8.2m
Hull draught (max).....	4.0m
Deadweight.....	1000tonnes
Crew.....	35
Passengers.....	1350
Vehicles.....	341 cars or 450 truck lanes metres and 123 cars
Speed.....	40.4knots, 500dwt, 32.8MW
Main engines.....	4 x MTU 20V 8000; 8200kW at 1150rev/min each
Gearboxes.....	2 x Renk ASL65; 1 x Renk ASL 2X80
Waterjets.....	2 x Kamewa 125 SII; 1 Kamewa 180 BII
Azimuthing bow thrusters.....	2 x Ulstein Aquamaster UL601
Generator sets.....	4 x MTU 12V 2000 M40 540kW each
Classification.....	Germanischer Lloyd +100A5, HSC-B OC3 High Speed Passenger/Ro-Ro Type MC, AUT

space for means to deploy thrust. However, Austal engineers arrived at some very elegant solutions for this design.

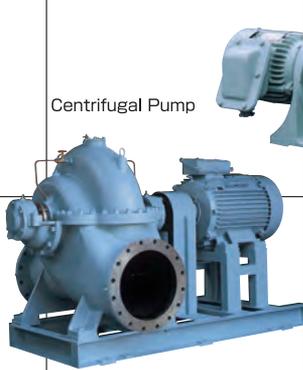
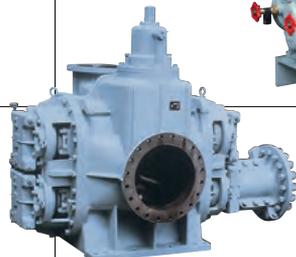
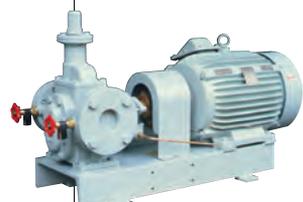
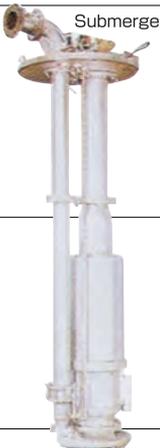
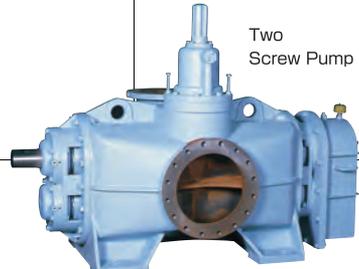
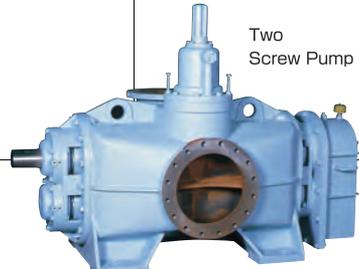
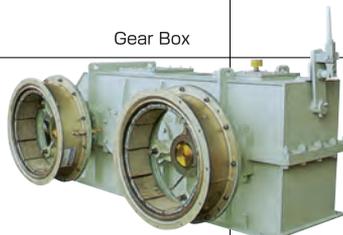
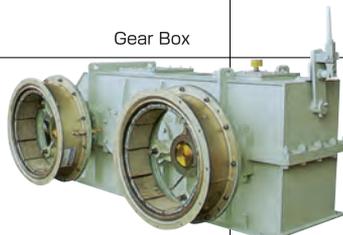
Three waterjets with centres arranged in a triangle on the transom occupy the very minimum space and thus reduce compromises in hull beam/length ratio. At the apex of the triangle is a Rolls-Royce Kamewa 180 BII waterjet, and slightly below it to port and starboard are the Rolls-Royce Kamewa 125 SII steerable reversing waterjets. Each of these wing units is powered by its own engine, the two engines

being installed in the aft engine room. All the engines have the same 8200kW power output and the intention is to uprate this to 9100kW each in 2006.

Four MTU 20V 8000 engines and the three Renk gearboxes are arranged in two engine rooms. The aft engine room contains a pair of MTU 20V 8000 engines. The engines are installed off centreline to permit the passage of the shaft for the boost jet. The two Renk ASL 65 single-stage reduction gears with horizontal offset for the steerable, reversing wing jets are a



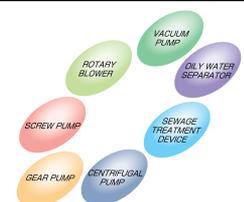
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LARGE FAST FERRIES

well-known, lightweight style gear including input clutch. Each gear has been sized to accept 9100kW at 1150rev/min and is driven by one diesel engine.

In the forward engine room two MTU 20V 8000 engines are installed fore and aft and separated just sufficiently to enable the output shaft from the forward engine to reach the gearbox, mounted aft in the compartment.

Exhausts for the aft engines exit via a funnel just above and aft of the command station. The exhaust attenuators are mounted vertically in a trunk that passes through the upper deck in way of its aft bulkhead.

This arrangement is very quiet both during manoeuvring and underway. The noise, vibration, and harshness levels are very low everywhere in the passenger compartment. The MTU engines, with the latest generation common-rail fuel injection and multi-stage turbocharging, ensure that passengers choosing to enjoy the open decks are not inconvenienced by either noise or the sight and smell of un-burnt fuel in the exhaust gases.

The arrangement challenged the Renk engineers to provide an innovative design for the twin input-single output gear. Its solution, the ASL 2 x 80, is designed for continuous maximum power input by two 9100kW diesel engines running at 1150rev/min. For maximum operational flexibility it also provides transmission when driven by either one of the engines.

The ASL 2 x 80 gearbox includes a clutch on each input shaft, primary reduction gears and a planetary second gear stage. The second gear stage provides a selectable two-speed output and enables the gearbox to match either twin or single engine input to the water jet. The overall design is compact and lighter in weight compared with conventional solutions.

The engines in the forward space exhaust via water-cooled ducts into the spaces between the hull and 'amahs'. The four MTU 12V 2000 M40 gensets are installed in the forward engine room. As a result a fifth, emergency genset is necessary and this MTU Series 60 machine is installed at observation deck level aft of the passenger cabin.

Ventilation for the forward engine room is supplied via a vertical duct incorporating the passenger lift shaft.

Control and safety

A control station, of minimum dimensions, is located above the observation deck. It is arranged for a three-person team, the master seated in the centre, with the chief engineer to port and chief officer to starboard. Visibility around the horizon is excellent with only a very small blind sector aft caused by the funnel.

The bridge is fitted with the latest in electronic, navigation, and communication equipment including inter-switched X and S band ARPA radars; electronic chart display, DGPS receiver, night vision, voyage data recorder, and steering control levers on the armrest for the master and chief officer. Austal's integrated monitoring, alarm and control system, Marine Link, ensures all vessel functions can be monitored and controlled from the chief engineer's console.

In order to ensure the highest levels of operability, *Benchijigua Express* is fitted with a sophisticated Seastate ride control system. Control surfaces include a T-foil forward, two roll fins at the aft 2/3 position and interceptors at the stern. Following sea trials, an additional rudder was fitted to enhance steering performance in extreme weather conditions.

The Fred Olsen SA ferry terminals in the Canary Islands have dedicated shore link-spans controlled from onboard the ship. The trimaran always berths stern first so an aft-facing docking console with CCTV monitors negates the need for bridge wings. The master stands on the centreline immediately aft his seat when berthing.

To ensure that turnaround times are kept to less than 30 minutes, Austal's trimaran was challenged to deliver manoeuvring characteristics equivalent or better than Fred Olsen's existing catamarans. Despite being much larger in terms of both length and capacity, this has been achieved by fitting two Ulstein Aquamaster UL601 electric retractable and azimuthing bow thrusters supplied by Rolls-Royce.

The 450kW thrusters and outboard water jets have an integrated control system to give the master excellent control, ensuring fast, efficient and safe operation in port. The master can choose to operate the bow thrusters and water jets independently via the extensive array of back-up controls.

Sea trials indicated that slow-speed manoeuvrability and dynamic positioning ability exceeded expectations. The trimaran was surprisingly agile when manoeuvring using the water jets only. Once in open water the electrically driven thrusters are retracted into the hull to reduce drag.

Hull fairing plates are fitted to reduce resistance when the thrusters are retracted and not in use. A Rolls-Royce propulsion control system links the jets and bridge.

Passenger evacuation is provided by Liferaft Systems Australia (LSA). The marine evacuation slide (MES) system consists of six MES in total. Arranged symmetrically three per side, a pair of 9m twin-path slides are installed aft at main deck level. Eight frames forward, but at mezzanine deck level, are a pair of 14m twin-

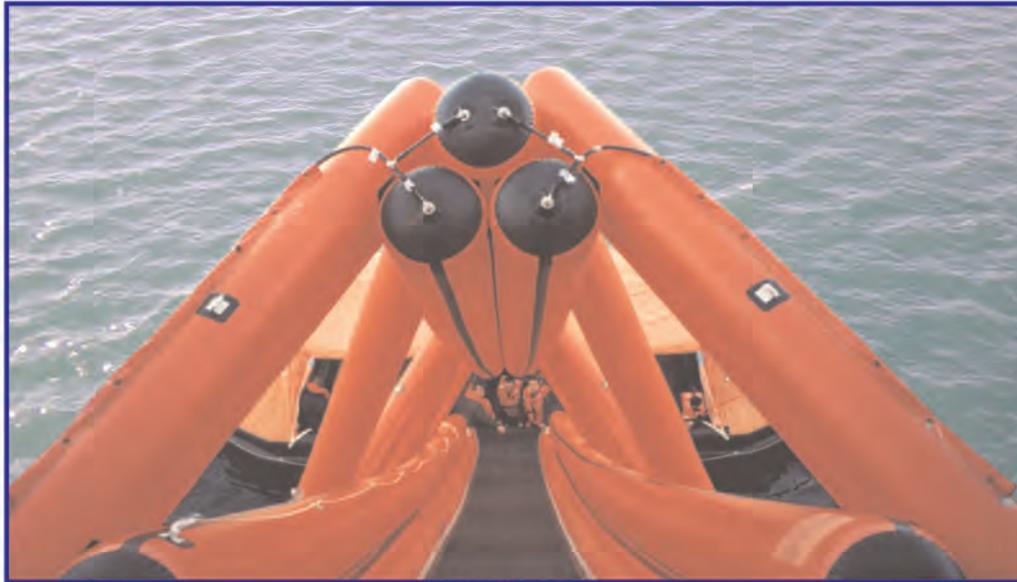
The onboard shop is glass-fronted and is located near the midship lounge.



This café servery area is light and airy, and is near the shop and inside and outside seating areas.



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path-slides. A further pair of 14m twin path-slides are located approximately central to the main passenger cabin.

Each of the six MES deploy a 100-person self-righting liferaft. An additional 10 100-person self-righting liferafts are installed and permanently linked to the marine evacuation slides, providing a total liferaft capacity of 1600 persons.

Interior layout

The interior design has followed the theme of previous Fred Olsen fast ferries. Passenger facilities for over 1200 persons onboard *Benchijigua Express* are located on one deck, the upper deck. Above this, on the observation deck, a VIP lounge caters for up to 134 'clase oro' (gold class) passengers.

Natural light and a view of the horizon are characteristics of the interior. Floor-to-ceiling windows feature in each of the vessel's main lounges. Three skylights above the central area of the main cabin, a skylight above the aft lounge and four skylights outboard provide additional natural light. The result is an apparent 360deg view of the horizon from anywhere in the upper deck, despite the presence of the central service areas.

The upper deck is divided into three distinctive lounge areas along its length, each featuring its own style of seating, colour scheme, and facilities. The aisles to and from the vehicle deck stairwells and between the lounge areas are spacious. The seating arrangements are varied and of high density; passengers travelling in groups will be able to sit together and maintain intimate conversation. Seating comes from the Beurteaux range.

Views may be enjoyed from the forward lounge which boasts a panoramic 300deg view of the horizon. The lounge caters for 296 passengers in forward facing Ocean Tourist reclining seats and is served by a bar equipped with facilities to provide a variety of food and beverages. Hard timber-style flooring around the front of the bar links to the passageways extending the length of the cabin port and starboard.

Access stairs to and from the forward vehicle deck are positioned port and starboard. Separating the aft lounge from the midships area is a facilities block containing male and female toilets, unisex disability toilet/baby changing room, and a passenger lift to the vehicle deck.

The midship lounge is the focal point for many onboard activities and is bordered by an impressive glass fronted shop/kiosk, outboard seating areas and aft, a café servery area. Hidden within in the shop are amplifiers for speaker loading, a VCR, an MP3 music player, a dual cassette deck and AM/FM tuner, a music monitor and selector panel, and a TV preview monitor. This is also the control centre for the purser, complete with a PA announcement panel, a general alarm/fire alarm push button panel and a digitised memory bank to pre-record announcements.

The most striking feature of the central area is the skylight, directing natural light onto the centre square. Here 78 passengers sit in tub-style seats around circular tables. Outboard, a further



From the forward lounge, 269 passengers can enjoy panoramic 300deg views of the horizon.

45 passengers are provided with tub seating around circular tables and sea views through the large floor to ceiling windows.

The children's play area is located in the aft end of the midship lounge on the port side; the playroom is decorated by colourful murals and comes complete with a 48cm monitor and VCR. Immediately outside the play area is seating for 48 supervising parents.

The café servery, faces forward, toward the shop. It is fitted with two refrigerated display units with curved glass fronts. Work areas and display racks are stainless steel laminated onto a lightweight honeycomb core. Behind the servery the food preparation area is surrounded with A-60 fire-resistant bulkheads and fire doors. It is outfitted with stainless steel worktops and shelving, three convection ovens with stands, three refrigerators, one freezer and two microwave ovens.

Just aft of the café and part of this central facilities block, is a fully equipped crew mess complete with seating for 20 crew members on comfortable lounge sofas positioned around three tables. A servery counter separates the mess from the rear of the food preparation area.

The aft lounge is finished with blues and reds, containing a mix of Ocean Tub seats with tables and Ocean Recliner style seats surrounding the forward facing bar which provides facilities to serve a wide variety of beverages and snacks. The bar is flanked by Ocean Tub seats with tables for 134 passengers while outboard of these a total of 264 passengers are seated in Ocean Club reclining seats. Passenger entertainment is provided by a large plasma screen TV monitor.

The observation deck is the gold class VIP lounge. Offering impressive sea views from the highest vantage point available to passengers, this deck is more than 13m above water level. Furnished in soft browns, the lounge is laid out with Beurteaux Ocean Tub and Ocean Executive seating for 134 passengers. A well equipped bar area complete

with six bar stools each with a circular foot rest serves these passengers. A private outdoor viewing deck is also provided with seats for 16 persons.

Passenger access

Six staircases (three each side) and the centrally located passenger lift comfortably transfer passengers between decks. The lift ensures passengers who may require assistance enjoy equal access to and from all areas.

Foot passengers board from midship and aft shell doors at main deck level. At the aft staircases foot passenger join the car passengers from the main deck. The aft staircases deliver the passengers from the main deck to the external viewing area on the upper deck. The midship staircases collect embarking passengers, the vehicle passengers from the main deck and car passengers from the mezzanine deck. The forward staircases collect the vehicle passengers from the main deck and from the mezzanine deck.

The external viewing area on the upper deck has seating for 112 on Beurteaux Ocean Steamer canvas outdoor seats. Entry to the cabin is via automatic sliding doors and each has a manual override system for a dead-ship condition.

Crew accommodation

A rarity for fast ferries, *Benchijigua Express* is equipped with crew cabins located in the centre hull below the main deck. Every comfort is provided in 12 two-berth cabins and four single-berth cabins. The single-berth cabins each have their own en suite bathroom while the two-berth cabins have shared en suite bathrooms.

A laundry room, fitted with an extraction fan and containing four washing machines, four driers and a full height linen store cupboard adjacent add to the comfortable living conditions for this fast ferry crew.

Vehicle facilities

With a capacity to carry 1350 passengers and 341 cars, *Benchijigua Express* will operate between Los Christianos in the south of Tenerife, and the islands of La Gomera and La

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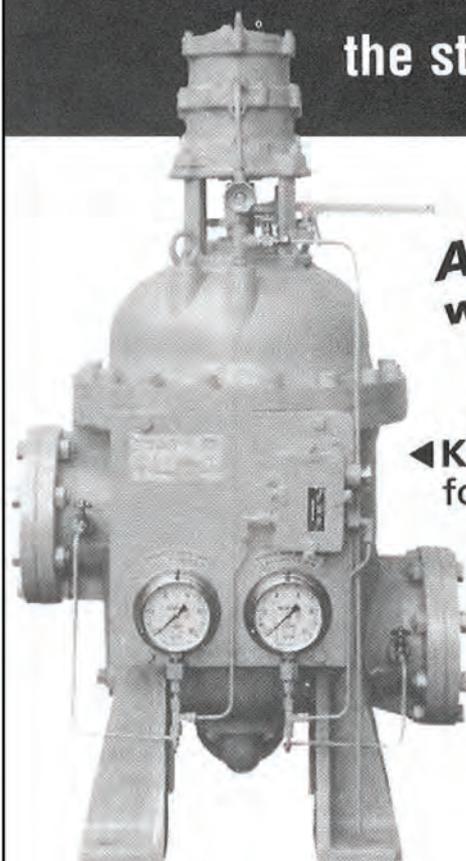
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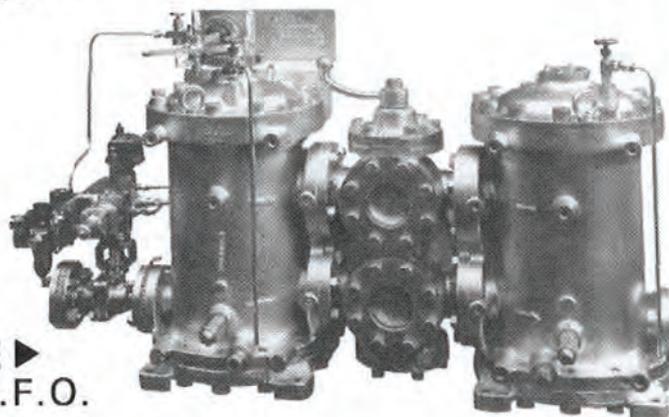
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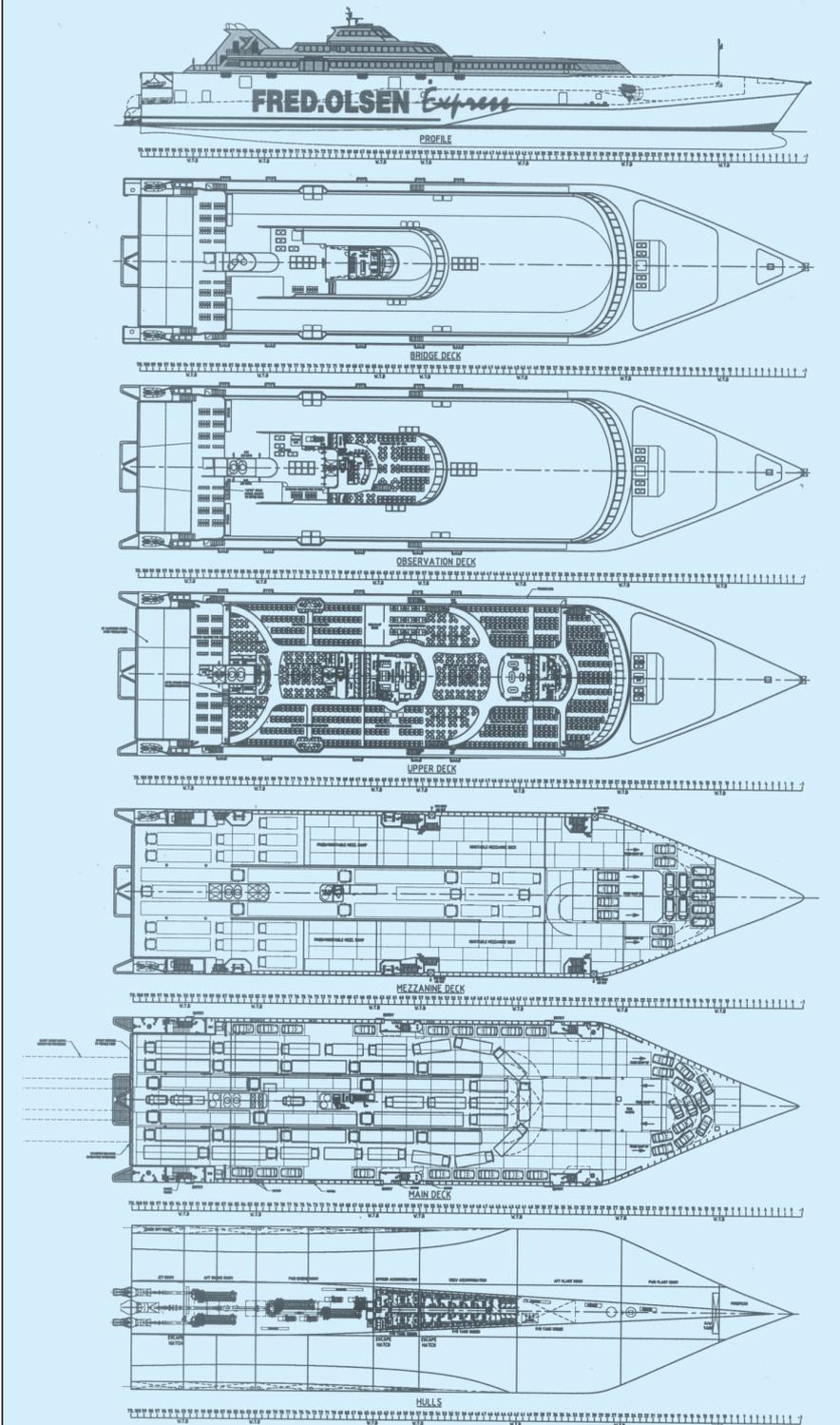


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General arrangement of *Benchijigua Express*, the Austal-built trimaran, currently serving on routes in the Canary Islands for Fred Olsen.



Palma. The vehicle decks offer a total of 450 truck lane metres, plus space for 123 cars or a total of 341 cars.

Hoistable mezzanine vehicle decks provide the flexibility to carry a mix of cars and freight. The main vehicle deck benefits from having full-width access across the stern; it is open forward and aft, creating a natural air flow through the space. Extraction fans are installed on each side to ventilate the area above and below the mezzanine decks.

High-speed craft may generate copious amounts of spray, especially in high sea states and strong winds. The trimaran is remarkable for the lack of spray generated at the bow of the amahs. The design of the stern areas also ensures minimal spray is dragged back onboard in the wake. Nevertheless spray protection for the vehicles is installed. The opening over the vehicle deck aft is protected by a light alloy structure at upper deck level and by curtains which can be drawn across the transom and tensioned manually.

Benchijigua Express is fitted with an active ballast tank heel control system. This consists of two ballast tanks and two heel control tanks. Both sets of tanks are designed to be filled in about five minutes on entering port. The ballast tanks are filled to increase draught to 4m. The heel control tanks are connected by two transfer pumps. With the tanks filled, the control system senses any change in heel angle during loading and unloading and rapidly transfers ballast to maintain a level deck. The ballast and heel control tanks are pumped out after loading.

Adhesive film livery

Close inspection reveals the hull and superstructure are not in fact protected by paint but by a self-adhesive film. Orca Marine's Offshore Film is a pure vinyl product that protects a surface much in the way paint does. The film has an expected lifespan of 10 to 12 years service depending on conditions. The use of protective film on areas above the waterline is expected to deliver substantial economic benefits due to a reduction in cost of application and a reduction in routine maintenance costs.

All passenger windows on the trimaran are fitted with a window washing system consisting of a nozzle located above each window. The water supply is controlled by electric solenoid valves operated from the closest bar or servery. The windows may be washed in sections rather than simultaneously.

In service

Benchijigua Express sailed to Tenerife via Cape Town. Three days later, on the May 2 2005 *Benchijigua Express* entered service. During her first day she performed without fault, completing seven one-way trips between San Sebastian de La Gomera and Los Cristianos (Tenerife), and one round trip between Los Cristianos and Santa Cruz de La Palma.

Austal chairman John Rothwell noted 'The theoretical advantage of the trimaran has now been clearly demonstrated in practice. This product has no peer in high-speed ocean transport and we now turn our focus towards the development of exciting new applications in the commercial and defence markets including the US Navy Littoral Combat Ship that is currently the subject of detailed design at Austal.'

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New Alaskan ferries designed by BMT Nigel Gee

TWO high-speed catamarans, designed by BMT Nigel Gee & Associates Ltd and now in service in the icy waters off southern Alaska, are believed to be the first fast vehicle ferries built in the USA. The 73m long passenger/car ferries, with an operating speed of 36knots, were constructed and delivered by the US shipbuilder Derecktor Shipyards, in Bridgeport, Connecticut.

The first to be delivered, *Fairweather*, which was put into service by the Alaska Marine Highways System in May 2004, achieved a top speed of more than 42knots during an initial sea trial. *Fairweather* now operates between the cities of Juneau and Sitka, where she makes the crossing in a little over five hours - less than half the time taken by the previous ferry for the 135 mile voyage.

Her sister, *Chenega*, launched in December 2004, was handed over to Alaska Marine Highways in May this year. However, the ferry, destined to sail between Cordova and Valdez in Alaska, was still completing crew training three months later - industrial action in the northernmost US state meant it was only due to enter service in mid-August.

Initial reports on the in-service performance of *Fairweather* have been glowing, especially regarding the fast speed.

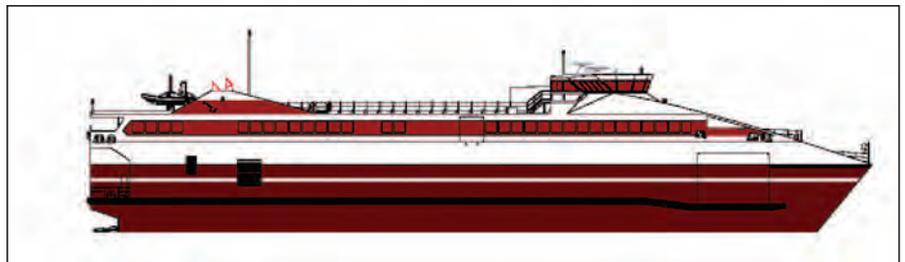
The new pair provides a vital link to the far-flung island communities in that part of the country. Included aboard the vessels is a helicopter pick-up area for emergency transportation should this be necessary.

The aluminium ferries are capable of carrying 250 passengers and 35 cars or a combination of truck/trailers and cars at speeds of around 36knots in comfort in the moderate sea state encountered in the region. High transport efficiency and low wake-wash characteristics are provided by the streamlined hull design.

Fairweather and *Chenega*, named after Alaskan glaciers, are each powered by four 3600kW high-speed MTU 16V595 TE70L diesel engines driving four Rolls-Royce Kamewa 90 SII waterjets. Each vessel is equipped with four 180kW Northern Lights generator sets.



One of the two new Alaskan ferries on sea trials.



Profile of the new Alaskan ferries designed by BMT Nigel Gee & Associates.

Passenger comfort is a major feature of the ferries, with a mixture of reclining and dining table seats in the interior main deck, the forward observation lounge and amidships snack bar. Further seating is available in exterior solariums aft. Features include separated dedicated areas for working and for playing video games.

Extensive noise reduction techniques, such as exhaust silencing and acoustic insulation, are employed onboard the ships to maintain noise levels below 75dB(A) throughout the interior.

Both ferries are classed to the standards of Det Norske Veritas and are approved by the US Coast Guard.

'The roll-on/roll-off ferries we have designed for Alaska State operate at high-speed, are highly fuel-efficient and are fitted with an active ride control system to provide comfortable motion in the anticipated sea state', reports John Bonafoux, technical director of BMT Nigel Gee and Associates Ltd. The ferries add to the designer's extensive portfolio of 100 vessels now in service around the world. ⚓

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New Gotland ferry under construction in Italy

AMONGST its many other interesting vessels on order, Italian shipbuilding group Fincantieri is constructing a new 122m high-speed ferry for Swedish owner Rederi AB Gotland for service in the Baltic. The keel for this vessel, with a top speed of 40knots, was laid at the Riva Trigoso, Genoa shipyard of Fincantieri's naval vessel business unit late in February 2005, with final delivery scheduled for early next year.

The Rederi AB Gotland subsidiary Destination Gotland already serves routes between the Swedish mainland and the holiday island of Gotland, with the 112.5m single-hulled high-speed craft *HSC Gotlandia* (built by Alstom Leroux & Lotz) and two larger Chinese-built fast ro-pax ferries, the 28.50knot *Gotland* and *Visby*, from Guangzhou Shipyard International (*The Naval Architect* April 2003, page 11).

Gotland's latest high-speed ship from Italy will be 16.65m wide and will be equipped with four 9000kW diesel engines driving four waterjets as well as two bow thrusters. With a maximum deadweight of 600tonnes, the ferry will be capable of carrying 800 passengers as well as more than 160 cars and eight buses. She will have a normal operating speed of some 36knots. The vessel is being constructed in accordance with the stringent requirements laid down by the Swedish Maritime Authority and will be equipped with catalytic converters to reduce the level of exhaust pollutants.

This Gotland vessel is the fifth of its type constructed by Fincantieri for service in the Baltic. The Finnish operator Silja Line, owned by Sea Containers, operates two 100m-long SuperSeaCat-type ferries constructed in 1999 for the Helsinki-to-Tallinn route. These SuperSeaCats, both 17m wide and with a top speed of 38knots, each carry respectively up to



An impression of the new high-speed 36knot ferry being built by Fincantieri's Riva Trigoso yard for Rederi AB Gotland.

671 and 707 passengers, as well as up to 140 cars and four buses. Guaranteed seating is offered to all passengers on two decks. Fincantieri has also delivered to the Estonian operator AS Tallink Grupp two high-speed passenger ferries for on its Baltic routes.

This Italian shipbuilder is drawing on different technologies, not least those from the naval field, in its design and construction of the new Gotland ferry. It employed these in creating a series of high-performance ferries built by its naval vessel business unit in the late 1990s.

These ships were developed from the experience of *Destriero*, which in 1992 won the Blue Riband, setting the record for the Atlantic crossing, without refuelling, at an average speed of more than 53knots, and peak speeds of almost 70knots.

The Gotland contract is important to the Italian shipbuilder as it strengthens its business links in Scandinavia. It is soon to deliver the first of three very large ro-pax designs, being built under a valuable contract, to the Finnish owner Finnlines, with an option for a further two vessels. ⚓

Rolls-Royce waterjets for Techno-Superliner

WHAT are believed to be the largest waterjets yet built are soon to go to sea on the latest version of Japan's Techno-Superliner, which is nearing completion at Mitsui's Tamano yard in Japan (*The Naval Architect* June 2005, page 52). Rolls-Royce Marine has designed and supplied two of its new Kamewa VLWJ235 waterjets, each of which will absorb 27,010kW, or 8% more than any others in the world at present, it is claimed.

The Techno-Superliner, named *Superliner Osagawara*, is destined to sail the route linking Tokyo with the Ogasawara islands when it finally goes into service later this year or early in 2006. She will carry up to 725 passengers and 210tonnes of cargo.

Waterjet propulsion will allow the ferry to cut the one-way voyage time by around 10 hours in contrast to the current ferry service - the Techno-Superliner is set to complete the 1000nm voyage between the Japanese capital and Ogasawara islands in 16 hours. The 14,500gt aluminium-hulled vessel is 140m long and will achieve a service speed of 37knots. Modules for

the waterjets were delivered on a schedule tailored to suit the ship's construction programme.

Propulsion for the Techno-Superliner marks a clear difference in design and capacity from the current Kamewa SII range of Rolls-Royce waterjets. The largest size of the SII range has a 2m diameter impeller while the jets for the new ferry are about 2.35m in diameter and use a different mechanical layout.

Each jet is divided into a series of elements. Integrated into the hull structure is the inlet duct. To this and to the transom is bolted the impeller chamber. Outboard of the impeller chamber is situated the guide vane chamber, also the steering and reversing system. The steering unit is operated by a hydraulic actuator located inside the hull via a stem that protrudes downward from the counter compartment over the jet units.

The impeller shaft is supported by a downstream bearing, has a seal box at its inboard end on the intake duct, and is supported within the hull by a split bearing. The massive thrust is

absorbed by a separate thrust block in the hull, connected to the impeller shaft by a stub shaft and coupling.

Smaller Kamewa SII-series waterjets have already been employed to propel multihull high-speed ferries in Europe, on Fred Olsen's AutoExpress 66 catamaran ferry *Bocayna Express*, constructed by Austal Ships, in Western Australia, and operating in the Canary Islands. However, the latest delivery to Fred Olsen is the world's first ro-pax trimaran, *Benchijigua Express*, delivered by Austal in May this year and now in service on routes linking Los Cristianos on Tenerife, San Sebastian, Gomera, and Palma island, again in the Canaries (see our special article in this issue).

Equipped with three Kamewa waterjets in the central hull, powered by four diesel engines located in separate engine rooms, the 127m aluminium-hulled ship delivers a service speed of more than 40knots. The trimaran configuration was selected to offer greater passenger comfort and transport efficiency in the prevailing rough sea conditions. ⚓



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Building progress with Incat's 112m-long catamaran

CONSTRUCTION of Incat Australia's 112m-long wave-piercing catamaran fast ferry is continuing apace, with the engineroom modules set up in a drydock in Hobart, Tasmania. This vessel, the largest high-speed ferry so far created by Revolution Design and constructed by Incat, the Tasmanian aluminium ship specialist, will achieve a speed of 40knots at 1000dwt. It will have capacity for around 412 cars or 589.9 truck lane metres plus 50 cars, and can carry up to 1400 passengers.

Wilson's complex, the deeper and wider drydock facility where the ferry is being constructed, was built by Incat to accommodate even larger vessels of up to and beyond 120m, and takes covered facilities at the Hobart yard to more than 50,000m².



An engineroom module for the 112m-long wavepiercing catamaran ferry being positioned during fabrication at Incat's Hobart yard.

It took two years to research the new 112m wave-piercing catamaran design, whose concept

was the subject of an article in *The Naval Architect* April 2005, page 6. Earlier, it became apparent that the capacity of Incat's previous 98m high-speed ferry, especially on the vehicle deck, was 'still not large enough for some high-volume ferry services, notably those in Europe', according to Incat's chairman, Robert Clifford.

Prefabrication work on the new catamaran had been in progress for some months prior to the laying of the first hull section of hull in May this year. The ferry is scheduled for completion by late 2006.

Modular construction, similar to that used to build the range of Incat 98m-long ships, is again being employed with the 112m vessel. However, the longer ferry displays a number of significant improvements over its predecessors. Transport efficiency is even greater - in combination with diesel engines chosen for improved specific fuel economy, the economics of operating the new vessel on a tonne deadweight scale are said to be approximately 18% better than previous wavepiercer designs.

Weight reduction has been a priority throughout the project, from the direct strength calculations and hydrodynamic modelling, through the development of lighter, stiffer extrusions for main decks, and composite driveshafts to save on machinery weight.

Each of the four drivelines comprises a single engine, gearbox and waterjet assembly. All four MAN B&W 20RK280 diesel engines are housed in a separate space. This allows for unscheduled maintenance to be carried out on one of the four trains while the vessel is underway on three engines.

Revolution Design points out that the ship's manoeuvrability is 'exceptional' due to the large-volume waterjets and an overall 30.30m beam. There is no requirement for additional bow thrusters, so maintaining a shallow draught and avoiding extra features.

The new ferry employs two trim tabs and a single retractable T-foil for ride control. If either surface suffers unexpected damage, the craft's ability to operate is not affected. Operating systems associated with these units can be serviced clear of the water.

This prototype ferry will contribute to ongoing research at Incat and Revolution Design by carrying a full hull monitoring system. Designed by Revolution, this will help quantify structural loads and fatigue-life details.

Now, Revolution Design has teamed up with Incat, the University of Tasmania, and the Australian Maritime College to carry out further research. A model test programme is underway in parallel with this vessel's design and construction, in which a segmented model will be used to further evaluate hydrodynamic loads on the hulls and centre bow structure.

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MANAGING RISK 


Forward-looking freighter has a future in shallow water

Many benefits are claimed for a modular-construction concept, which features a tunnel running through the length of the hull, reports David Foxwell, in this lead article for our annual Germany report.

THE first example of a completely new type of sea-river vessel with unit-based modular construction, intended for use in shallow water on Europe's inland waterways, is under construction at Con-Mar Ingenieurgesellschaft, in Brake, and is due to be launched in mid-November.

Designed by former Schiffko naval architects at New-Logistics, in Kiel, working closely with Schiffko, the Futura Carrier is the first example of a range of innovative designs intended for use on the inland waterways system and in sheltered, coastal waters. Other examples include a Futura Tanker, a pure container carrier, and a proposed Futura Ferry.

The keel-laying of the first Futura Carrier took place at the Con-Mar yard in early June, this first example of the new design being 97.50m length overall with a breadth of 13.60m, draught of 4.15m, cargo hold of some 5000m³, and deadweight of approximately 3000tonnes.

Tailored to carry a mix of rolled paper and strengthened for the carriage of steel coils with containers on deck, the prototype Futura Carrier will be powered by four MTU Series 2000 main engines each rated at 600kW and each driving a HRP 5000 rudder propeller at each 'corner' of the vessel.

RMS Kiel, as the vessel will be christened, has been ordered by BWK Schiffsinvest MS RMS Kiel GmbH at a cost of some €6.8 million, part of which is funded by the Federal German Ministry of the Environment. In April, federal minister for the environment Jürgen Trittin awarded a further €2.2 million support package to the Futura Carrier river/coastal freighter, which will be operated by RMS in its trades between the UK and Wörth, on the upper Rhine.

Replacing old and obsolete designs

Ships destined primarily for use on inland waterways have mainly been built and operated as relatively 'fat', single-hull displacement vessels



An artist's concept of New-Logistics' Futura Carrier.

with little priority accorded to the ratio between ship weight and the weight of the load carried or the geometry of the load. Moreover, when the great majority of these ships were built, the container had not even been invented.

Today, much importance is attached to a high container-carrying capacity, and with new ships becoming ever wider in the beam it is increasingly difficult for them to operate economically, particularly in shallow water. For many years, it has been extremely difficult to operate this kind of inland waterways ship in a competitive manner at all, which, in Germany, and elsewhere, has led to a significant reduction in the number of new freight-carrying ships

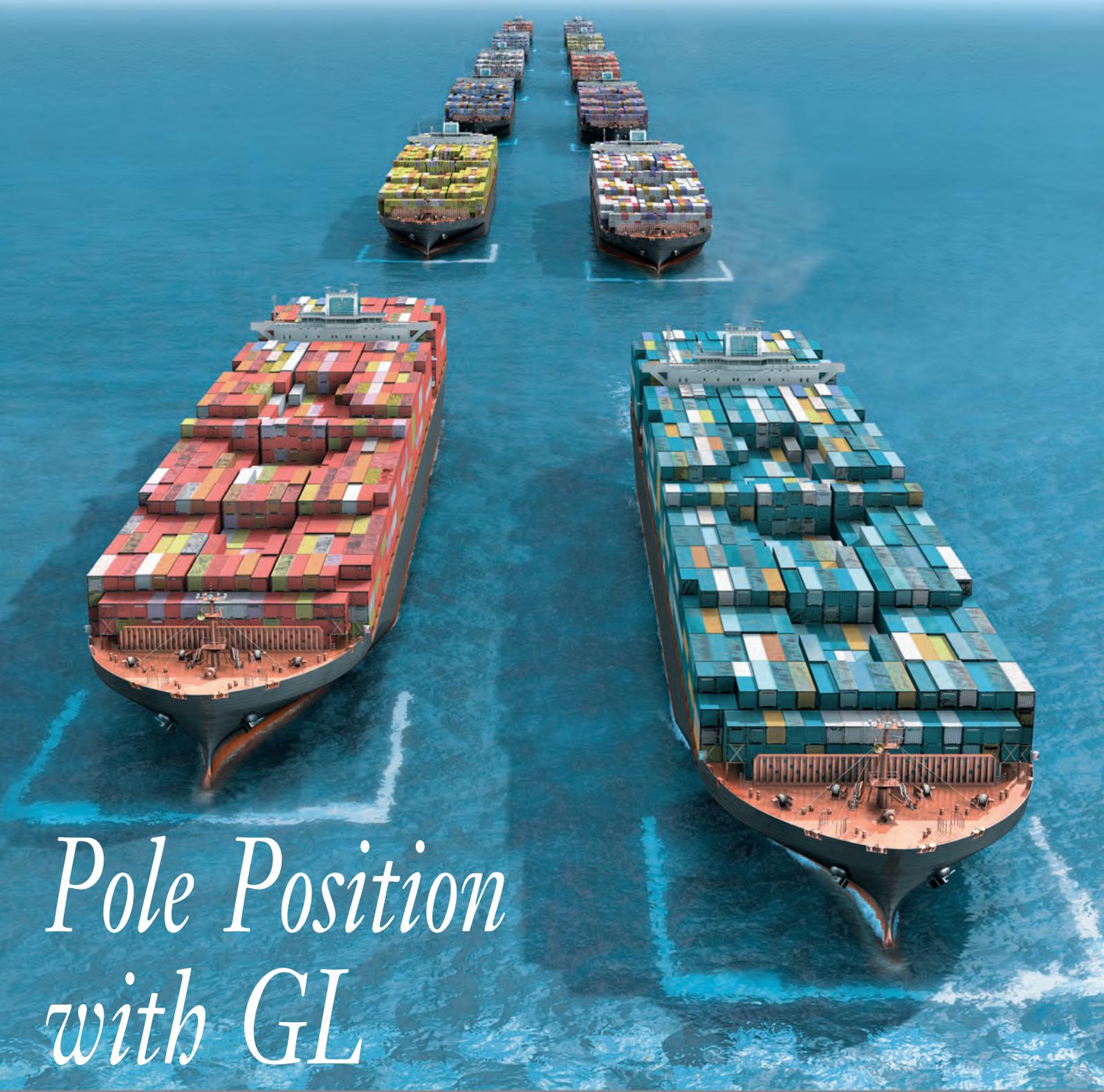
being built for inland use. This, in turn, has led to a situation where much of the German inland waterways fleet is approaching obsolescence.

Waterborne transport on inland waterways also suffers in comparison with transport by road or rail in as much as it is slow. There are also various other limitations - such as depth restrictions, clearance height beneath bridges, beam restrictions in canals, size limitations imposed by locks, and the effects of seasonal changes in the water level. On the other hand, inland waterway transportation is extremely economical and environment-friendly.

The Futura Carrier combines a novel hull form, innovative propulsion with propulsors, with an optional air bubble lubrication system designed to reduce resistance, a combination that New-Logistics believes will provide a number of advantages compared with existing, conventional inland and coastal vessels, including:

- greater freight carrying capacity at the same draught or the same freight carrying capacity with reduced draught
- low fuel consumption, and hence reduced operating costs and reduced environmental impact
- very high levels of manoeuvrability
- reduced space required in port (any berth that provides the ship's length plus a minimum tolerance of approximately 1m-2m fore and aft can be reached quickly and easily)
- a high level of operational safety.

TECHNICAL PARTICULARS RMS KIEL			
Length, oa.....	97.50m		
Breadth.....	13.60m		
Draught	4.00m		
Deadweight	3300dwt		
TEU/hold.....	230/5180m ³		
Futura Tanker Concept Designs			
Length	110.00m	85.90m	85.00m
Breadth	11.45m	11.45m	9.50m
Draught	3.50m	3.50m	3.00m
Deadweight	2900tonnes	2250tonnes	1500tonnes
Tank capacity	3500m ³	2500m ³	1800m ³



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Unlike a conventional displacement hull form of the type normally used on an inland navigation vessel, the novel hull form selected for the Futura Carrier, for which a patent has been applied, has a tunnel running the length of the vessel which reduces wetted area and frictional resistance. The geometry of the bow and stern has been optimised to operate in the extreme water flow conditions often experienced in shallow water and in restricted waterways, the hull having been exhaustively tested at the SVA model tank, in Potsdam, Germany.

The location of the propulsors was selected in such a way as to ensure that they are always provided with good water flow conditions, even when in shallow or restricted waters. The propulsion system is based on four identical, fully azimuthing units, each driven by an identical engine, which provide excellent manoeuvrability with relatively small propeller diameters and contribute to ease of operation in shallow waters, an arrangement which ensures that, in the event of repair or overhaul, the propulsion modules can be quickly and easily replaced, avoiding long periods out of service. New-Logistics notes, however, that, if required, an owner can opt to fit different propulsor types fore and aft.

Ease of construction is another important feature of the design, the accommodation modules being prefabricated, self-sufficient units which are fully outfitted prior to final assembly, the wheelhouse of all types of Futura Carrier being largely identical in respect of technical and ergonomic features. Division of space, design and finish are individually tailored to customer requirements, and all the container and cargo holds can be equipped with optional Flexiguide cell-guide bulkheads.

Due to the concept's specially developed hull lines, and the optional installation of cell guides which can be equipped with illuminated indicators linked to the ship's loading computer, loading and discharge of containers is efficient and uncomplicated, even using container cranes in sea ports. These features make the Futura Carrier ideal for 24 hour operation (for which, in

addition to a navigation radar, it is also fitted with an infra-red camera system for safe navigation at night).

Model tests

In order to evaluate the behaviour, handling characteristics and powering requirements, model tests of the Futura Carrier were carried out in deep and shallow water, the shallow water tests being particularly interesting, a 1:10 scale model having been tested in a basin some 8m wide with a water depth of 350mm. The model ship - which represented a vessel 135m in length with a beam of 18.90m, draught of 2.50m, and deadweight of 3800tonnes - was loaded to a draught that corresponded to manoeuvring in a canal 80m wide and 3.5m deep, and was able to navigate successfully in conditions that would have rendered a conventional inland ship with a draught of approximately 3.50m inoperable.

As the company explains, passage through a waterway such as a canal is subject to many restrictions. In deep, unrestricted water, the displacement current induced by the ship can spread out on all sides, but in a canal it has to work its way around and beneath the ship.

Important benefits for canal operation

Every ship in motion constantly displaces an amount of water corresponding to its submerged volume, pushing that mass of water along as a bow wave. In a canal, this leads to an important drop in the water level around the ship, as higher backflow speeds beside and beneath the ship ensure that the canal behind the ship is refilled to its original water level.

As a ship's speed increases, so the speed of the backflow also has to increase. However, each increase in backflow speed adds to the resistance experienced by the vessel, which leads to a physically determined limit on speed, which decreases in direct proportion to the relation between the canal cross-section and the cross-section of the ship's main frames.

Unlike a conventional inland ship, the advantageous hull shape of the Futura Carrier

allows it to make way within the possible speed limitations without important trim requirements and at low propulsion performance levels. When a ship is making way through unrestricted waters, it generates a wave system that is only speed-related, and which results in a specific wave resistance against the ship. As the water depth reduces, wave height and length increase due to constriction of the water flow configuration.

This means that in shallow water, at a relatively low speed, a ship already generates a wave configuration that would not normally be generated until a higher speed was obtained in deeper water. The same wave configuration allows us to infer the same resistance.

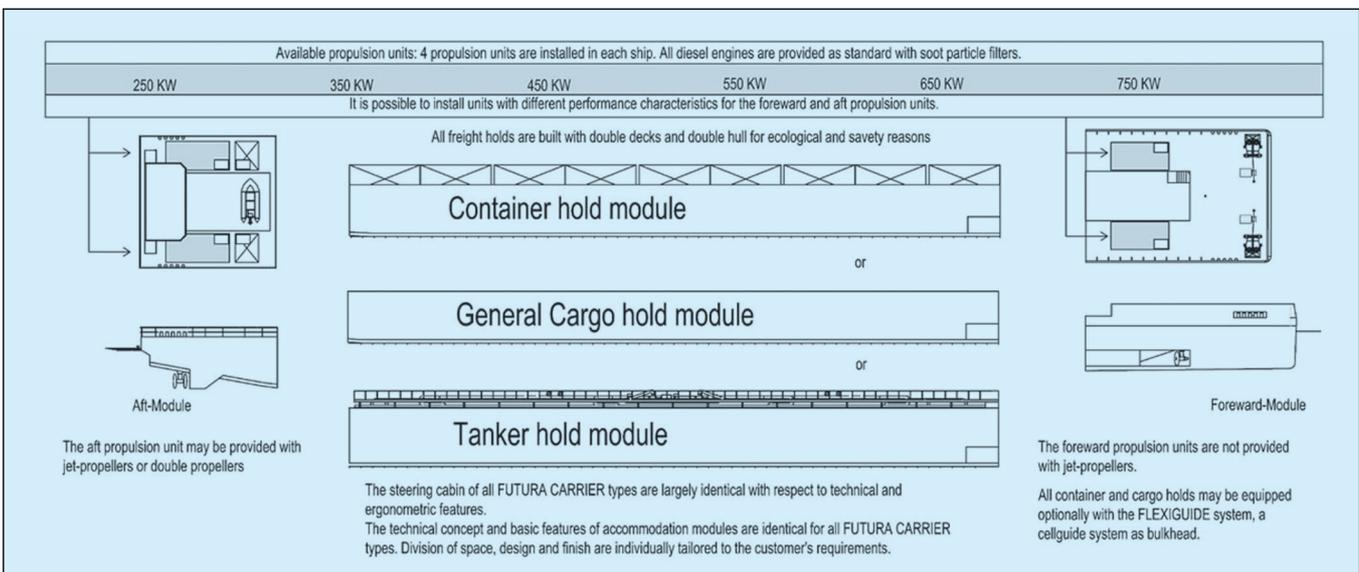
However, at a speed of advance equivalent to approximately 11km/h, the Futura Carrier has a very positive wave configuration, a configuration which can be further reduced by the use of air bubble lubrication, which, claims New-Logistics, all but eliminates the wave configuration experienced at that speed.

'With the air-bubble lubrication in operation, no noticeable wave system was induced by the model at all', says the company, noting that the test results clearly demonstrated that the use of the air bubble lubrication system significantly reduced hull resistance and, therefore, the propulsion power required.

In fact, as New-Logistic's managing director Udo Wulf explained, the tank tests and propulsion tests in Potsdam showed that the shape of the ship's bow, air bubble lubrication, and quartet of propulsors resulted in propulsion performance and cost savings of around 35%, in addition increased high manoeuvrability and a high level of redundancy and hence operational safety compared with an inland vessel with conventional hull lines and stern-mounted propulsion.

The air bubble or 'micro-bubble' air lubrication system can be installed as an 'add-on', Mr Wulf reports, and is used to create an air film that adheres to the hull surface. This is based on tried and tested technology used in waste water treatment that requires little power. *continued*

The Futura Carrier is designed for modular construction, using virtual identical bow and stern sections. These diagrams indicate the various possibilities for fore and aft modules.





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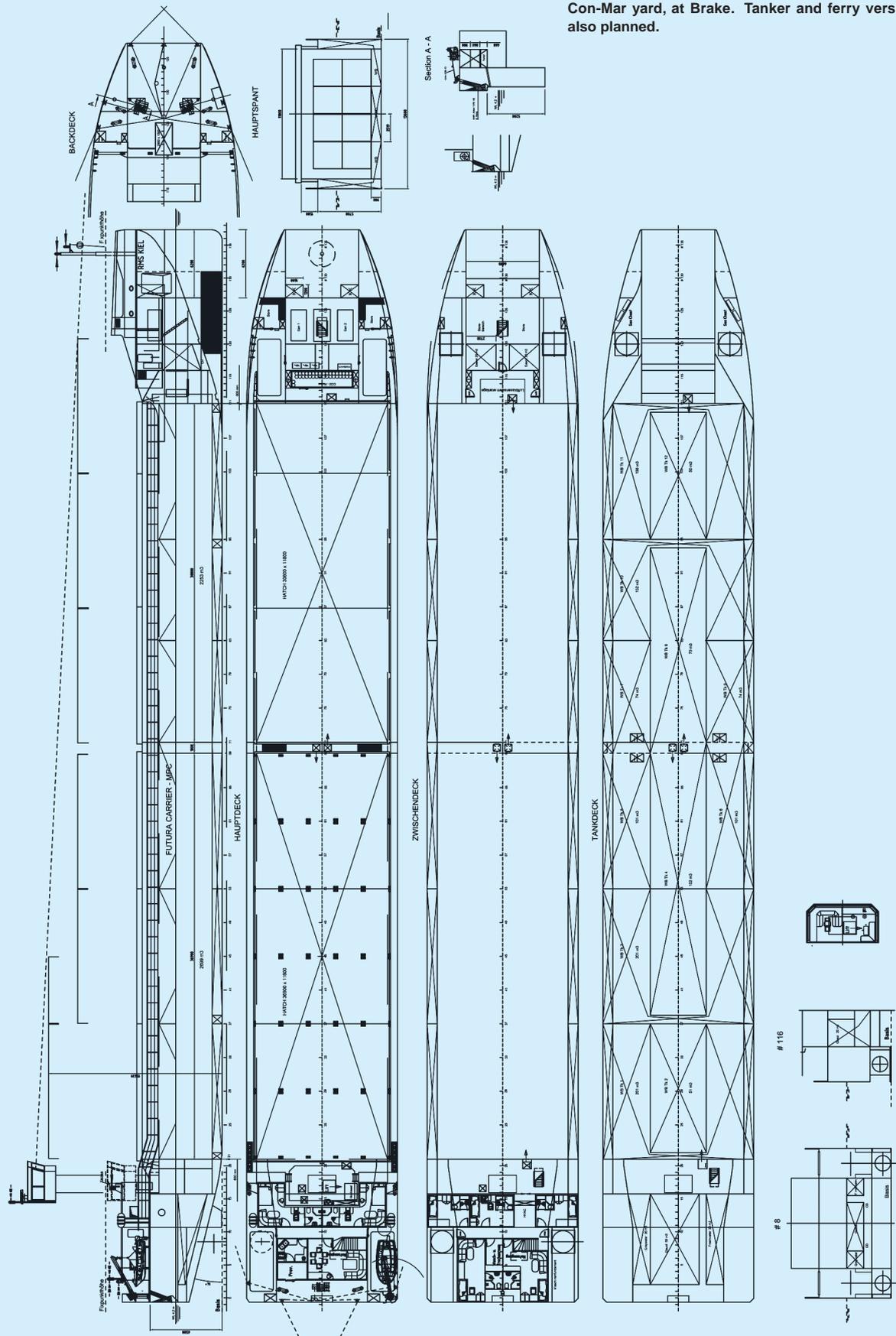
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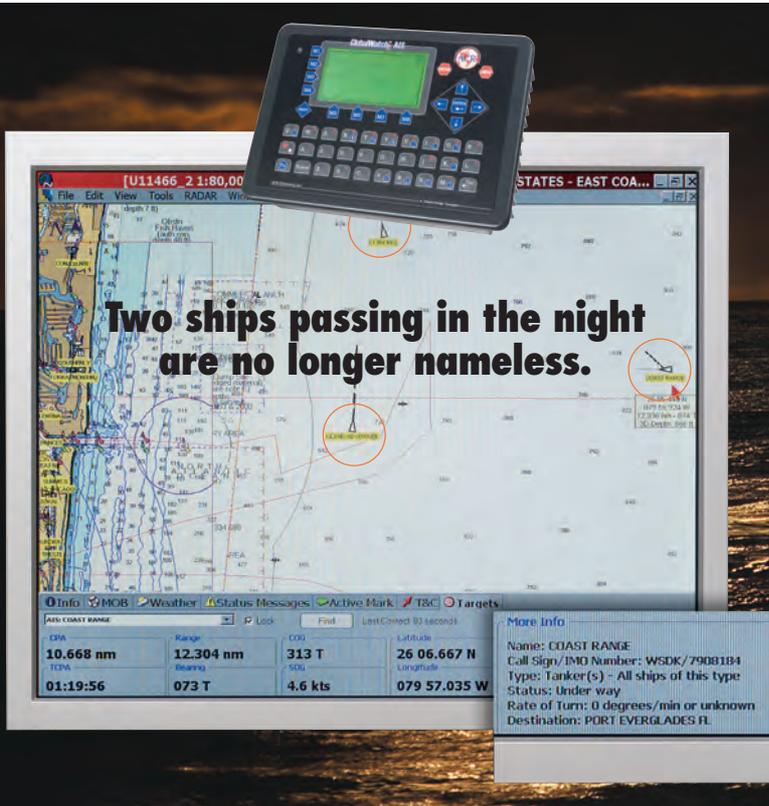
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General arrangement plans of New-Logistics' advanced short-sea/inland cargo ship, the Futura Carrier. The first example is expected to be launched late this year by the Con-Mar yard, at Brake. Tanker and ferry versions are also planned.



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An artist's concept of New-Logistics' Futura ferry.

Looking to the longer term, New-Logistics is understood to be negotiating construction of a pair of double-hull tank vessels for inland waterways; an iron ore carrier for the same use; and a combination carrier for transporting cement in the coastal trades.

Futura tankers

Tanker versions of the Futura Carrier concept would have a number of additional advantages, notes Mr Wulf, as almost all existing vessel types are single-hull designs, and the modifications required to convert them into double-hull vessels have proved difficult and usually resulted in a reduction in cargo capacity. In the New-Logistics' design, however, the Futura Carrier hull geometry has enabled the production of a double-hull design with the same cargo capacity as a comparable single-hull vessel.

The German company has provided details of a trio of proposed Futura Tanker designs, ranging in length from 85m to 110m, and in deadweight from 1500tonnes to 2900tonnes. It has also developed a family of basic container ships, ranging in length from 85.00m with a deadweight of 1600dwt carrying up to 84TEU, to a much larger vessel of 135m overall with a deadweight of 6700tonnes carrying 490TEU.

Futura ferry

A family of Futura Ferry double-ended ferry designs is also on the drawing board, these having an open car deck on one level and passenger accommodation above on another, separate deck. Also intended for use on inland waterways and in sheltered, coastal waters, the Futura Ferry also has a quartet of azimuthing propulsors and would make use of the same air bubble lubrication system.

New-Logistics' proposed 500-30 Futura Ferry is 80m overall with a beam of 16m, and draught of 1.80m. Displacing some 1400tonnes, with a minimum freeboard to the vehicle deck of 2.40m, this version has 240lane metres for trucks and 160lane metres for cars, with 4.5m headroom on the car deck and passenger accommodation spaces of some 530m². The propulsion machinery takes the form of a quartet of 900kW main engines providing a service speed of 16knots with a 400tonne load.

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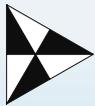
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Mooring system reduces ship motion

WORKING closely with Marine Service GmbH, the Hamburg-based consultancy, Hatlapa has developed an advanced mooring system primarily intended for use with larger oil and gas tankers. This is specially designed for use on ships required to load and unload at piers or floating platforms outside sheltered coastal waters, where they may be exposed to substantial forces from wind, waves, and currents that can produce significant motions.

As the company points out, excessive vessel motions can lead to an interruption in loading and unloading or, in a worst-case scenario, to the disconnection of loading arms and hoses. Larger vessels can create high dynamic loads on mooring lines, while cyclic tensioning and de-tensioning during vessel motions can cause fatigue in mooring lines in a relatively short period of time. Hatlapa highlights, however, that the cause of excessive movement of moored vessels is not just the magnitude of the forces acting on the vessel, but also of the cyclical component of these forces.

To reduce the movement of a vessel, it is necessary to continuously absorb energy from the system at the same rate at which energy is 'added' by the waves, currents, and wind. A conventional solution to reduce the amplitude of oscillating systems would be to install shock absorbers or dampers, such as dampers in the fenders. However, because the speed of the movement in question is very slow, such a damper would have to have a very high stiffness to be effective, thus making the fenders very stiff and increasing the risk of damaging a hull during berthing.

Hatlapa's solution to improve the performance of conventional mooring systems and reduce vessel motions is to add two additional mooring winches and lines with a control system similar to a constant-tension system. In contrast to constant-tension winches, however, the control system adjusts tension of the mooring line depending on the rotational direction of the winch drum, allowing them to effectively act as damping units.

If the drum pays out the line, the pull is set to the maximum pull of the drum, whilst during hauling-in, tension is reduced to a minimum to avoid a slackening of the line, or too large a variation in the line load. Steel ropes with tails are used in the damping winch units in order to couple rotation of the drum as directly as possible to the vessel's motions, and the units can be located on the pier and pull the ship, or vice versa.

The damping units can be electrically or hydraulically driven, although a high-pressure hydraulic system has the advantage that the cooling required is simpler because, as the unit continuously extracts energy from the vessel, heat generated is absorbed from the hydraulic oil by a cooler.

Hatlapa says calculations prove that the mooring system with damping units is capable of reducing a vessel's motions very effectively, with, for example, the amplitude of swaying

motions reduced by about 80% from approximately 1m to about 200mm in one instance.

To make sure that the wire stays in good shape for a long time, notes Hatlapa, a spooling device should be installed and, depending on the situation, it might be necessary to install deviation points in front of the winches to prevent inadmissible deviation angles of the steel wire to the spooling device.

Working with Marine Service in Hamburg, Hatlapa has developed a mooring system designed to reduce ship motions in exposed locations.



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Equipment manufacturers on the crest of a wave

GERMAN equipment manufacturers are making the most of the current high level of demand for their products by investing for the future, which, the VDMA, the German Engineering Federation, believes is unlikely to see orders sustained at such a high level. Speaking in June, Dr Alexander Nürnberg, chairman of VDMA's marine and offshore Equipment section, said the marine equipment industry was using full order books 'to sharpen our international competitive edge'. With around 70,000 employees, German marine equipment suppliers registered sales of approximately €8.7 billion in 2004, achieving average growth of 5.2% compared with the previous year.

Speaking at the VDMA's annual press conference, Dr Nürnberg said he anticipated that global shipbuilding production would probably continue at a very high level for the next two to three years but anticipated that, due to the cyclical nature of the industry, what he called the 'fat years' would be followed by lean ones. 'We want to focus on preparing ourselves for these now and invest a high proportion of our profits in the future', Dr Nürnberg explained, noting that, of the many small or medium-sized equipment suppliers in Germany, around 80% expected to see further growth in orders from overseas this year, with

some 60% also expecting more business from domestic customers - both for container ships and special-purpose vessels.

However, Dr Nürnberg noted that this gratifying situation was to some extent overshadowed by increasingly fierce competition, particularly from Asia and other non-EU countries, and by issues such as the Dollar/Euro exchange rate, difficulties obtaining raw materials, their high cost, short delivery deadlines and other factors that would not make it easy for manufacturers to maintain the current high level of capacity utilisation they are experiencing or improve their profitability.

Faced with increased competition and with increased costs, German manufacturers were concentrating on distinguishing themselves by developing innovative products and components, and by focusing on enhancing their global service and support networks, which had, he explained, become an increasingly important factor in the marketplace.

The dominance of the Asian shipbuilding market continued to be evident in 2004, Dr Nürnberg noted, and with some 2410 orders booked worldwide, 633 ships were accounted for by Japanese yards, 514 by South Korean yards, 384 by China, 282 by the EU (and 358 by the newly enlarged EU countries), with 76 orders booked by German yards, and 236 in the rest of Europe.

Demand for equipment for the offshore oil and gas industry also continued to increase significantly as a result of the strong growth in demand, particularly from China, and high energy prices, which also stimulated investment. 'In 2004, expenditure by global oil and gas companies surged by 7.5% to approximately US\$160 billion, including around US\$100 billion for the offshore area', noted Dr Nürnberg, referring to German suppliers' excellent opportunities for significantly increasing their world market share (currently at a level of about 3%) in the medium term by offering future-oriented solutions for equipment for deployment in very deep waters.

Increasingly, noted Dr Nürnberg, marine equipment suppliers are focusing on serving not just as suppliers, but as life-cycle partners for their customers. As he also reported, 'selling marine equipment increasingly means being where the customer is, and in this respect our Asian competitors in Korea and China naturally have advantages that we have to offset', emphasising that many German marine equipment suppliers are investing in production facilities in the region, their aim being not just to safeguard exports and thus also jobs in Germany by reducing production costs, but also ensuring that they have improved 'market presence' for sales and service, and are able to meet 'local content' requirements. Ⓢ

HSVA participating in Arctic shipping initiative

THE Hamburg Ship Model Basin (HSVA) is an active participant in an EU-sponsored project called SAFEICE, the main aim of which is to improve the safety and cost-effectiveness of Arctic shipping, and to reduce the potential risk of the environmental impact of navigation in the Arctic. The three-year project got under way in September of last year.

Apart from HSVA, research organisations in Canada, Japan, and Russia are also participating. SAFEICE is focusing on research in three complementary areas:

- ice loading on ships
- development of ship structures for improved ice load carrying capacity
- an integrated traffic control infrastructure.

As HSVA points out, customising ships to enable them to navigate safely in icy waters is important, but there is also a need for a more direct and transparent design approach based on first principles. The project will also find ways to enhance and improve the support infrastructure for ships navigating in this part of the world, including furnishing vessels with better 'ice state' information, including real-

time ice charts and forecasts. However, the main aim of the SAFEICE project is to create a scientific basis for new, improved ice class rules. The specific goals of the project are to:

- develop semi-empirical methods based on measurements to determine the ice loads on a ship hull
- determine relationships between operational conditions and ice load
- develop ship-ice interaction models
- assess the design ice loads on ships' hulls
- develop methods to estimate the ultimate strength of shell plating and frames
- develop methods to analyse ice damage.

The goals will be achieved by compiling a database of existing information on ice loads and ice pressure; using advanced model tests with local ice-load measurements on the model surface; and using numerical models to obtain an overall view of the ice loading on a hull as a function of the ship speed in a suitable range of ice thickness values. HSVA is the lead organisation for EU Work Package 6, which is addressing load modelling. Further information on SAFEICE can be found at www.hut.fi/units/ship/research/safeice/public. Ⓢ

SRPs selected for innovative Norwegian ferries

AN order for the propulsors for a series of five 129.5m double-ended LNG-powered ferries, which are being built by Aker Brattvaag, in Norway, for ferry operator Fjord 1 has been won by Schottel. The ferries will operate on two routes in the Bergen and Stavanger areas, and were designed by LMG Marin, in Bergen (*The Naval Architect*, January 2005, page 18), after extensive model testing at Marintek, in Norway.

Three larger ferries will each be equipped with a quartet of Schottel SCD 2020 Combi Drives (4 x 2750kW, twin-propeller version) and are designed for a speed of 21knots.

Two more ferries of similar design but smaller capacity will be equipped with four mechanically-driven STP 1515 twin propellers, each of 1600kW, giving these vessels a cruising speed of 17knots. Ⓢ

Fin stabilisers in demand for cruise ships



A typical modern folding fin stabiliser from B+V Industrietechnik, showing the tip fairings now fitted to all models to reduce cavitation and improve lift.

HAMBURG-based B+V Industrietechnik has recently secured its 528th order for fin stabilisers in the form of a set for the new cruise ship ordered by NCL from Meyer Werft in May of this year. The company has enjoyed a high level of orders for its range of fin systems during the last 12 months, securing a particularly large number of orders for cruise ships.

As the company notes, the development of modern ferries, cruise ships and larger types of yacht has led to increased demand for roll stabilisation, a demand that B+V Industrietechnik has responded to with its Simplex-Compact retractable S-series and FK-series fixed types. Today, all Simplex-Complex fin stabilisers from the company are equipped with anti-vortex fairings to prevent the onset of cavitation, and thus increase lift, reduce drag, and save fuel.

The new NCL liner will be fitted with S700 fin stabilisers each with an area of 14m². In July, B+V Industrietechnik also received an order for S300 fin stabilisers with areas of 4.2m² for three vessels for the Norwegian Coast Guard, and in April signed a contract with the Italian yard Nuovi Cantieri Apuania for S400 fins each with an area of 5.5m² for a quartet of ferries for

Genoa-based Grimaldi. Earlier in the year, two shipsets of 16m² S700 fin stabilisers were ordered for Aida newbuildings at Meyer Werft. Both Grimaldi and Aida are repeat customers for the German company's products.

B+V Industrietechnik fin stabilisers have also been ordered for newbuildings at Aker Finnyards for Royal Caribbean International. Each of the two *Freedom*-class vessels now under construction will receive S800 fin stabilisers with fin areas of 18m², with negotiations for fin stabilisers for the third *Freedom*-class vessel currently ongoing.

The company's range of fin stabilisers is split into eight sizes, starting with the smallest - the S100 - and ending in the largest - the S800. Each of the different models in the range can also have different surface areas, the area being determined in accordance with the cruising speed of the vessel to which it is fitted; faster vessels require a smaller surface area, whilst vessels cruising at a lower speed have a larger fin area. This is, for instance, why the smaller Aida vessels mentioned above have fins with a surface area of 16m², whilst those stabilisers for the *Freedom*-class liners have an area of 18m². 

New cruise class for Celebrity to be constructed

IN August, Meyer Werft confirmed that it had won another important potential order in the form of the first of a new class of cruise ships for Royal Caribbean Cruises' Celebrity division. The letter of intent between the two companies includes an option for a second ship of the same type.

In a statement issued at the time, Meyer Werft said the new design would be Celebrity's first wide-body vessel, and would be 117,000gt with a length of 314.85m and breadth of 36.88m, making it a post-Panamax ship.

The 1425-cabin cruise ship will accommodate 2850 guests (double occupancy)

and 1250 crew, with more than 90% of the ship's cabins being outside, and more than 90% of those having balconies. Meyer Werft said the standard cabin on the new ship would also be 'much larger' than the cruise industry standard, the average standard cabin on Celebrity's new ship being 19.9m². Other distinctive features are planned for the new design and will be announced in coming months.

Celebrity Cruises expects delivery of the ship in Autumn of 2008, and has to exercise the option for the second vessel by March 2006. 

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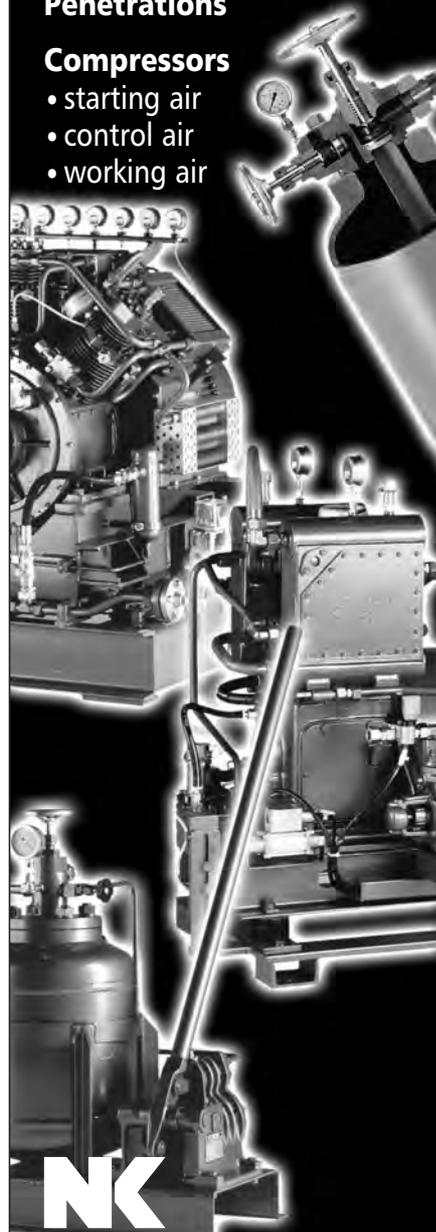
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Germanischer Lloyd at forefront of key research projects

CLASSIFICATION society Germanischer Lloyd is playing a key role in a number of international research projects and, like shipbuilders and marine equipment manufacturers in Germany, reports that it enjoyed an excellent 2004 and has had a good start to 2005.

The worldwide boom in orders for newbuildings is reflected in the level of ship classification business secured by the society, leading to significant growth in consolidated sales revenues of 22.7% to €268.5 million. 'Thanks to the order boom in newbuildings, sales revenues were boosted in the business area of material and component inspections. Furthermore, the large number of new ships delivered led to considerable growth in surveys of the fleet in service, and turnover also rose as a result of the introduction of the ISPS Code and associated certification', noted the society.

As of the end of 2004, Germanischer Lloyd has 844 newbuildings on its orderbook, with a worldwide market share of 45.6% for container ships and 21% for multipurpose ships. More than 370 ships classed by Germanischer Lloyd were delivered in 2004, and the fleet-in-service grew by 8.5% to 5401 ships and a total of 47.8 million gt. Reckoned by tonnage, the average age of the GL fleet is nine years, and as of May 2005, GL was classing 5462 ships or 48.9 million gt.

In the current year, the tonnage for which GL is responsible will exceed the 50 million gt mark, and despite the full workload at yards worldwide, further increases in turnover are anticipated. As of early May, Germanischer Lloyd had an orderbook of 940 ships amounting to almost 19 million gt.

This year saw the kick-off meeting for the four-year SAFEDOR project, for which GL is co-coordinator. SAFEDOR stands for design, operation and regulation for safety, and the SAFEDOR Steering Committee includes representatives from across industry, including flag states (the Danish Maritime Authority), classification societies (Germanischer Lloyd and DNV), shipowners (Carnival), and shipyards,

also equipment manufacturers such as SAM Electronics, and academia (Glasgow and Strathclyde Universities).

The EU-sponsored project involves more than 50 organisations drawn from across the EU maritime industry, and is focusing on risk-based ship design in which safety levels are considered as objectives in the design process from the outset, rather than being treated as a constraint, as is the case using today's conventional ship design methods and prescriptive rules.

It is anticipated that this new approach will also provide scope for novel and inventive design solutions and encourage innovation, and whilst the work of the project aims to achieve advances in maritime safety that will benefit the international shipping community as a whole, it is also envisaged that the competitiveness of European companies will be enhanced.

Whilst SAFEDOR is building on existing methods of reliability theory and the formal safety assessment approach adopted by the International Maritime Organisation (IMO), one of the project's key objectives will be to develop a proposal for a new regulatory framework which will enable the approval of innovative ships that challenge today's rules.

A total of nine concept designs - including cruise liners, ro-pax ferries, gas tankers, oil tankers, and container ships - will be used to demonstrate the project results. Individual studies are tackling areas such as structural integrity and assessment of risks from flooding, collision, grounding, fire and explosion. Other subjects for consideration include bridge management and operations, cargo securing and lifesaving arrangements.

Benefits of paperless document transfer

GL also notes that shipyards, engine manufacturers, and equipment suppliers are increasingly exchanging technical drawings and documents with the classification society in paperless form, and GL now has more than 30 customers worldwide participating in a new Internet platform named Global Exchange (or

Globe for short). More than 400 drawings a month are already being exchanged electronically, and all of the information needed for plan approval can be transmitted conveniently and speedily in digital form.

GL says the benefits offered by electronic transmission of documents include: faster throughput times for plan approval; reduced costs with reduced administrative effort and no need to make copies; and information on the state of plan approval is updated continually and available worldwide.

Using Globe, documents to be approved are exchanged between yard or manufacturer and Germanischer Lloyd in PDF format. Another benefit is that the platform can be reached through a standard browser without the need for any additional software. Access is password-protected, and the security of the digital data exchange is ensured by SSL encryption of the type used for home banking. Enhanced security is available on the basis of the RSA Token system.

Shipping companies and owners of bulk carriers can now use a new database developed by Germanischer Lloyd to obtain comprehensive information about all of the requirements relating to structure and equipment in connection with the cargoes to be conveyed using GL's new cargo compliance tool Provisions for Transportation of Solid Bulk Cargoes (PROTOS), which was unveiled at the Bulker Forum earlier this year.

PROTOS references all statutory structural and equipment-related requirements applying to a bulk carrier for a specific cargo. As GL notes, in view of the approximately 60 or so different types of solid bulk cargoes which bulkers carry, requirements for, for example, ventilation and explosion protection, may differ considerably. On the basis of a ship survey, the PROTOS requirement catalogue, and an examination of the ship's documents, GL can issue a 'Bulk Certificate' and a Document of Compliance for the Carriage of Solid Bulk Cargoes confirms that the ship meets the prerequisites for proper and safe transport. 



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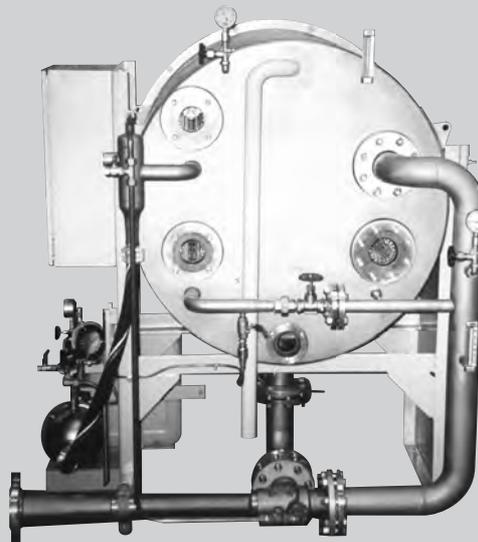


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50th anniversary for Schiffko

ON September 23 this year, Schiffko, the leading German naval architectural consultancy will celebrate its 50th anniversary. The company's name is derived from the German words for ship design and development, which reflects the intentions of Professor Dr-Ing Kurt Wendel, a lecturer in naval architecture at Hanover and Hamburg Universities, and Dipl-Ing Wilfried Stummer, who founded Schiffko in 1955.

Since the company was set up, Schiffko has worked on the design, consulting and engineering of some 1500 vessels with a total capacity of 7 million gt, and participated in another 2000 naval design projects, studies, or tenders over the course of the last five decades.

Schiffko is particularly well known today for container ship designs, especially for its CV 1100 Plus feeder types, which have been continuously enhanced to meet the latest rules, regulations, and developments in container traffic, with ISO, Euro, and high-cube box sizes. So successful is the concept said to have been that the number of repeat ships has now reached the 100 mark, with vessels currently under construction at eight shipyards in China and Romania.

Depending on owners' requirements and availability of equipment, various options are available in propulsion and power generation machinery as well as deck equipment, along with high ice strengthening for Baltic trades. To meet the growing demand for reefer container transport with high-cube containers, Schiffko developed the 300XT reefer container ship for air- and water-cooled containers, a lengthened 350XT version, which is optimised for a full number of high-cube boxes in the holds and all air-cooled containers, as well as the more beamy 450XT (1250TEU) version.

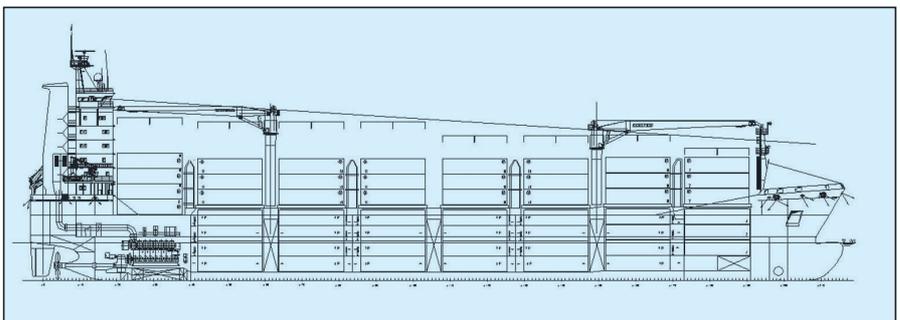
For P&O Nedlloyd - now named Blue Star Ship Management - and its Mercosul Line, Schiffko developed the 1700TEU capacity CV1700 Plus container vessel, four examples of which are now under construction at Brazilian Shipyard Estaleiro Itajai SA.

This design has been further enhanced for higher cargo capacity and reefer cargo in the form of the CV1800-550 and the still larger CHC2500 - which is strengthened for heavy cargo and metal coils (all Schiffko container types are suitable for transport of heavy cargo, making the designs very versatile, and allowing owners to use the ships for various trade patterns).

Following the very successful consultancy service provided to the Middle East owner United Arab Shipping Co (UASC) in Kuwait/Dubai for its series of 10 3800TEU vessels constructed simultaneously at three shipyards in Japan, Schiffko was awarded a contract for tender specification and bid evaluation for that company's new 6800TEU jumbo container ships, assisting UASC in the contract award to builder Hyundai Heavy Industries. Schiffko was also awarded the plan approval, construction supervision, and acceptance on behalf of the owner, with delivery of the last of the series of eight vessels planned for the end of 2008. Ongoing design studies by the consultancy are focussing on even larger container ships with capacities of 10,000TEU-12,000TEU.



The pipelay barge *PLB 132*, one of Schiffko's latest designs, is approaching completion at SADRA shipyard, in Iran.



Profile of the new Schiffko CV350XT container ship, which is mainly geared to carrying large numbers of refrigerated boxes; all holds are engineered to load up to 155FEU air-cooled containers.

On behalf of Indian client Oil and Natural Gas Corp (ONGC), Schiffko continues to provide consulting activity for the construction of a new seismic survey vessel - a dual-source, six-streamer, 3D type - with plan approval, construction supervision, and acceptance at Amur Shipbuilding Plant, in Russia, on behalf of the owner. Previously, Schiffko prepared the very extensive tender design and bidding documents for the new vessel, which will be delivered at the beginning of 2007.

For the German Navy, Schiffko has just completed the design of deck equipment for the conversion of two replenishment tankers, *Rhon* and *Spessart*, vessels which will be capable of replenishing two warships at the same time with fuel, water and kerosene, using the latest NATO tight-wire system.

Schiffko also contributed to the Innovative Barge Train (INBAT) project funded under the European 5th Framework Programme for inland shallow-water transportation by developing innovative, lightweight push-barge trains made of

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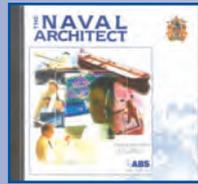
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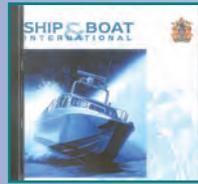
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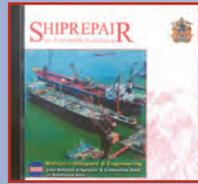
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new materials and using joining techniques new to shipbuilding. Following on from the promising conclusions of this research work, Schiffko is preparing a project for a demonstrator unit.

As highlighted elsewhere in this feature, Schiffko has also been closely involved in the design (with New-Logistics) of the innovative Futura Carrier concept, the first example of which

is under construction at Con-Mar shipyard in Germany. For this project, Schiffko not only prepared the basic design with all classification drawings, but also produced the detailed design with full set of workshop information, applying the ShipConstructor software.

This year has also seen Schiffko complete the design of a new pipe-laying barge, *PLB 132*,

which will use the S-lay technique for pipelines of up to 1.01m diameter including piggy-back pipe of 101mm diameter to a water depth of 100m for operation in South Pars Gas Field in the Persian Gulf. The construction of the vessel is approaching completion at SADRA shipyard in Iran, and *PLB 132* is due to be delivered and commissioned into service shortly. ⚓

A computer-generated profile of the new 1721TEU container ships to be built at Estaleiro Itajai for Mercosul. They are specially designed to trade along the South American coastline, being able to access ports situated on large rivers in that region.



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Roll damping with VSPs

THE well-known as a supplier of Voith Schneider propellers (VSPs) and Voith cycloidal rudders (VCRs) for main propulsion, Voith Schneider, says studies it has carried out recently suggest that VSPs and VCRs could also have an important role to play in roll stabilisation onboard a wide range of vessels as diverse as crane ships, offshore supply vessels, and corvettes.

In order to reduce rolling motions, rotational movement about the ship's longitudinal axis needs to be reduced by a producing moment that periodically opposes the moment on the ship that causes the rolling motion. Generally speaking, roll stabilisation techniques are of two main types, active or passive. Active operation produces a counteracting moment by means of actively controlled machines. Examples of this type of technique include fin stabilisers (retractable or fixed) and active tank systems.

The advantage of active systems of this type is that they have good roll-damping characteristics; the disadvantages are: complexity and expense, high weight (particularly the liquid used to fill roll stabilising tanks), a large volume within the ship is required to accommodate them, they can be maintenance-intensive, and fin stabilisers only work efficiently at design speed - and can even add to a vessel's resistance, even when retracted. Fin stabilisers also increase a vessel's draught.

The passive mode of operation works on the principle of increasing roll resistance and thus damping rolling motions through the use of, for instance, bilge keels. However, as Voith points out, VSPs and VCRs can generate both propulsion and steering forces, and the thrust produced can be adjusted extremely rapidly in magnitude and direction.

This very rapid generation and variation of thrust, and the very high moments produced make it possible to use the VSP and the VCR to reduce rolling motion, particularly when a ship is stationary or at low speed. Recently, Voith has completed a series of investigations to prove the efficacy of VSPs and VCRs in this role, in order to demonstrate that the propulsors can damp the rolling motion of a ship (without forward motion) and reduce the oscillation of a suspended load in case of a floating crane, the damping effect being referred to by the company as 'active damping'.

To prove the concept, studies were made to demonstrate the effectiveness of such propulsors on several vessel types, including a crane ship, an offshore supply vessel, and a corvette. In the case of the corvette, Voith assumed a vessel with a length overall of 84m, breadth of 10.8m, draught of 3.7m, and displacement of 1800m³. The metacentric height GM on which the computation was based was 1.2m.

Two VCRs with a static thrust of a total 117kN were used as a basis for the computation of the active roll damping achieved, a value that corresponds to 85% of the maximum attainable transverse force, which was reduced in order to make allowance for the mutual influence of the VCRs.



Voith believes that VSPs and VCRs can play a key roll in reducing roll damping in addition to acting as propulsors.

Assuming a wavelength of 174m with a period of 10.5sec, this arrangement was found to reduce the roll effect almost entirely for a significant wave height of $H \frac{1}{3} > 1\text{m}$. The amplitude of the rolling motions was reduced by half in the case of a significant wave height of $H \frac{1}{3} = 2\text{m}$. The roll reduction achieved was smaller with higher waves.

For the crane ship, Voith assumed a vessel with a length bp of 133.8m, breadth of 26.5m, draught of 6.5m, and displacement of 15,820m³. The metacentric height on which the computation was based was GM = 1.3m.

Two VCRs with a static thrust of 417kN were used for roll damping. With crane ships, even small rolling motions can produce large roll excursions as a result of the load hanging on the hook.

For the most unfavourable significant wave period in a natural swell with 1.5m significant wave height, Voith's calculations demonstrated that the amplitude of the oscillation of the load

can be reduced by approximately 50%. A larger reduction in the oscillation amplitude is possible for smaller significant wave heights.

The platform supply vessel in question was assumed to have a length bp of 77.4m, with a breadth of 19.2m, draught of 6.05m, and trim of 0.6m. The metacentric height on which the computation was based was GM = 1.3m.

The ship was assumed to be fitted with two VSPs, producing a total transverse thrust of total 467kN, including the factor 0.85 as stated above caused by the mutual influence of the VSPs.

On this vessel, the rolling motions were almost completely suppressed up to a significant wave height of 6m and a long-crest periodic swell with a period of $T = 15$ seconds. The same damping characteristics were computed up to a wave height of 3m for a wave period of $T = 10$ seconds. In contrast to the corvette, the reduction in rolling motion reduction of the PSV increases with increasing GM and reduces with diminishing GM for a wave period of 10 seconds. ⚓



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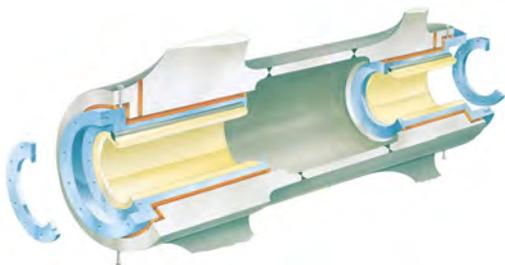
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New leading-head rudder for tankers and bulk carriers

BECKER Marine Systems has become well known for a wide range of rudder designs for specific ship types, a notable example being its twisted leading-edge flap (or TLFKSR) type. More recently, the company has also developed an innovative solution for bulkers and tankers, and other types of larger, slower-moving vessels in the form of the Herus rudder.

In this design, the rudder blade is supplied together with the leading head and steering gear foundation, and the shipyard welds the leading head structure into the aft end of the hull as a complete structure module. The steering gear foundation is also incorporated into the module, and no additional alignment procedures are required by a yard. This permits a simple and quick installation of the rudder system.

The leading head replaces the rudder horn of traditional semi-spade arrangements, and is formed from a trunk-tube connected to a forged bearing housing. Additional fairing, using the profile of the rudder blade, provides extra stiffening. Steel castings are thus no longer required, which ensures that material quality is guaranteed and production lead-time is reduced.

The main neck bearing in the leading head structure is positioned close to the centre of pressure on the rudder blade, which means that



A recent reference for Becker Marine Systems' TLFKSR rudder design, an example of which is seen here, is the new 8400TEU container ship *Savannah Express*.



“Hi Marines”,

the bearing is continuously submerged. This improves lubrication, and absorption of bending moments is dominated by the leading head rather than the rudder stock. The rudder stock's diameter and hence its weight are therefore reduced.

In respect of hydrodynamic performance, the Herus rudder should offer most of the advantages of a spade rudder, with virtually the entire propeller slipstream being captured by the moveable rudder area; as a result, deflection of the propeller slipstream is optimised and side forces developed are increased. The reduced diameter of the rudder stock allows a thinner rudder section to be used, resulting in reduced drag, and the fixed leading head also has a favourable effect on course-keeping.

Among notable recent references for the TLFKSR rudder is the 8400TEU container ship



Savannah Express, which completed initial sea trials in late March. *Savannah Express* is owned by Norddeutsche Reederei Schuldt GmbH & Co and is currently the largest ship in its fleet. This post-Panamax ship is equipped with a 67m² TLFKSR rudder, and has a propeller diameter of 9.1m and a service speed of around 26knots.

A Becker Herus rudder installation, showing the extra leading head fabrication above the horizontal plate. This offers hydrodynamic efficiency and bending moment absorption, as well as improved course-keeping.

New modular cabin system

BREMEN-based Kaefer Isoliertechnik has developed a new customised modular cabin system, the MCS, based on the Lolamat wall and ceiling material developed by its subsidiary CF-Systems GmbH. The new cabins are of lightweight design and said to be easy to assemble into complete, finished units. The material used is also fire-resistant and designed to reduce transmission of airborne noise.

Kaefer believes that the fact that the system modules (including surfaces) are

prefabricated provides the new concept with a key advantage in as much as installation time onboard is reduced and, since electrical connections are also pre-assembled, interior designers can begin furnishing the cabins immediately, saving time and money.

The original Lolamat wall and ceiling system was developed especially for passenger ships and mega yachts, and is available with a wide range of finishes, from wall paper, to veneer to any choice of

special surfaces, and can also be used to design corridors, gangways and public rooms such as restaurants.

Lolamat is a very lightweight, seamless panel which is fire-resistant. The system uses a sandwich construction, which is glassfibre reinforced, and the filling consists of fire-resistant materials and mineral wool to B15 standard. Cabins can be fitted with ceilings or with fully fitted airconditioning units.

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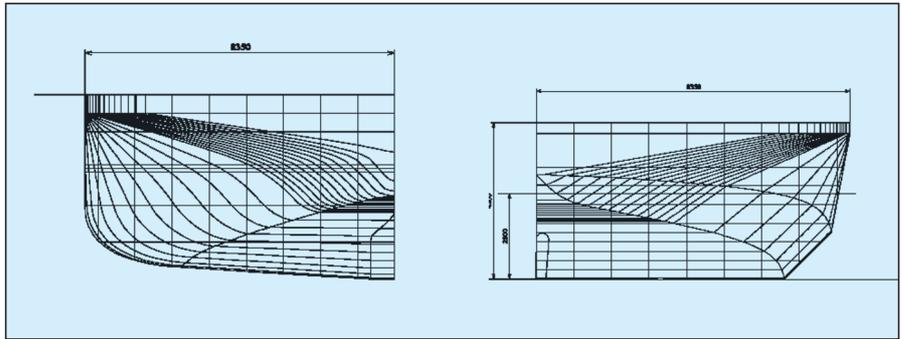
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Innovative drive and hull lines for Norwegian ferry

FOR DECADES, double-ended ferries have been an important market segment for Voith Turbo Marine, and the company has equipped a total of 372 such ferries with Voith Schneider propellers (VSPs). Using its experience with such vessels, Voith has engaged in a number of studies designed to optimise the propulsive efficiency of double-enders, and notes that, in light of increased fuel costs, one of the main goals of its work has been to optimise hydrodynamic efficiency and the efficiency of the propellers, thus leading to improved efficiency, reduced fuel costs, and more environment-friendly operation.

The company's efforts culminated in the design and construction of the Norwegian double-ender *Julsund*, which was delivered to MRF in Norway late last year. At 83.90m overall, *Julsund* has a length between perpendiculars of 80.90m, beam of 15.30m, draught of 2.60m, a car deck of some 82.90m, and is capable of carrying 87 vehicles and 196 passengers. The machinery selected for this double-ender is based on a quartet of main engines, each of 404kW, linked to Voith Turbo VSP 18 propulsors. Using CFD techniques, Voith Turbo Marine improved the hull lines for the vessel, results which were verified during model testing at Marintek and during sea trials in December 2004.



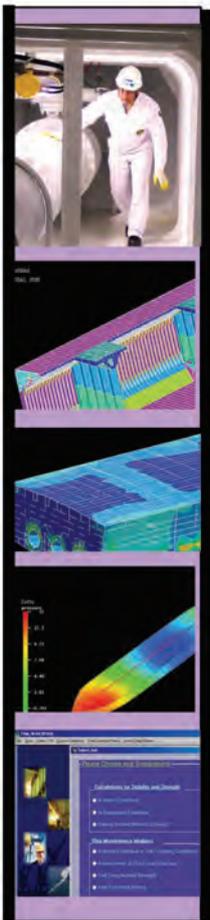
The original hull lines (left) for the ferry, and the lines optimised by CFD (right).

Voith Turbo Marine also developed a new propeller type for the Norwegian ferry with a propeller size of 18 (a blade radius of 1.8m). Compared with the previous model, this propeller increased the power available by 56%, to 780kW.

The ferry is distinguished by a high level of course stability and manoeuvrability. Voith Turbo Marine notes that the customer also attached a high level of importance to ensuring that the ferry had an adequate service and low investment cost, objectives which Voith was

able to comply with by optimising the ship's lines, selecting the new propeller type, and by adopting an innovative arrangement in which the fore and aft VSPs are each connected to two motors, via belt drives.

By adapting the pitch of the propellers, it is possible to operate the double-ended ferry at its service speed using only one of the two motors. As a result, maintenance work can be carried out on the motor at standstill, which, in turn, extends the service intervals between maintenance routines and the service life of the motors. ⚓



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Record-breaking *Norwegian Jewel* delivered

In early August, Meyer Werft, in Papenburg, handed over the 93,500gt cruise ship *Norwegian Jewel* to Norwegian Cruise Line (NCL). Built in just 22 months, the vessel is the first of a series of four new liners which Meyer is building for NCL; she is the fifth vessel that the yard has built for the Star Cruises/NCL group.

Claimed to be the largest Panamax ship of her type, *Norwegian Jewel* also has the highest number of cabins on a Panamax vessel (1188, of which 70% are outside) and, with a maximum speed of 25.60knots, she is particularly fast compared with other ships of this size. *Norwegian Jewel* is also believed to be the largest passenger vessel ever built in Germany.

Fitted with podded propulsors and diesel-electric machinery, *Norwegian Jewel* is 294.13m length overall, with a moulded breadth of 32.20m, and has 15 decks in total. She is designed to carry 2376 passengers, has a crew of 1100, and is classed by DNV, bearing the notation + 1A1 Passenger Ship, ECO, CLEAN.

Last May saw confirmation of the latest order for Meyer Werft from NCL in the form of a sister to *Norwegian Jewel*. This latest order follows that announced in December 2004 for an identical ship to be delivered in February 2007.



Norwegian Jewel is the largest Panamax ship of its type and the largest passenger vessel ever built in Germany.

Also, in June, the yard secured orders for a pair of LPG tankers for Solvang, in Norway, these ships being 154.90m length overall, with a breadth of 22.70m, and cargo capacity of 17,000m³.

Although not prominent recently, gas carriers have been a speciality of Meyer for many years. In July, the yard also secured an order from Reederei Aida Cruises for an 86,500gt cruise ship for delivery in April 2008.

Some examples of the quality public rooms and accommodation on *Norwegian Jewel*.





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CFD fire simulation on ships with mechanically ventilated enginerooms

In this article, by G W Zou, H Dong, Y Gao, Department of Building Engineering, Harbin Engineering University, Harbin, China, and W K Chow, Research Centre for Fire Engineering, The Hong Kong Polytechnic University, Hong Kong, China, fires on ships with mechanically ventilated enginerooms were simulated by computational fluid dynamics (CFD). Large eddy simulation was used to simulate the fire environment under four different ventilation conditions with the same fire. The CFD package Fire Dynamics Simulator (FDS), based on the modified set of Navier Stokes equations for thermally driven buoyant flow, was selected.

SHIP fire safety should be evaluated carefully [Ref 1]. The engineroom in a ship is nearly always positioned at the lower part of a vessel and it is the key element in providing power for operating ship facilities and systems, thus risk of fire is high due to machines, electrical equipment, and liquid fuel and exhaust-gas pipes - 75% of ship fires are reported to begin in such spaces [Ref 2].

Fire detection and suppression systems are more difficult to provide in the usually relatively small engineroom because of the units inside. Corridors, passages, and staircases are narrow, making evacuation and fire control very difficult. Therefore, it is very important to understand fires in this area, so as to design effective software fire safety management and hardware fire protection engineering systems [Ref 3].

In this article, ship engineroom fires with forced ventilation were studied. The CFD package Fire Dynamics Simulator (FDS) [Refs 4-9] based on large eddy simulation (LES) was used. This model had been applied [Ref 10] to study air pressure in a well-sealed chamber and was found to be very helpful for such studies. Air flow characteristics under four different ventilation conditions with the same fire were investigated and the transient distributions of air flow parameters during the development of the fire were predicted.

Compressible buoyant air flow of low Mach number will be induced by a fire in a closed chamber with mechanical ventilation. There are difficulties [Refs 4-6, 11] in solving the set of conservation equations numerically while converting the set of partial differential equations into discrete forms. For example, employing a high-order scheme for changing equations into discrete forms in time and space with very small intervals; air speed under buoyancy is relatively low, say 4m/sec^1 to 5m/sec^1 ; the size of an engineroom is relatively large in comparison with the eddy sizes; and longer computing time is required with small time steps. However, using a second-order or even higher-order difference scheme might have numerical instability. CFD software commonly used in the market might not be suitable.

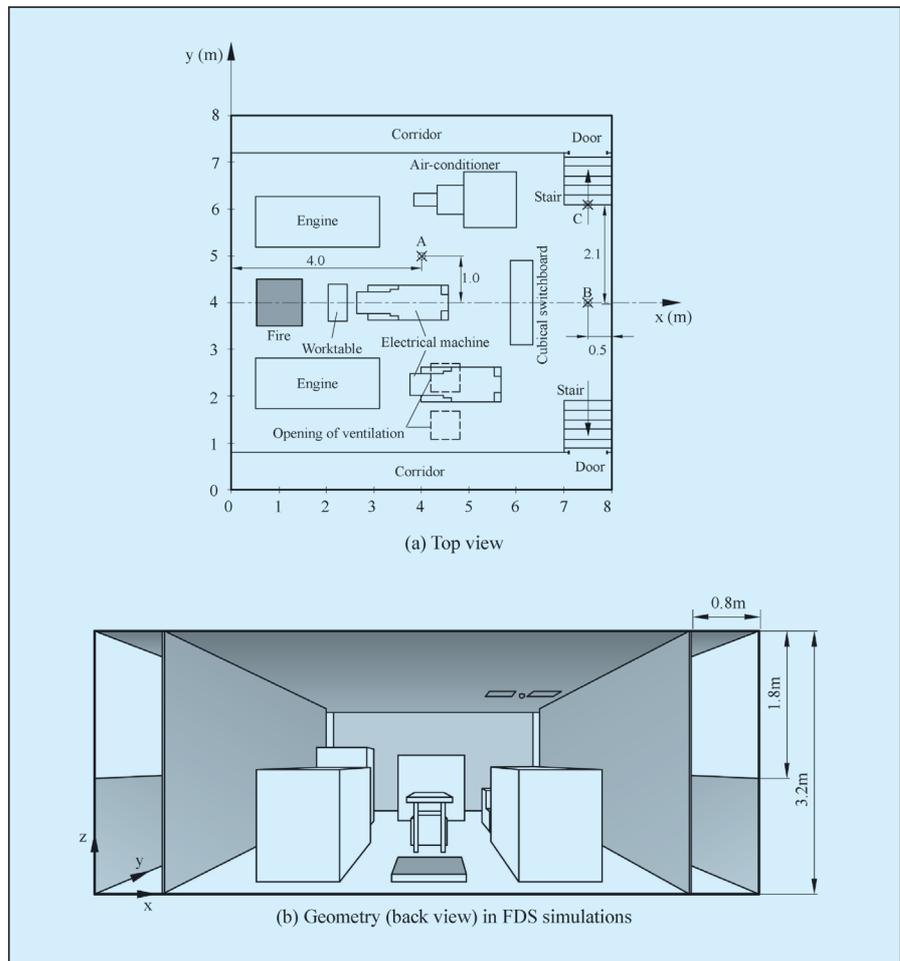


Fig 1. The ship's engineroom used in the simulations.

In FDS [Refs 4-9], the set of Navier Stokes (N-S) equations was modified for buoyant flows with low Mach number [Refs 6] together with large eddy simulation. This software is specially developed for simulating building fires.

The discrete form of the momentum equation can yield the Poisson equation for total pressure. In the discrete form of the filtered N-S equation set, the finite difference method and staggered grid system are used. The explicit second-order accurate Runge-Kutta form is adopted in solving the discrete form of the equations in time; and

second-order accurate central difference form is employed for the discrete equation in space. The Poisson equation is solved directly through Fast Fourier Transforms. Theoretical details were discussed in the literature and are not repeated here.

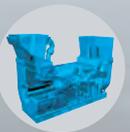
Numerical experiments

The engineroom in a small ship of length 50m and width 8m was considered [Ref 12]. The engineroom is of length 8m, width 8m, and height 3.2m as shown in Fig 1. Two diesel

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engines, two power generators, one centralised air-conditioning unit, one cubicle switchboard, and one working bench were provided. There are corridors of width 0.8m and height 1.8m on the two sides, each accessing to a door and a staircase. The door is of width 0.8m and height 1.8m.

There are two ceiling vents for exhausting hot air in the plant room. Low-noise axial fans with exhaust rates $9000\text{m}^3/\text{h}^{-1}$ - $12000\text{m}^3/\text{h}^{-1}$ were installed. The value of $3.0\text{m}^3/\text{sec}^{-1}$ was used in this study.

Three-dimensional Cartesian coordinates x , y , and z were adopted, with length along x of 8m, width along y of 8m, and height along z of 3.2m. The grids are uniformly distributed of size 0.1m. The grid numbers NX, NY, and NZ along the x , y , z directions are 80, 80, and 32 respectively.

Predicted data were studied at three locations A, B, and C, with 17 vertical points at intervals of 0.2m at positions A and B. The smoke layer height was determined at B and C; and the pressure inside the engineroom was investigated at B at 1.5 m from the ground.

A fire of size 1.0m x 1.0m was located at the central axis at 0.5m from the rear wall. As leaking oil inside the engineroom is inflammable, the heat release rate Q (in MW) at the early stage of the fire is taken as ultra-fast growth t^2 with a cut-off value of 2MW at 100sec:

$$Q = \begin{cases} 0.2t^2 & t \leq 100\text{sec} \\ 2 & t > 100\text{sec} \end{cases} \dots(1)$$

The curve is shown as the 'FDS input' curve in Fig 2.

Four different ventilation conditions under the same fire were simulated: Case 1: doors closed, fans operating; Case 2: doors open, fans not operating; Case 3: doors open, fans operating; and Case 4: doors closed, fans not operating.

In practice, the doors are closed so that unauthorised staff cannot enter. The fans in the ventilation duct are switched on for cooling the engineroom as in Case 1. In case of a fire, fans and the ventilation duct might be closed to prevent the fire spreading and cut off air supply to sustain combustion. The doors are open during evacuation and fire suppression as in Case 2.

For reducing the smoke threat to humans and to increase visibility during evacuation and fire suppression, fans and ventilation ducts are open for extracting smoke. The doors are open as well and this is the situation for Case 3. In the case of a fire, the engineroom might be completely sealed during fire suppression to cut off the supply of oxygen; this is the condition for Case 4.

All solid walls are constructed of steel with heat conduction rate of $43.2\text{Wm}^{-1}\text{K}^{-1}$, specific heat of $470\text{Jkg}^{-1}\text{K}^{-1}$, and density of $7790\text{kg}/\text{m}^3$. The wall surface is under non-slip condition which can conduct heat. The velocity near the wall U is given in terms of the vertical distance Y of the wall grids:

$$U = Y^{0.5} \dots (2)$$

Free boundary is adopted for the interface between the computation region and the external environment, which allows free fluid flow in and

out of the computation region. The pressure on the free boundary is equal to the ambient pressure, the velocity gradient and temperature gradient are both zero. The outlet of the vent opening has a constant volume flow rate. A personal computer with a CPU of 2.0GHz and RAM of 1.0GB was used to simulate the results up to 700 seconds; the computational time required was 51hours.

Heat release rate of the fire

In the FDS, the fire source is described by the heat release rate (HRR) per unit burning area. The caloric value of the fuel is transformed into the flow rate of fuel per unit area. Then the fuel is injected into the calculation region through the solid wall or opening. Combustion will take place once the fuel is mixed with oxygen and heat will be released. Therefore in each case, there is an HRR as an input parameter, and an output HRR calculated based on the consumption rate of oxygen in the simulation process.

The input HRR curves and the calculated HRR curves for Case 1 and Case 4 are shown in Fig 2. The input HRR curves for the four cases are the same. As the output HRR curves for Case 1, Case 2, and Case 3 are basically the same, only the results of Case 1 are presented in the figure.

In Case 4, the doors were closed and the fans were not operating, the HRR developed according to $Q = 0.2t^2$ to a maximum value of 2MW. After staying at the maximum value for 40 seconds, the HRR started to decrease. When all of the oxygen had been consumed inside the engineroom and there was no fresh air supply, the fire was extinguished at 250 seconds. From the HRR curves, it can be observed that fire suppression in a 'sealed' room was achieved in Case 4.

Smoke layer thickness

Smoke in a fire is a major threat to human due to the optical obstruction, toxicity, and high temperature. Combustibles inside an engineroom are mainly leaking oil and electric cables, both of which generate large volumes of black and toxic smoke. Black smoke reduces visibility, delaying evacuation. As a result, occupants would be exposed longer to high temperature and toxic gases.

The predicted variations for the smoke layer interface height at B and C for the four cases are shown in Figs 3a and b. It is observed that the smoke layer interface height at positions B and C are similar. For easier comparison, the smoke layer height at B in the four cases are presented together in Fig 3c.

The smoke layer height in Case 1 and Case 3 are about the same at 1.9m. Smoke can be kept at a higher position, ensuring that it is less hazardous. The fans in these two cases were operating, and most of the smoke was extracted out by the fans.

The smoke layer height in Case 2 is 1.3m, lower than the human body and would be dangerous. Since the fans were not operating in this case but the doors were opened, smoke would flow out through the door. In Case 4, the smoke layer interface height was below 0.5m from 100 seconds to 450 seconds. Smoke would fill up the entire engineroom.

Air pressure

The pressure variation curves at A at 1.5m from the ground are shown in Fig 4. The pressure

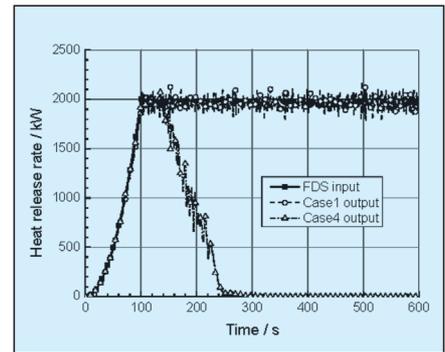


Fig 2. Heat release rate.

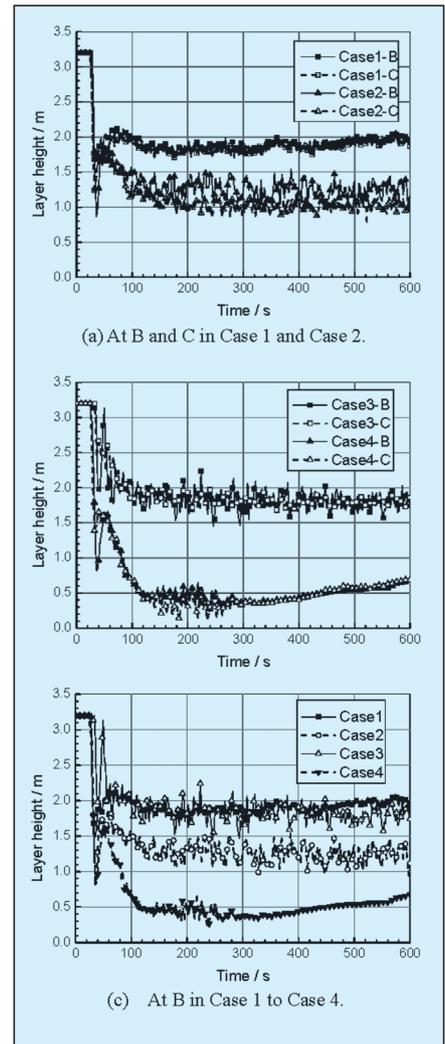


Fig 3. Variations of smoke layer height.

variations for Case 1 are shown in Fig 4a. Since enginerooms are required to be well sealed, there was no other air flow path except the fan opening in Case 1. When the fans are running, air pressure inside the engineroom is decreased to a negative value, however, such a large negative pressure would not occur if there are other air flow paths due to leakages. The actual extraction rate of the fans cannot reach the ideal state as in the numerical calculations.

As seen in Fig 4b, the pressure in Cases 2 and 3 are similar. It is because the doors were opened, so the pressure inside the engineroom



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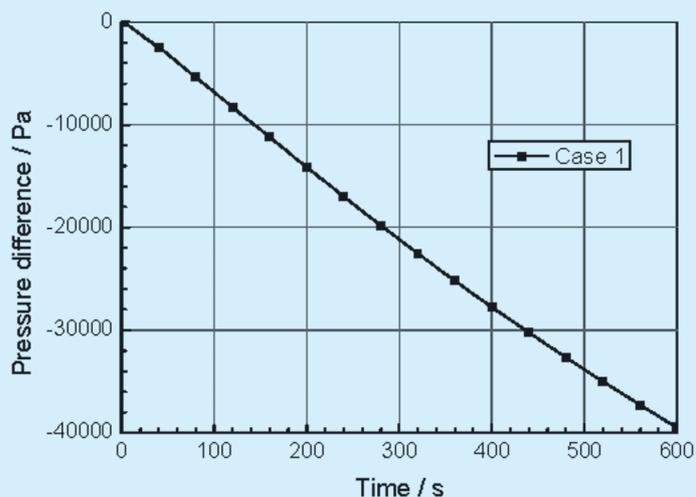
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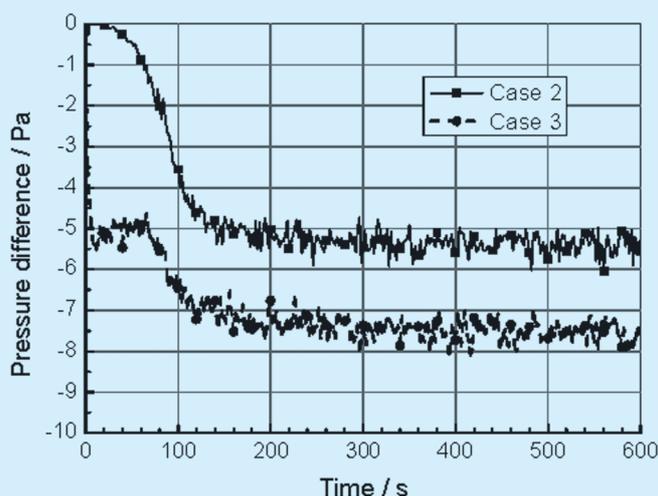
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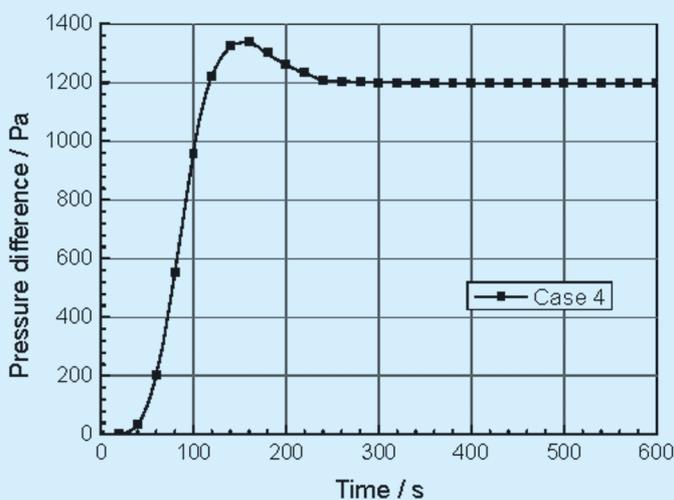
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(a) Case 1.



(b) Case 2 and Case 3.



(c) Case 4.

Fig 4. Pressure variations at point A at 1.5m above floorplate level.

was close to ambient. Pressure contours on the central plane along the y direction at 300 seconds for Case 2 are shown in Fig 5. It is observed that the neutral plane is at 2m above the ground, the pressure is negative below the neutral plane. Therefore, the two pressure difference curves in Fig 4b are both negative. The fans were operating in Case 3 but not in Case 2. The negative pressure in Case 3 is lower than that in Case 2.

The pressure curve for Case 4 is shown in Fig 4c. Since the doors and the vents were all closed, air temperature increased inside the engineroom due to heat released during combustion. As gases inside the engineroom heat up, pressure was higher than ambient. Under a 2MW fire, pressure inside the engineroom reached more than 1200Pa. Therefore, when sealing a room for fire suppression, staff are not recommended to enter too early, as hot gases expelled when opening the door (ie, the back-draught) might injure people, and supplying fresh air while opening the door might lead to re-ignition.

Discussion

The occupied zone is roughly up to the height 1.4m to 1.8m above ground level. Hot air at that height can greatly affect evacuation, fire detection, and suppression. The temperature variation curves at A at 1.4m and 1.8m above ground are shown in Fig 6. The temperature is lower than 70°C at these two positions in Case 1 and Case 3, and much lower than the values in Case 2 and Case 4. It is also shown in Fig 3c that the smoke layer height in these two cases are at a higher position, more so than those in Case 2 and Case 4.

In Case 1 and Case 3, operating the fans would not only remove smoke from the room but there would also be a cooling effect, and the indoor environment would not be so hazardous to staff trapped inside. However, providing more air might enhance combustion.

In Case 4 where the doors and vent openings were closed, the temperature inside the engineroom increased at a much faster rate than in the other cases. Therefore, it is very important to select the right time to close the room for fire suppression; isolating the room too early might result in a rapid increase of the inside temperature. This would adversely affect evacuation of staff remaining.

Conclusion

The fire environment in a ship's machinery space under four different ventilation

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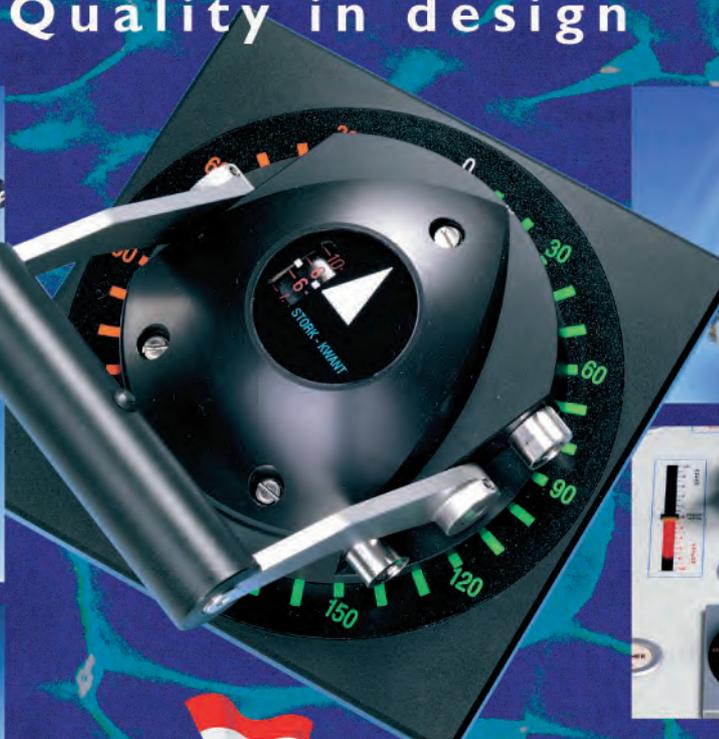
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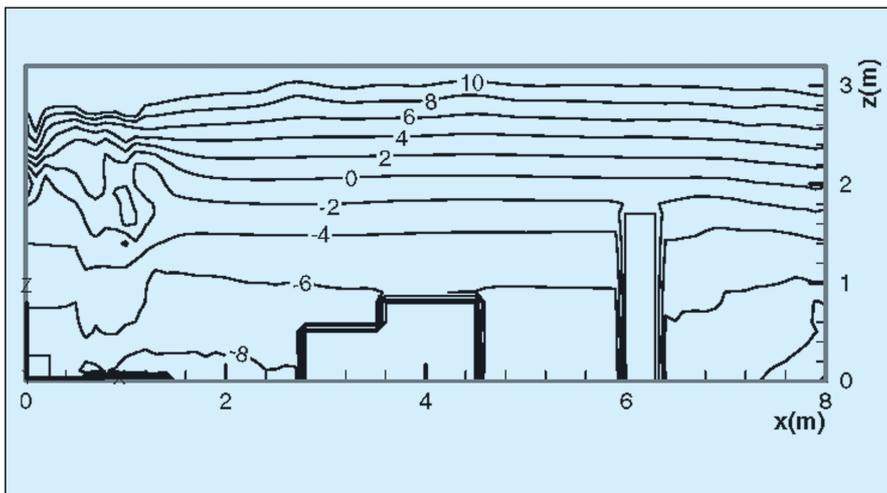


Fig 5. Pressure distribution at 300sec for Case 2.

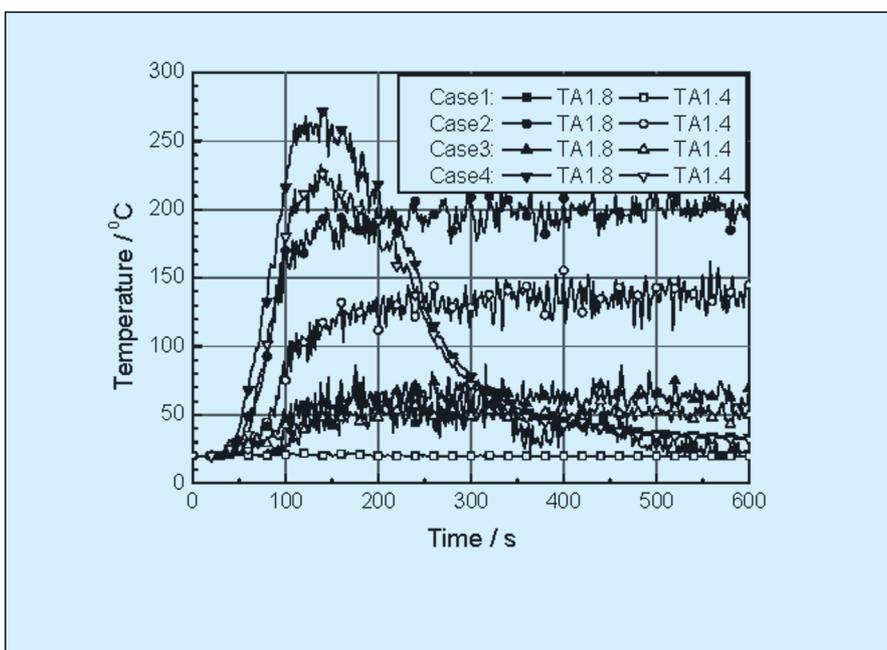


Fig 6. Temperature variations at point A, at 1.4m and 1.8m above floorplate level.

conditions was simulated by the CFD package FDS. Although the engineroom selected for computation in this article was small, the results on the fire environment are applicable to larger spaces on bigger ships.

Predicted results indicated that ventilation conditions inside an engineroom, especially opening the vents and the operating condition of the fans, would give a significant effect on the development of a fire, and smoke can be extracted effectively while operating the fans. This would be helpful for evacuation at the early stage of a fire as providing better ventilation would supply more air for combustion to give faster spreading rate of flame. It is very important to isolate the room by closing all the openings at the right time during fire suppression, since sealing too early or too late might lead to more serious consequences.

These simulation results can give also information on the spatial distribution of physical parameters. The CFD software FDS

can be used to study the smoke movement and the distribution of toxic gases in fires occurring in the engineroom or other larger rooms in ships of more complicated geometry.

Acknowledgement

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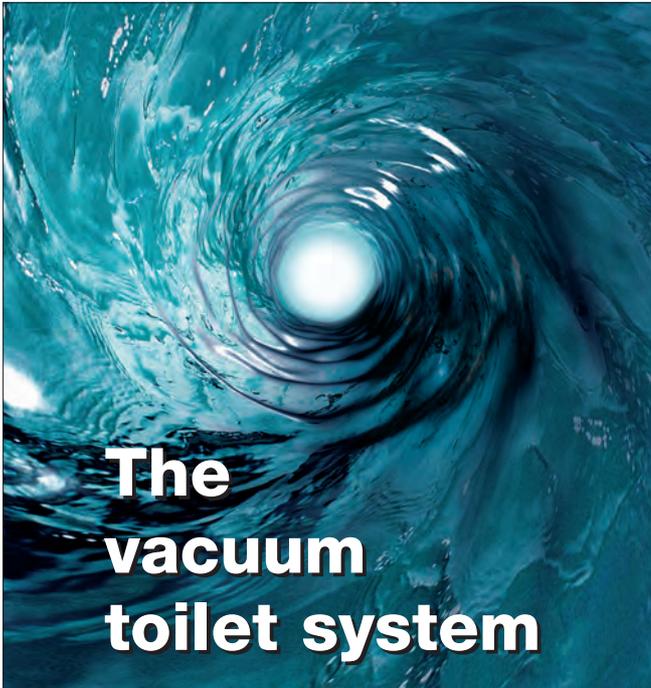
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Uljanik stands on two strong legs: tankers and car carriers

FOUNDED in 1856, Uljanik Shipyard, at Pula, on the Istrian peninsula, had emerged by 1998 as the probably the most prolific, versatile, and successful Croatian shipbuilder, with a stable, modern, cost-conscious management, and a well-adjusted workforce. This is all a result of the forward-looking development of two decades, which avoided hasty, unjustified changes of personnel and uncompromisingly followed the path of reliance on the yard's own engineering design and technical staff. Other Croatian yards are only now starting to introduce something akin to Uljanik's own long-term programme for structural adjustment and monitoring the success of business operations.

The Pula yard is part of a holding since 1993, which is owned to the tune of 12% by small shareholders (staff in the main) and 88% by state funds and the state. Employing 2000 today, Uljanik has a 250-strong design team (also involved in selling designs abroad), three building berths, and capacity to build five or six ships annually.

The largest 273m x 60m building berth is temporarily out of use, and at present, complete vessels up to 235m x 51m and 80,000dwt can be built on the second; both berths are on the yard's island site, which is linked to the rest of the yard by a short causeway. There will be no return to the yard's special expertise for constructing VLCCs in two halves and joining them afloat, because - as marketing director Dario Marchi points out, 'it would be too expensive - modern techniques are so advanced that Korean and Japanese yards are building VLCCs in one piece almost on a production-line basis'. He adds that 'Uljanik has an investment plan divided in three phases and the company is currently at the end of the second, having fully improved welding capacity and automated the preparation of steel plates. So far, US\$60 million has been spent, plus US\$10 million on an IT system. In the third phase, large new workshops are planned, together with a steel-handling crane'.

The Danish MARS system from Logimatic, for materials handling and production control, was implemented during 2002, and in the interests of integrating that with the CADDS/Trident shipbuilding CAD system and thus upgrade IT, interfaces were developed between the two, relying on internet technologies and development tools of an Oracle RDBMS platform. Further system integrations are also nearing completion. Finally, a recertifying audit by Lloyd's Register of the yard's ISO 9001-2000 quality assurance system was completed in 2002.

Bid for Viktor Lenac

In June this year, Uljanik posted a bid for the Croatian repairer Viktor Lenac, hoping to breaking the gridlock that developed since the latter filed for bankruptcy in November, 2003. This is now being considered by the Croatian government along with two other related

HELPED by the global boom in shipbuilding contracts, and the bulging order books of Far Eastern yards, Croatia's five big shipbuilders - Uljanik, Brodosplit, 3 Maj, Brodotrogir, and Kraljevica - have considerably improved their fiscal status in recent years, and even once-leading repairer and occasional builder Viktor Lenac, bankrupt since 2003, is staging a modest comeback. In May this year, the combined order book of the six totalled 76 ships of 2,722,698dwt, or 1,439,316cgt and worth around US\$2200 million.

This is not to be scoffed at, but due to the debts built up in the years of the Yugoslav civil war and since, and the very slowly lifting credit crunch, five of the yards are still loss-makers and only Uljanik is believed to be profitable. A major recent problem has been loss of skilled staff to other countries, including China, where pay is considerably better.

While the Ministry of Economics and the Croatian Privatisation Agency see the solution in terms of sell-off of equity to strategic investors, yard managements are less than keen. There is also tentative talk at government and inter-ministerial level about the putative creation of a state holding company (as happened in Spain); however, after consideration, this appears unlikely to happen. It can virtually be taken for granted that the status quo, allied to a gradual emergence from the shadows of the past, will continue in the foreseeable future. Ivan Berenyi reports.

solutions proposed by the Pula yard, involving the acquisition of Viktor Lenac's spun-off drydock.

Many car/truck carriers on order

Uljanik remains primarily a builder of tankers, but it has substantially extended its grip on the market in recent years to become additionally a well-established builder of car-truck carriers, as well as returning to an earlier role of constructing rail ferries, too, thus standing on two firm legs and one smaller but equally interesting one.

Uljanik delivered its first new-generation car carrier, the 4300-unit *Dyvi Prebla*, in 1999, followed by her sister *Dyvi Pamplona*, in 2000. These were followed in the same year by three 12,743dwt 10-deck designs to Liberian companies, namely *Dresden* and *Mosel Ace* to

Providence Shipping, of Monrovia, and *Verona* to Montagu Bay Shipping, each for US\$36 million. The 10 decks provide 36,542m² of space for up to 4310 cars with four decks strengthened for heavier vehicles and up to 391 lorries. Two ramps on each deck provide the link between decks. The trio was chartered for five years by Krupp-Seeschiffahrt GmbH, with an option for a further five, ie, *Dresden* to NYK, *Verona* to Wallenius Williamsen, and *Mosel Ace* to Mitsui OSK.

Alongside these, a healthy series of nine car-truck carriers have been ordered by Grimaldi Compania di Navigazione, of Naples, Italy, and eight have been delivered. The first two were of 12,500dwt - *Grande Benelux* and *Grande Italia*, completed in 2001. When the number ordered with a 4300-car capacity reached six, Grimaldi upgraded the last two to 5000 cars-plus capacity.

The seventh and eighth of the series, the 12,353dwt *Grande Lagos* and *Grande Anverse* were delivered, with 5404-car capacities, in May and September 2004, leaving just one on order. However, in January 2005, Grimaldi contracted three 55,000gt multi-purpose ro-ro vessels with two 40tonne cranes and ro-ro ramps for truck trailers, each costing US\$70 million. These could carry up to 3000 cars and 1000 20ft containers, and are scheduled for delivery in 2008 and 2009.

Meanwhile, Ray Car Carriers Ltd, of the Isle of Man, controlled by Israeli shipowner Rami Ungar, had ordered four 12,300dwt car-truck carriers in 2003, each costing US\$40 million, one for delivery in 2006 and three in 2007. Ray added two more in January 2005 with 2007 delivery dates.

In early 2004, a remarkable contract was placed by Gram & Co AS, of Oslo, for two extremely large, 16,700dwt/56,000gt, 200m long pure car-truck carriers, each worth US\$50 million and capable of carrying up to 7000 cars, with deliveries scheduled for 2007. These are amongst the largest such designs anywhere in gt terms.

Continuing train ferry involvement

Uljanik's involvement with train ferries stretches back to the late 1970s, when the yard built a pair of large vessels (*Geroi Shipki* and *Geroi Plevni*) to carry freight wagons between Odessa in the USSR (now in the Ukraine) and Varna, Bulgaria, thus avoiding rail difficulties in Romania. The yard then started participating in tentative talks about new train ferries for the Caspian Sea in the second half of the 1990s and at the turn of the new millennium.

Talks in Makhachkala (Dagestan) turned serious from March, 2003 regarding a US\$80 million initial order for building four special freight-only train ferries, which would be part-financed by the Croatian Bank for Reconstruction & Development and two Russian banks. Subsequently, Moscow-based Maritime Investment & Development (MIR) placed an initial order in April, 2003 for four

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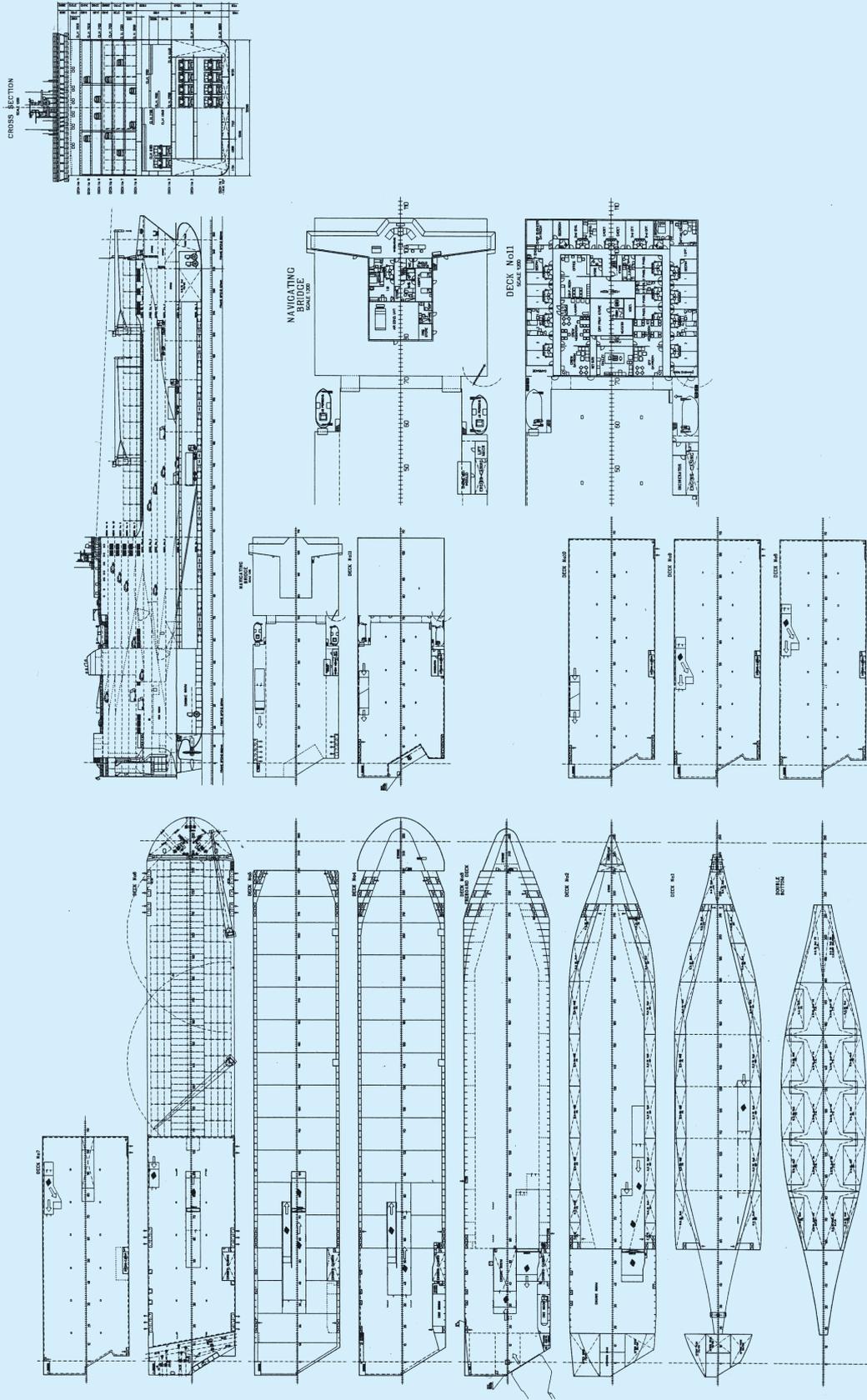
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General arrangement plans of the new 24,800dwt ro-ro/container liners being built by Uljanik for the Grimaldi group for delivery in 2008 and 2009. They can load up to 3000 cars and 1000 x 20ft containers. Trial speed is 21.90knots.



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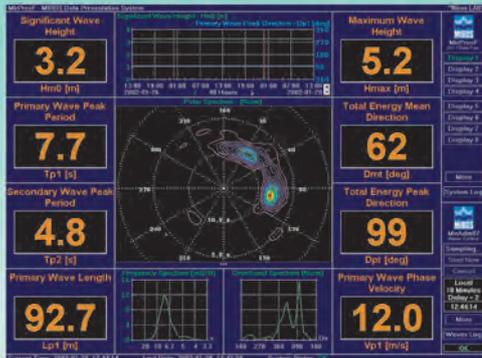
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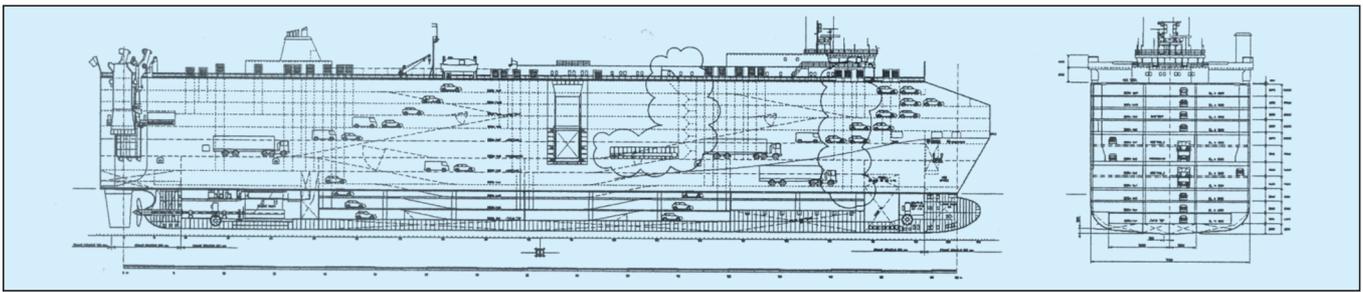
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Profile and cross-section of the 12,300dwt car/truck carriers ordered from Uljanik by Ray Car Carriers. Each is capable of loading 4900 cars.

5000dwt vessels, with two deliveries planned for 2005 and two for 2006. The first of these interesting 5000dwt designs, which are specially dimensioned (147.00m length bp, and 17.50m breadth moulded) to pass through the Russian inland waterway system to reach the Caspian Sea, is expected to be delivered soon. As explained in our July/August issue, these ferries are planned for a special service on a route where no pipelines exist, and the operator considered hauling the oil in rail tank wagons (52 x 12m long in total on two decks) to be the most cost-effective method. Twin Uljanik-MAN B&W 5S26MC 'baby' two-stroke engines will provide a trial speed on a draught of 4.50m of 14.00knots.

On Uljanik's other main plank, tankers, numerous orders have been placed in the last few years, including Novoship's 2001 two-plus-two oil/chemical designs of the popular 47,000dwt

size via Liberian offshore subsidiary Intrigue Shipping, of Monrovia; the options were converted into firm orders in October that year. Three of the four units were delivered and chartered to Stena Bulk, and the fourth is due for completion this year. Several more ships of this size have been placed by various owners.

One of Uljanik's more risky ventures was completion of a Stolt-Nielsen parcel-tanker partly built by the ACH yard in Le Havre, France, following the latter's collapse. Uljanik towed home to Pula the 36,000dwt parcel-tanker, with its stainless steel tanks, for completion to the Stolt-Nielsen Transportation Group's strict quality standards. It was however completed in less than seven months, in 2001, but apparently without profit.

From this project, Uljanik gained much experience in working with duplex stainless steel as well as developing new procedures. For the

work with duplex stainless steel, which has high resistance to corrosion but demands complex handling in the production process with particular care to welding. Uljanik has built a new pipe shop exclusively for stainless steel and a whole series of welding procedures have been applied and certified. Another project of a trio was a 'humane' livestock carrier. A further interesting project was the construction (and delivery in 2002) of a one-off livestock carrier, the 13,400dwt *Becrux*, for Panama-based Sussex Shipping Inc (SSI), while a third project failed to come to fruition. A further most interesting project was planned to be ro-pax ferries designed by Norwegian consultancy SeaTrade for Swiss-Italian PanAdriatic. Apparently, a contract for two-plus-two ships of the very advanced Starship 2000 type with its innovative hull lines (*The Naval Architect* April 2001, page 8) was, alleges the yard, broken by the owner. 

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Tankers galore at Brodosplit

A SUBSTANTIAL tanker order book at Split Shipyard (Brodosplit) means that this leading Croatian yard is in a very fortunate position today. Nevertheless, the management appears to be in two minds as to whether this is a curse or a blessing in disguise. 'On the one hand, we would like to scale down the dominance of tanker production, because we can expect severe competition in this sphere from Korea and from China', stated sales and design manager Damir Polyak, 'and we are thinking about passenger vessels for a counterweight, and keeping a balance between steel production and outfitting.

'On the other hand, however, we would like to keep our very successful tanker production at a high level, particularly Panamax vessels, and continuing the series with our existing owners', he added. 'Tanker fabrication is limited to the technology available here, it has to be admitted, but then the Far East is not so flexible when it comes to special designs, and we are trying hard to be flexible'.

This is by no means an exaggeration. Brodosplit, a state-owned joint stock company, is knee-deep in special tanker designs, and the yard's heavy involvement in Stena's novel P-Max type is making full use of the shipyard's exceptional design strength. The latter is however being somewhat diminished by a 'brain drain' to the Far East, to Korea, and China, where Croatian staff can find good positions as supervisors.

In general, this situation is now slowing, although the yard does lose some engineers to northern Europe and workers to northern Italy, reported Mr Polyak. While the payroll of the former naval and special vessel yard, Brodosplit BSO, has shrunk to just 300, the workforce of the infinitely larger yard producing merchant ships, plus the diesel engine plant and 12 subsidiaries, currently stands close to 4000 as a result. However, it was double that a few years ago.

On March 8, 2005, the order book stood at 20 building contracts, totalling 1,326,761dwt, 447,656cgt, and US\$662,788,000 in value. Of these 20 orders, just two are for BSO, an 800dwt Supetar ro-ro ferry, 87.6m x 17.5m, accommodating 100 cars and 600 passengers, for



An image of the twin-screw, wide-beam and shallow-draught P-Max tankers that are being built at Split for Stena. The first is scheduled for delivery in November this year.

Jadrolinija, and a small search-and-rescue boat for the Croatian government. All the 18 large ships are tankers.

The four deliveries in 2004 were also tankers: two 108,078dwt Aframax product tankers, *Sakhalin Island* and *Governor Farkhutdinov* (delayed from 2003 because of a fire) for Prisco Tankers Ltd; for Cyprus-based Nord Aframax Tankers, the 94,143dwt *Elka Vassiliki*; and the 101,970dwt *Elka Athina* supplied via Liberian offshore companies to Greek European Navigation.

Included among companies with contracts for tankers in the present Brodosplit order book are Marininvest Shipping, European Navigation Inc, Liberian-based Karlin Navigation and Lydia Investments, Malta-based Aenona Maritime, Tankerska Plovidba, Concordia Maritime AG, of Switzerland, and last but by no means least Bermuda-based CMP-Max Ltd.

Sweden-based Marininvest Shipping AB placed orders for five 74,999dwt Panamax long-range crude/product tankers, Ice Class 1A, in 2004 in two lots, without further options. One is scheduled to be delivered in 2006, and equally two-plus-two in both 2007 and in 2008. They are reported to be likely to join the Torn Waterfront pool.

Local Croatian shipowner Tankerska Plovidba, from Zadar, is expecting to take delivery of one 166,300dwt, Suezmax tanker directly in 2007, on the basis of a third Suezmax order placed for US\$52 million in

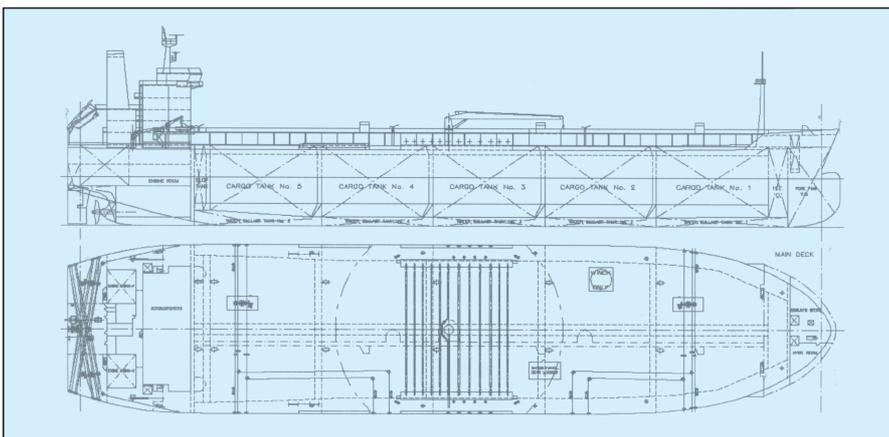
February, 2004 with Brodosplit. The first two Suezmax tankers were ordered for Tankerska Plovidba in 2001, the building of the trio having been made the subject of a prioritised, subsidy-supported government programme to aid the construction of vessels for local owners by local yards.

This contract was placed via Aenona Maritime, of Valletta, Malta, with deliveries originally planned for 2003. The first, *Alan*, was delivered in January 2004, and the delivery of the second, *Hrvatska*, was delayed, slipping into this year. Both are to be fitted with a Manta integrated bridge system operating through four displays from Kelvin Hughes.

P-Max tankers for Stena

One of the most interesting contracts at Brodosplit today is that placed by the Stena Group in 2003 for six 54,000dwt, ice-strengthened (Finnish/Swedish class 1B) crude/product tankers of the new P-Max type, the first of which (*Stena Paris*) is now to be delivered in November this year and the rest to follow at intervals up to February 2008. The price of the first two tankers will be US\$35 million and for the next two there will be an option of increasing the price to US\$37 million.

The P-Max is an extension of Stena's V-Max VLCCs and the C-Max product/LPG tankers; the design continues the wide-beam, shallow-draught concept, and like the others, the new medium-range ships at Brodosplit will be fitted with twin propellers and twin rudders, as explained in our October 2003 article, page 6, so that they can comply with the Det Norske Veritas RPS notation for redundancy. On the same overall length as a traditional medium-range tanker, the new ships will be able to carry almost 30% extra cargo; they also feature extra-deep hopper tanks. The deadweight was originally quoted at 49,900dwt. Stena also has two ice-strengthened Panamax tankers on order at Split, for delivery in October 2006 and February 2007. They will be named *Stena Polaris* and *Stena Poseidon*. 



Profile and deck plan for the twin-screw super-safe P-MAX tankers.

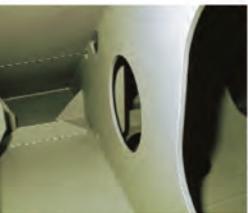
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Concentration on Handysize tankers at Trogir

A WELL-EQUIPPED, medium-sized shipbuilder, Croatia's fourth largest yard, Brodotrogir - or Jozo Lozovina Mosor Shipyard as it was known post-war prior to the mid-1990s - was invariably noted for its design forte, and over-stressed its versatility as a result at times, trying to change tack in product terms. Sited on an Adriatic island, which is linked to the Dalmatian mainland by a bridge, its facilities include 155,000m² total area, with two building berths - one of 200m x 47m, the other of 160m x 20m - suited to building vessels up to 55,000dwt.

JLM became Trogir Shipyard, or Brodotrogir, in 1993. During that year, 12 oil and chemical tankers of 40,727dwt were ordered in Croatia by Novoship. This was split four ways with the three major yards. In 1996 a new series of nine 47,400dwt oil and chemical tankers was ordered by the Russian Sovcomflot through Liberian offshore companies for around US\$33 million each, which was split three ways, but all were designed at Trogir.

Trogir also obtained some of the allocations and delivered one of seven in 1995, two in 1996, one in 1997, two again in 1998 and the last one in 1999, along with the hull of a 8430dwt multi-purpose semi-container cargo vessel to German yard

Cassens. Trogir Shipyard had 1200 employees by 1998, having more-or-less turned the corner, following post-civil war difficulties, and it now has 1280. A considerable role was played in this tanker success story by good design work and long-term cooperation with Russian owners, also by the robust promotion work of the Moscow office of Croatian national shipbuilding association CSC Jadranbrod, which orchestrated the Russian deals.

In 2000, the delivery of a second, identical cargo-ship hull followed suit to Cassens, while Aurora Holding took delivery of the similar 9861dwt *Kegeštrov*. In 2001 and 2002, two further multi-purpose cargo ships, the 9802dwt *Apollo Tiger* and the 9804dwt *Apollo Lion*, were delivered to German-owned Transbulk Navigation, of Nicosia, Cyprus with identical dimensions to those of *Kegeštrov*. In 2000 a new series of six 46,733dwt chemical/oil tankers was ordered by Swedish based Laurin Maritime Group. A typical example of a modern Trogir-built tanker was the 46,864dwt chemical/product *Tarantella*, which was presented in *Significant Ships of 2002*.

Brodotrogir is a tanker-builder first and foremost, and it derives certain advantages from its lengthy experience with this type of ship and the stance it developed as a

result. Today, Trogir claims to be able to deliver vessels within six months, according to Ms Vedrana Vukman, sales director, and is now preparing to save a further month/ship. The state subsidy received over the past four and a half years averaged 10% of building contracts, and €8 million has spent within the same time-frame on new equipment, namely a panel line, welding equipment, plasma cutting and transporter for sections. In 2001, too, Schlick, of Germany, upgraded the 18-year-old steel fabrication line with an up-to-date control system.

Trogir can currently build two and a half Handymax ships annually, up from two since the end of the 1990s, and the plan is to advance to three by 2009. Further investment is planned, but is subject to board approval. Trogir Shipyard is 10%-owned by small shareholders, with 90% held by the state, and no further privatisation is anticipated in the short-term.

The company intends to further upgrade designs and capacities, to build small passenger ships, chemical tankers, and to extend the maximum ship length from the present 200m. Nevertheless, the prime preference is for modern, sophisticated IMO II Handymax vessels. Ⓢ

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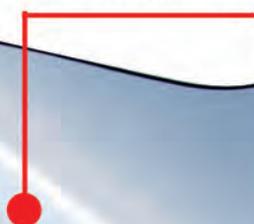
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3 Maj: strong in tankers and resisting privatisation

ARCH-SURVIVOR extraordinary, 3 Maj Shipyard, of Rijeka, is celebrating its 100th anniversary this year, having sailed close to the wind and come within a hair's breadth of demise many times during its colourful history. Today, it is a safe bet that 3 Maj will be around for another 100 years, pre-destined to overcome any conceivable crisis.

The longest period of dangerous twilight drifting is recent, lasting against the backdrop of the Yugoslav break-up from 1990-2002, but then the order book bulged from 11 contracts representing US\$299.17 million, 389,800dwt in February 2002 to 15 contracts worth US\$482.437 million, 706,700dwt by March 2005.

The 15 vessels on order include 10 chemical/product tankers of 51,800dwt, and 195m x 32.20m x 17.80m dimensions, for €240.8 million, ordered by Crown Navigation Inc, of the Marshall Islands, on behalf of tanker fleet operator Latvian Shipping Co.

Eight were ordered at the end of 2003, the rest later, and three-plus-three are scheduled for delivery in 2006 and 2008, with four in 2007.

For all 10 tankers the Sperry Marine business unit of Northrop Grumman Corp is to supply a complete package of electronic navigation equipment from 2006-2008. Each vessel is to be fitted with an integrated bridge system, featuring Sperry's multi-station voyage management system incorporating an electronic chart display, an IT system, radars, autopilot, gyrocompasses, and Doppler speed log.

The remaining five vessels at the shipyard, all set for 2005/2006 delivery, are made up of three chemical and product tankers of 47,300dwt for Liberia and two 23,400dwt German units. Of the former, one is to go to Fluorite Navigation Inc, another to Lavaca Investments Inc, both of Monrovia, and the third to Uljanik Shipmanagement Inc. All the German ships are for Carl Büttner. Uljanik Shipmanagement had already received two 47,300dwt tankers for US\$30 million apiece, *Ebony Pond* and *Ivory Point*, in December 2004 and a third in February, 2005, the third one being scheduled for delivery in April 2006.

Büttner wanted additional safety in terms of propulsion for its two vessels. The yard proposed a combined shaft generator/motor in addition to the main engine, for emergency use as a solution, but the last two ones are to have dual MaK main engines, and a design change was agreed upon.

Added to the already impressive total of 15 orders is an early June letter of intent signed with the Rijeka yard by NSC Schiffahrtsgesellschaft, of Hamburg, controlled by Chilean businessman Roberto Echevarria, for three 4900-vehicle pure car-truck carriers. Deliveries have been fixed for August and December, 2008 and April 2009, but prices are yet to be divulged. The yard is clearly well out of the danger zone but it was still out to prove its mettle quite recently, to quieten intermittent demands for its early privatisation.

In May/June, 2004 the shipbuilder - hoping to sell designs, knowhow, and equipment -



Delivered at the end of last year by the 3 Maj yard to Uljanik Shipmanagement was the 47,300dwt product/chemical tanker *Ivory Point*. She is the second of three similar ships for this owner.

conducted prolonged negotiations in lieu of a 'cooperative partnership' with Bender Shipbuilding & Repair Inc, and Halter Marine Inc, both from the USA. A the time, 3 Maj triumphantly claimed an agreement for Bender to build five 47,000dwt tankers in the USA according to the design already employed for Uljanik Shipmanagement, and expecting to be the prime supplier of equipment for the job.

However, president Gvozden Rukavina admits unequivocally that the US government is yet to give the green light for this interesting project.

The Croatian Privatisation Agency and the Ministry of Economics call from time to time for a partial sell-off of equity and for finding a strategic investor with deep pockets in order to relieve the state budget from having to provide loans to sustain production, and occasionally



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bailout cash, alongside a regular 10% subsidy, but yard management is - perhaps predictably - robustly against the proposed assault on its self-rule.

President Rukavina adopted a matter-of-fact stance when questioned concerning the issue, readily admitting to not having any practical privatisation plans, because 'the re-structuring of the shipyard had to come first to increase its value and clear its debts, which would itself inevitably take a few years to finish'. The very ownership split of the yard made this crystal clear, too, since apart from the 15% holding of equity in it by employees, state institutions share the balance, ie, the State Bank Agency (24%), the Croatian Privatisation Fund (15%), the Ministry of Finance (13%), the Croatian Health Fund (9%), and 'others' (5%).

'The yard produces five ships a year on average, generating US\$30-US\$35 million/vessel or US\$150-US\$200 million income annually', the president said. 'All this has to be covered by loans to the tune of 50%-60%, with 40%-50% covered by advance

payments from owners. Then there is the weak dollar problem; this caused a US\$40 million loss for us in 2003 and that was only the beginning of the trouble. In 2003, we had a cashflow/liquidity problem, and the government came up with a US\$45 million loan guarantee'.

3 Maj Shipyard has extensive facilities including building berth No 1 with dimensions of 195m x 22.13m, occupying 4315m² area offering optimal ship's parameters of 189m x 29m and a maximum of 220m x 32.2m; and building berth No 2 of 214m x 28m, occupying 5992m² area and offering optimal ship's parameters of 260m x 32.2m and a maximum of 260m x 50m. Meanwhile, covered building berth No 3 (136.2m x 30.5m), has already been phased out. These berths allow the building of ships in general up to 260m x 50m, tankers up to 111,000dwt, container ships up to 4000TEU, and bulkers up to 130,000dwt.

The fully employed workforce is 2200, or 2800 including those in the equipment and diesel engine factories; up to 1400

subcontractors can be called in when needed. 'The pay is half at best in comparison with the EU, and while the gap is narrowing with excruciating slowness, employee desertions to the EU - and in particular to Italy and, to a lesser extent, Germany - remain high', stated president Rukavina. 'In our design and engineering offices, there is less fluctuation, because recently 3 Maj gives hope for a better future in spite of the fact that we pay our highly-educated staff even worse than the blue-collar staff, with respect to the EU shipbuilders policy'.

New equipment acquired by the shipyard in recent years includes a line handling steel sheets and profiles, combined with a conveyor and a marking system from Schlick GmbH in 2001, and subsequently a line for treating profiles, a refurbished panel line, a micro-panel line for smaller parts, a line for pipe-bending, an NC plasma cutting machine, a mobile crane with 40tonne hoisting capacity, a gas plasma cutting machine, a semi-automated pipe cutting line, and a 180tonne section transporter. 

First of new asphalt tankers at Kraljevica set for delivery

THESE are sweet and sour times for the 1729-founded Kraljevica Shipyard, Croatia's oldest building and repair yard for 276 uninterrupted, glorious years, and a participant in the construction and repair of both naval and commercial vessels for most of this period. The sweet side is, unequivocally, that the building programme of the yard, which is sited at the entrance of the sheltered Gulf of Bakar 7nm south of Rijeka, has been vastly more successful for the first six years of the new millennium than it had been for the final six of the old, with just four modest deliveries.

In contrast, six ships have been delivered in the 2000s, just one of them - a 30m long aluminium oil spill recovery craft for the Ministry of Environmental Protection - so far in 2005, but with three more still due still this year, to be followed by seven next. Thus, there are 10 remaining ships on the order book for the time being.

A significant delivery in September will be *Asphalt Seminole*, the first of a series of 9240dwt new-design asphalt tankers, and three more to follow. Two are for Asphalt (Caribbean) Ltd, and two for Asphalt Transporter Shipping Co. Each of these has 10 cargo tanks and is specially designed to cope with high temperatures up to 250°C, needed to avoid solidification of the cargo. Two 400m³/h cargo pumps are fitted, together with an emergency portable one 150m³/h.

The sour side of Kraljevica is that the management of this medium-sized shipyard longingly harks back, in one respect, to 1994 and the mid-1990s. Then the yard still had a bulging contingent of skilled workers, and it could count on timely deliveries; today, with the skilled workforce having disappeared to foreign yards, this is no longer the case. The initial asphalt carrier, for instance, was in early 2002 booked for delivery in 2003.



Photograph: Dalibor Barbalic

Asphalt Seminole, the first of four 9240dwt new-design asphalt tankers, is scheduled to be handed over this month (September) to Asphalt (Caribbean) Ltd. The ships were originally ordered by US owner Sargeant Marine.

'We have a payroll of 590 today, up from 413 at the beginning of 2001', says sales director Sinisa Ostojic. 'They receive an average pay of Kuna3600/month, essentially approximately the same as in most other Croatian shipyards, but this is just roughly half of the take-home pay at EU shipbuilders. No wonder, given this sort of continuing differential, that the lion's share of the skilled labour force has drained away in a decade'.

The number of staff depleted from 1200 at the tail-end of the 1980s, two-thirds of it migrating off by the end of the millennium, but then the pendulum swung back from 2001/2002. 'We

started re-collecting skilled staff in particular, in a modest way to start with', says Mr Ostojic, 'but the trend is accelerating, and I am confident that eventually we will reach the old level - probably not in numbers, but in quality'.

The present shipbuilding/repair/naval split is 70%, 20%, and 10% but it looks likely that the missile gun boat *Kralj Dimitar Zvonimir*, delivered to the Croatian Navy in 2002, will have been the last naval newbuilding for a long time to come, because the Ministry of Defence has no further funds at its disposal; thus, that naval 10% is restricted to repairs. 'We would, of course, very much like to build more naval craft, and this

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A model of the 9240dwt asphalt tankers being built at Kraljevica Shipyard.

would also be the wish of the defence ministry and the Navy', Mr Ostojic laments, 'only a lack of government priority prevents this happening - that is an unsurmountable hurdle'.

The four vessels delivered in the final six years of the past millennium were two 3400dwt units - a container-paper carrier and a hull of the same design - to Sea Link Alpha, of The Netherlands, and the research ketch *Hrvatska Cigra*, delivered to a Croatian offshore yacht club in 1994, plus the car/passenger ferry *Kijevo* for Jadrolinija Rijeka - which serves Croatian island traffic - in 1997. All these are ship types of little future consequence for the yard. Jadrolinija was an old customer, and *Kijevo* was the 12th vessel built for it by Kraljevica since 1955, while the container-paper carrier model was a derivative of a trio of pallet-carriers built for export from 1989-91.

Despite lack of interest in small vessels, last year, the 700dwt *Sveti Krsevan* double-ended ro-ro/passenger ferry of 87.6m x 17.5m for

Jadrolinija's domestic island services, and a new oil-spill recovery craft for the Ministry of Environmental Protection, were both delivered. *Sveti Krsevan*, powered by four Ulstein Aquamaster azimuthing thrusters directly driven through cardan shafts by Caterpillar engines, was the first of three ferries allocated to Kraljevica, under a preferential Transport, Maritime Affairs & Communications Ministry programme announced in August, 2001. This covered the construction of nine ferries with capacities for 100 vehicles and 600 passengers, with the state bearing 20% of the costs. Originally, the ferry was to be delivered in 2003. Due to the bankruptcy of Victor Lenac Shipyard, Kraljevica's allocation was increased to four ferries.

An additional project allocated to Kraljevica in March, 2003 was the completion under a US\$8.6 million contract of a ro-ro vessel for Stena Ro-Ro, towed from La Spezia yard Societa

Esercizio Cantieri (SEC), in Italy, which was in trouble. Marine electronics specialist Elektromehanika, of Rijeka, was to carry out a significant part of the work, due to be finished within six months; other participants included corrosion protection provider Teri Crotek, also of Rijeka, and Maritime Montering, of Norway, for interiors. In the end, the task proved more demanding than initially envisaged, schedules slipped, and delivery only took place in March, 2004. The final profit was believed to be only €1 million.

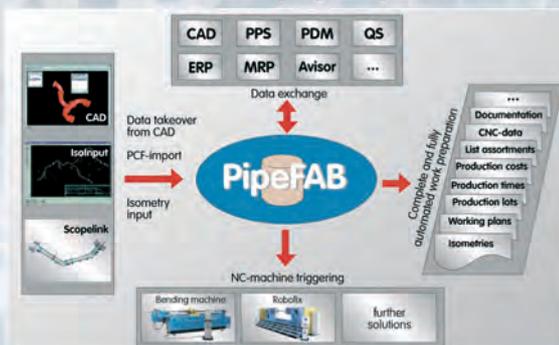
In 2001, Kraljevica embarked on a US\$3.5 million four-year investment programme for new equipment and technology. Purchases have extended to an automated plasma cutting line, automated pipe-cutting and welding equipment, 100 portable welding kits, and, most importantly, a transporter capable of carrying sections up to 200tonnes. The acquisition of additional equipment is still being negotiated. ☪

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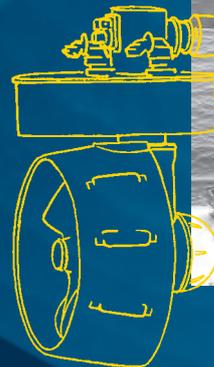
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Hydrogen-fuelled gas turbine-powered high-speed container ship: a technical and economic investigation

At the recent international conference on Fast Sea Transportation, FAST 2005*, I J S Veldhuis from the ship science department, and R N Richardson and H B J Stone from the low-temperature engineering group, Southampton University, UK, presented a paper on a study conducted into the technical and economic feasibility of a hydrogen-fuelled long-haul feeder container ship. The properties of hydrogen offer the potential for increased payload, particularly in long-haul operation, which in turn improves economics. The research focuses on the design and operation of a liquid hydrogen-fuelled, 64knot, foil-assisted catamaran (FAC), container feeder ship (600TEU) and the associated port/terminal facilities.

THE combination of hydrogen fuel and high-speed catamaran technologies provides an interesting opportunity to significantly increase the transport efficiency of container ships, allowing such ships to transport economically sized payloads, at fast speeds, non-stop on current oceanic sea routes. The research presented here describes the potential for a high-speed container feeder ship capable of storing and utilising liquid hydrogen (LH₂, boiling point 20.3K) to fuel aero-derivative gas turbines for propulsion.

The research builds upon the conceptual design presented previously [Ref 1] and includes a number of improvements. Research into hydrogen fuelling of gas turbines was conducted as early as 1943. Initially this was focussed on aviation applications [Ref 2, 3] but more recent research has included industrial gas turbines. This latter work [Ref 4] suggests that a modest increase in thermal efficiency can be achieved utilising pure H₂ fuel rather than a hydrocarbon fuel.

Combining these results with fundamental data for hydrogen, specific fuel consumption and realistic fuel load figures for oceanic crossings may be established. This information plays an important role in establishing design feasibility. The use of hydrogen in a high-speed marine application has implications for both the onboard fuel system and the port infrastructure. Furthermore, the proposed design assumes that hydrogen will be stored as a cryogenic liquid onboard the vessel and that hydrogen will be produced at dedicated port terminals by steam reformation of natural gas at both ends of the target route.

The high-speed sea container transport system described envisages delivery of a time-sensitive product of the type currently subject to just-in-time (JIT) supply chain management by multi-nationals on long-haul oceanic trade routes for both the Pacific and the Atlantic oceans. The choice of H₂ fuel obtained from natural gas has implications for the economic viability of such high-speed ship operation.

The combined ship and port terminal/H₂ production site investment and ship operation costs are investigated for two Pacific and one Atlantic target routes. The results of these economic investigations are presented in TEU freight rates for break-even operation (ie, cost equals revenue) and zero net present value (NPV) operation. Such analysis allows for identification of market positioning of a LH₂ ship operation. The projected freight rates for this type of ship operation may then be compared with other hydrocarbon fuelled, high-speed, long-haul container transport design studies and current market freight rates.

High-speed container ship design

Introduction

The engineering synergy between high-speed FAC ship and LH₂ fuel technologies allows an economic opportunity for the introduction of long-haul high-speed sea transport suitable for current and future intra-company trade flows, generated by the success of JIT production schemes of multinational companies.

Both marine engineering of LH₂ fuel applications for propulsion and power generation and naval architectural research related to high-speed FAC design required for the very high ship speed set, namely 64knots, must be considered. However, the focus of this paper is the integration of LH₂ fuelling in a marine environment. The high-speed ship design, presented previously [Ref 1], is the platform on which the technical feasibility and economic viability of hydrogen fuelling in the high-speed marine environment will be tested.

Design of the high-speed FAC container feeder ship utilised here commenced in 1997. A summary of the design evolution and revised layout, suitable for LH₂ storage and utilisation, is presented in this section. This design is the subject of on-going research at the ship science department of the University of Southampton.

Layout and particulars

The high-speed LH₂ container feeder ship concept, presented in Fig 1, is based upon a foil-assisted catamaran design. Such ship types show reduced resistance characteristics [Ref 5] at high Froude displacement numbers (Equation 1) via reduction of the wetted surface facilitated by a vertical ship elevation. Such resistance characteristics are preferable for high-speed ship operation, in which frictional resistance dominates. The vertical elevation, 2.95m in this ship design, is generated by six hydrofoil pairs, located at the underside of each demi-hull. The essential features of the design are summarised in Table 1.

$$F_{\nabla} = V / \sqrt{g \nabla^{1/3}} \quad (1)$$

V: Ship speed [m/sec]

g: Gravitational constant [m/sec²]

∇: Submerged hull volume of demi-hulls [m³]

The ship dimensions and layout are governed by the aspect ratio of the 600TEU dual layer container arrangement on the watertight deck of 25 by

Length overall	[m]	175.50
Length waterline	[m]	164.18
Beam (container deck)	[m]	42.50
Beam (foils)	[m]	62.15
Depth (WT deck)	[m]	18.30
Draught (service speed)	[m]	4.25
Draught (floating)	[m]	7.20
Container capacity	[TEU]	600
LH ₂ fuel space capacity	[m ³]	14,656.5
Service speed	[Knots]	64.0
Froude displacement number*		2.646
Range	[N. miles]	5300
Crew		18

* At service speed draught

Table 1: High-speed LH₂ container feeder ship particulars.

Tank type	Amount of tanks	Geometric volume	Storage volume*
[-]	[-]	[m ³]	[m ³]
A	6	1,690.2	9,735.8
B	2	1,098.6	2,109.3
C	2	333.3	639.9
D	2	1,131.0	2,171.5
Total			14,656.5

* Maximum fill factor of 96% to allow for H₂ above LH₂ fluid level.

Table 2: Summary of fuel storage capacity.

12TEU containers. The catamaran cross-body structure carrying the 600TEU payload allows space for the cryogenic fuel storage. It is known from cryogenic aviation design [Ref 2] that fuel volume is a primary design factor in establishing overall vehicle dimensions.

Liquid hydrogen has a high gravimetric energy density but, because of its low density, a relatively low energy content per unit volume. This has implications for fuel storage requirements, thus influencing dimensions such as the cross-body height. For Pacific Ocean crossings an LH₂ fuel capacity of 14,656.5m³ distributed over 12 cryogenic tanks is needed. This gives a total fuel mass load of just over 1000tonnes.

The ship's service speed dynamic equilibrium, as indicated by Andrewartha [Ref 6] for FAC ships,

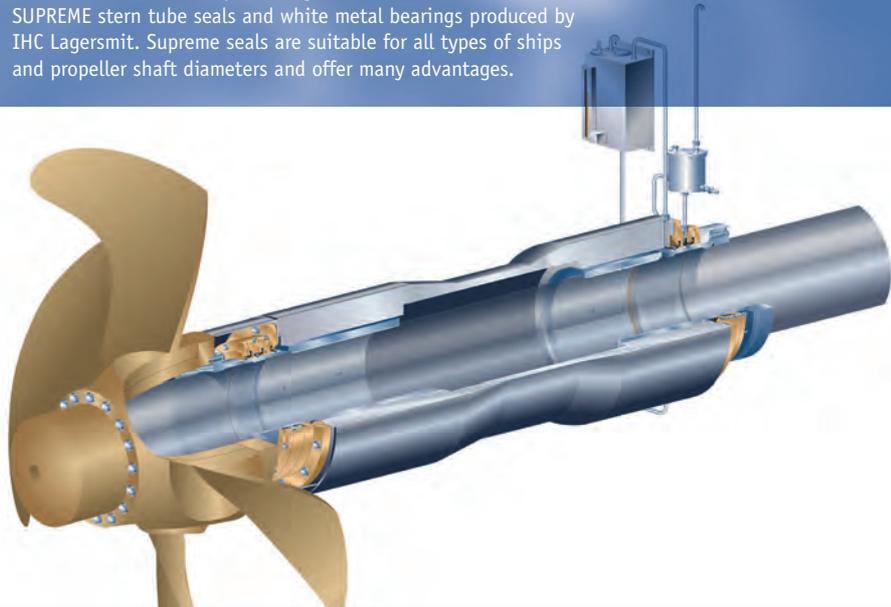
TECHNICAL PARTICULARS LH₂ CONTAINER FEEDER VESEL

Length, oa.....	175.50m
Length, wl.....	164.18m
Breadth (container deck).....	42.50m
Breadth (foils).....	62.15m
Depth (to main deck).....	18.30m
Draught (service speed).....	4.25m
Draught (floating).....	7.20m
Container capacity	600TEU
LH ₂ fuel space capacity.....	14,656.5m ³
Service speed	64.00knots
Froude displacement number.....	2.646
Range	5300nm
Crew	18

*Held on June 27-30, 2005, in St Petersburg, Russia.

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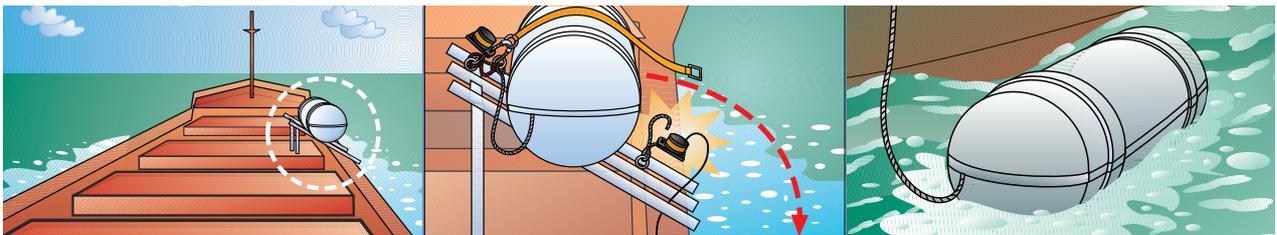


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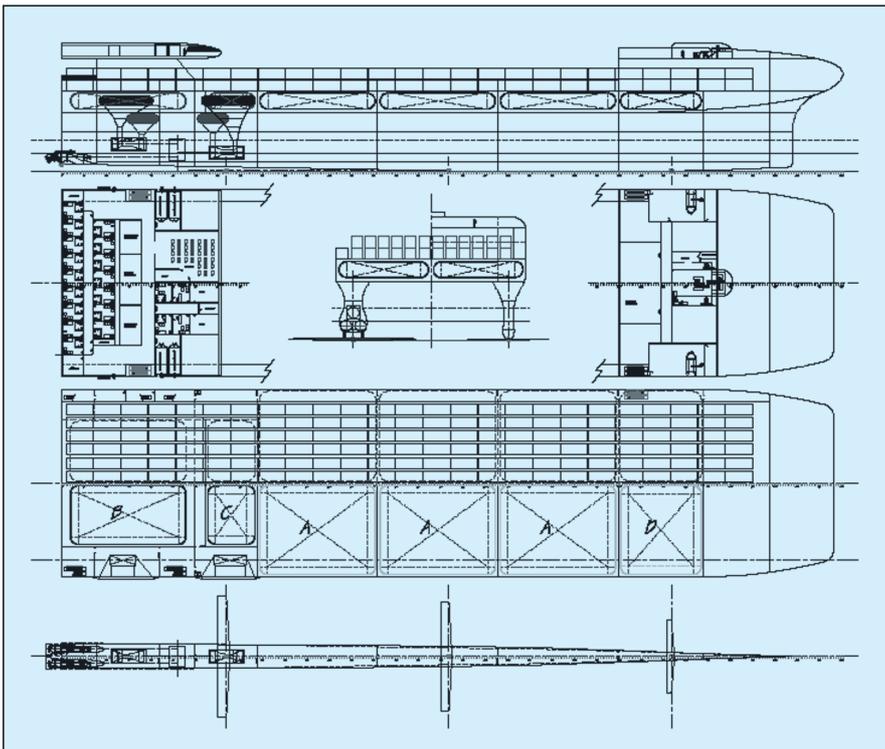


Fig 1. General arrangement of the 600TEU container feeder ship, fuelled by LH₂.

has a significant overall design importance. Hydrofoil lift and catamaran hull buoyancy/dynamic lift combined with waterjet propulsion thrust must form a force equilibrium with the ship's mass at this dynamic condition.

Hydrofoil longitudinal placement, hull buoyancy distribution, fuel tank, superstructure and engine room placements are thus inter-related, complicating the design process. Additionally, the reduction of LH₂ fuel mass during oceanic crossings will influence mass distribution and thus the dynamic equilibrium.

Resistance and propulsion

The resistance characteristics of this high-speed container feeder ship remain as outlined previously [Ref 1]. The frictional (56%) and foil (35%) resistance components are the dominant resistance components, while the wave resistance component is relatively small due to the high length-over-beam ratio (27.2) of the catamaran demi-hulls. The ship requires an installed power of 185.2MW to sustain the 64knots with the aid of four 2.5m diameter waterjets, located in the demi-hull transoms.

The overall propulsive efficiency assumed is 73.4%. This is higher than used previously [Ref 1] but it is supported by data [Ref 7] for large waterjet propulsion systems currently in service on high-speed ferries.

The propulsive power is provided by four gas turbines modified for LH₂ fuelling located in separate engine rooms inside the demi-hulls. The turbines envisaged are based on the LM6000 Sprint turbine by General Electric [Ref 8] with a rating of 49.2MW each. Turbine inlet air is drawn via air ducts located on the

outside of the cross-body structure, while turbine exhaust is ducted via the demi-hull side shell underneath the cross-body structure.

Hydrogen storage facilities

Aviation research [Ref 2] has indicated a fuel mass reduction factor of 2.8 for an identical vehicle range when using LH₂ rather than a liquid hydrocarbon but, because of the low density, fuel volume increases by a factor of 4.15. The mass reduction has a beneficial effect on the transport factor [Ref 9] of high-speed ships allowing a payload increase, which in turn improves transport economics. It also increases range, making oceanic crossings with an economic payload a realistic option.

However, LH₂ fuelling complicates the ship design process through the introduction of cryogenic systems. The fuel system envisaged includes 12 insulated tanks in a closed pressurised system. Air infiltration must be prevented to avoid potentially explosive mixtures and because at the temperature of LH₂ (20.3K) air will freeze and possibly cause blockages in the system. The LH₂ tanks are constructed from aluminium alloy and insulated by a dual 75mm layer of closed cell foam (35.24kg/m³) with vapour barriers between the layers and on the outer surface. The cryogenic storage tanks are non-integral with the ship structure to avoid stressing of the tanks by ship deflections. Table 2 provides an overview of the LH₂ fuel capacity in this ship design.

The operating temperature of the cryogenic tanks must be maintained during sea operation, even after the tank is emptied of liquid, in order

		LH ₂	Synjet*
Molecular weight		2.016	168.0
Density	[kg/m ³]	70.42	800.0
Lower heating value	[kWh/kg]	33.3	11.9
Boiling point	[K]	20.27	440 - 539
Specific heat at boiling point	[J/grK]	9.69	1.98

* Aviation fuel (CH_{1.92})

Table 3 Properties of LH₂ compared with current gas turbine fuels.

to avoid undesirable expansion/contraction cycling and excessive 'flash' loss of H₂ on refilling. Cold H₂ gas, generated by boil-off, will be used for this purpose. Warming of the storage tanks is only envisaged during scheduled drydocking. Additionally, all fuel lines must be insulated to minimise fuel loss due to boil-off and prevent an air liquefaction hazard. The use of a cryogenic fuel makes for a bulkier, heavier and more complicated fuel system compared with conventional hydrocarbons but it is believed that this is more than compensated for by performance and economic advantages.

Ship design improvements and limitations

Various changes have been implemented to the previous design [Ref 1] to improve performance. These are firstly an increase of foil (2m to 4m) and transom (1.7m to 2.5m) submergences to avoid foil emergence and waterjet aeration in a seaway. Secondly, the 'bridge' has been moved aft of the forepeak bulkhead in line with the 2000 IMO HSC Code. This latter change has created more payload space and the container capacity has been restored to 600TEU containers from 592 previously.

Further research is required to establish lift, drag and cavitation characteristics of the six hydrofoil pairs in the steady-state flying condition at the cruising speed of 64knots. The high speeds will require the use of either super or partially cavitating hydrofoils. The lift and drag characteristics of these cavitating foils and their influence on the motion behaviour of the high-speed ship is the subject of ongoing research.

Benefits of hydrogen as a fuel

Hydrogen is the simplest and most abundant of all the elements, consisting of one neutron and one electron, but does not occur naturally on earth in an elemental state. A major hurdle to the development of a hydrogen-fuelled economy is therefore the requirement to dissociate hydrogen from the compounds in which it is most commonly found (eg, H₂O and CH₄).

A number of processes can be used to dissociate hydrogen; the two most common being steam methane reforming (SMR) of natural gas (NG) and electrolysis. The density of hydrogen is such that gas phase storage, even at very high pressures, would not provide sufficient energy density for the proposed application. The gas must therefore be liquefied and stored at

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		H ₂	CH ₄
Stoichiometric air-fuel ratio	[by vol.]	2.38:1	9.42:1
Flammability limits	[% vol.]	4.0 - 75.0	5.0 - 15.0
Minimum ignition energy	[mJ]	0.018	0.033
Stoichiometric combustion temperature	[K]	2550	2390
Flame speed	[cms ⁻¹]	265	33

Table 4. Combustion characteristics in air.

Route no.	Start Port	End Port	Distance
[-]	[-]	[-]	[N. Miles]
1	Yokohama	Tacoma	4274
2	Philadelphia	Cherbourg	3265
3	Yokohama	Long Beach	4838

Table 5. Ocean transport routes investigated.

Investment type	No. of	Unit costs	Total costs
[-]	[-]	[M. €]	[M. €]
LH ₂ ship.	2	94.97	189.93
Terminals	2	20.00	40.00
H ₂ SMR plant	2	112.69	225.38
LH ₂ plant & site storage	2	9.97	19.95
Aluminum containers	1	117.00	117.00
Total			592.25

Table 6. Capital investment Route 3.

cryogenic temperatures. With any form of hydrogen fuel there are safety implications and design constraints, and these are compounded by the very low temperatures encountered with liquid phase storage. These issues will be discussed in the remainder of this section.

Production

On an industrial scale, SMR is the most common hydrogen production technique, accounting for 48% of output in 2002 [Ref 10]. The SMR process involves the mixing of superheated steam and natural gas (~80% Methane CH₄) in the presence of a catalyst at a temperature of 1173K. Two thirds of the final hydrogen is dissociated from the methane. The final third is derived from the steam (H₂O) in a reaction referred to as the 'water-shift'. The release of carbon and oxygen in the form of carbon monoxide (CO) and carbon dioxide (CO₂), both greenhouse gases, is a disadvantage of the SMR process. Sequestration of CO and CO₂ is possible, but this may increase production costs by 7% [Ref 11]. However, in the short term, SMR is the only technique likely to be able to provide hydrogen in the quantities required by the high-speed container feeder ship.

Liquefaction is achieved by a cycle of compression, cooling and expansion common to the production of many cryogenics. The energy consumed by the liquefier can be equivalent to as much as 40% of the energy potential of the resulting LH₂. However, the efficiency (defined as the theoretical work of liquefaction compared with the actual energy consumed) of current hydrogen liquefiers is barely half that of those used to produce oxygen and nitrogen. There is, therefore,

considerable room for improvement which is likely to occur as demand rises and R&D increases.

Storage and handling

The low temperature of LH₂ demands that careful consideration is given to the design of storage vessels/tanks and fuel handling systems. The only example of comparable large-scale liquid hydrogen storage is that of NASA's vacuum insulated spherical tank [Ref 12]. A spherical tank is the preferred geometry, where space is available, as the maximum volume is obtained with minimum area of tank in contact with the liquid which is desirable to reduce heat leak and in turn boil-off. Boil-off rates for stationary storage are ~0.06% [ref 13] per 24 hour period. However, the hydrogen fuel tanks on a cargo ship must be designed to fit the available space/shape and also limit boil-off from transient motion such as sloshing [Ref 14].

Fuel safety

With the growing interest in hydrogen as an energy carrier, in aircraft [Ref 3] and vehicles [Ref 15], a number of international standards have been published or are in the process of being drafted. The most relevant to the marine environment are those dealing with hydrogen quality and refuelling technology [Refs 16-18].

Elements of these standards offer direct application or the potential for technology transfer, for example, those relating to aircraft hydrogen fuelling. The very low temperatures involved have implications for the safety of both equipment and personnel. Great care must be taken in selecting

materials and designing equipment such that it has adequate strength at low temperature and is able to accommodate the contraction likely to occur on cooling. Consideration must also be given to the potential problem of hydrogen embrittlement.

Physiological hazards, for example cold burns from direct contact with liquid hydrogen or LH₂ cooled surfaces, are unlikely as all low-temperature surfaces will need to be insulated to minimise boil-off losses and prevent ambient air liquefying and freezing (itself a hazard because of oxygen concentration [Ref 19]). However, personal protective equipment should be used and operators will need to be trained in emergency procedures in the event of mechanical failure. Hydrogen is odourless and colourless in the gaseous phase. In the event of a spillage in a confined space, displacement of the air might result in an asphyxiation hazard if the oxygen level falls below 14% [Ref 19]. In addition, of course, any leakage of hydrogen presents a significant fire or explosion hazard since the flammability limit in air is from 4% to 75% [Ref 20] and the ignition energy required is extremely low.

Table 3 summarises the physical properties of liquid hydrogen and draws a comparison to currently employed gas turbine fuel.

Hydrogen for marine gas turbines

The use of gas turbines for marine propulsion is not new although to date, and with the exception of certain experimental installations, their application has been limited to naval vessels, ferries, and cruise ships [Ref 21] and the fuels employed are liquid hydrocarbons.



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The fuelling of gas turbines with hydrogen is a developing technology with much research having been focused on aeronautical applications and growing experience with industrial turbines. The only known marine example is a report of experiments on a small, 260kW, turbine installed in a USN landing craft successfully converted for hydrogen operation [Ref 22].

The interest in hydrogen across all sectors is its potential to minimise pollution at the point of use and a high (gravimetric) energy density. The principal attraction of gas turbines for marine propulsion is their high power density (in terms of both the weight and size of the installation) when compared with the alternatives of reciprocating engines or steam turbines. They are also reliable, vibration-free, require minimal maintenance between scheduled overhaul and, being 'external' combustion heat engines, offer the potential for low emissions even when conventionally fuelled.

For example, NO_x emissions from turbines are lower than from marine diesels whilst those from hydrogen-fuelled turbines are lower still. All these factors make gas turbines the ideal choice for the proposed high-speed FAC container vessel. The turbines used in marine installations are usually aero-derivative, based on the thermodynamically 'simple' Rankine cycle, rather than the heavier and bulkier, although potentially more efficient, industrial type. They are usually supplied and installed as self-contained 'power modules' [Ref 8] with the only connections required being to the fuel and air supplies, exhaust and mechanical output.

Experience has been gained with a wide range of fuels in static aero-derivative gas turbine installations. These include various grades of petroleum distillates, refinery gases (usually mixtures of methane, CH₄, and H₂) and natural gas (principal component CH₄). Combustor design must be optimised for a particular fuel although dual fuel operation is possible. Natural gas fuelled turbine/generators play an important role in many on-shore electricity grids and dual-fuel turbines are extensively used on offshore oil and gas production platforms. In the majority of current marine installations the fuel used is conventional gas-oil although gas turbines are under consideration for use in LNG tankers [Ref 23] where they might be fuelled exclusively by boil-off gas or have a dual-fuel capability.

H₂ operational experience

Whilst limited research into hydrogen fuelling of gas turbines commenced as early as 1943 [Ref 2] the potential of a hydrogen-based economy has resulted in a resurgence of interest. The properties of hydrogen and its combustion characteristics present particular challenge.

Gas turbines employed in oil refineries have been fuelled with hydrogen-rich process gas for many years but experience of pure hydrogen is limited. However, the potential and feasibility has been demonstrated. Moliere [Ref 4] reports that a 40MW GE gas turbine operating at a refinery in Korea has achieved over 50,000 hours of operation with six hydrogen concentrations of over 97%. Further, Moliere calculates that changing the fuel from methane to hydrogen results in a 2% increase in thermal performance.

The difficulties to be overcome in fuelling with hydrogen fall into three main areas; combustion characteristics, thermal effects and the thermo-physical properties of the gas and the way these may affect materials with which it comes into contact. These latter considerations are as relevant to the gas storage and supply systems as to the turbine itself.

Combustion characteristics

- very high flame speed (typically 8 x CH₄)
- high flame temperature (150K greater than CH₄)
- high diffusivity and dissociation at flame front
- stable flame but high flashback risk.

Thermal effects

- high flame temperature leading to enhanced convective and radiative heat transfer has material implications
- turbine blades subject to intense (1400K-1700K) and turbulent gas stream.

Thermo-physical considerations

- H diffusion to grain boundaries in crystal structure of metal can cause H₂ embrittlement
- sealing can be difficult, H₂ will readily diffuse through gaps that are leak-tight to CH₄
- low density and high diffusivity of H₂ require additional safety systems and procedures.

Logistics and H₂ fuel economics

Proposed fast long-haul container service

The mode of operation proposed involves, for each route, two ships and a dedicated container terminal and LH₂ fuel plant at each port. The frequency of departure within a four-week period (block period) depends on the sea-route length and turnaround time.

The high-speed ocean routes considered are shown in Table 5. Departure frequencies for the routes are 9, 12, and 8 respectively within one block period, including an eight hour turnaround time for the unloading/ loading/ re-fuelling cycle.

The departure frequency influences the transport chain's economic viability, as both running costs and transport income are influenced by the departure frequency. Hinterland communications are an additional factor in the transport chain economic viability but are outside the scope of this paper.

Capital investment

Capital cost for the ships is difficult to estimate because of the novelty and complexity of the design. However an indication can be gained by comparing published contract values for similar fast catamarans, such as the Stena HSS1500, and applying dimension-based admiralty coefficients. Such analysis indicates a capital cost of €85.6 million per FAC. A 15% contingency has been added to reflect the novelty of the H₂ FAC giving a final figure of €95 million. Linear depreciation of the ships, and other capital costs, has been included in the economic model. The residual value expected after a 25-year service life is 20% of initial investment.

Route	Transport rate Zero Profit*		Transport rate Zero NPV*	
	[€/TEU]	[€/kg]	[€/TEU]	[€/kg]
1	2427.67	0.486	2983.60	0.597
2	1868.88	0.374	2288.15	0.458
3	2735.49	0.547	3363.27	0.673

Including linear depreciation of invested capital.

Table 7: Identified transport rates for break-even operation.

Previous research [Refs 24, 25] has indicated that H₂ fuel plant capital costs and H₂ unit cost depend on the capacity of the SMR and liquefaction plants. In this application, this is determined by the refuelling requirements of each ship which is in turn route-dependent. These LH₂ fuel quantities are 911.2tonnes, 696.1tonnes and 1031.4tonnes for routes 1 to 3 respectively.

Combining fuel load data with ship departure frequency leads to the required block period fuel capacity per terminal. The average production rate across all the routes is 145.5 x 10³m³/h H₂ gas which is liquefied to yield 12.1x10³kg/h LH₂ fuel.

Utilising investment data from previous research [Ref 24, 25] of €8.04/GJ and €0.09/kg for the unit capital costs of H₂ SMR and liquefaction respectively, the costs for the fuel plant are obtained. The longest route, 3, requires the maximum fuel plant investment, as indicated in Table 6, but the investment required for routes 1 and 2 is of similar magnitude.

Provision of the dedicated terminals and aluminium containers also require investment. Container terminal investment is small as only horizontal transport is envisaged for ship loading, additionally, terminal holding capacity is small; 2500TEU. Approximate unit costs for the TEU and FEU aluminium containers are 16 x €10³ and 23 x €10³. Total investment is therefore €589.0 million, €582.3 million, and €592.3 million for routes 1 to 3, respectively.

Running and unit costs

H₂ fuel costs are critical to economic viability as they are a significant fraction of total costs. Other factors to be considered include: salaries, container moves, insurance, maintenance, and repair and drydocking. The cost of H₂ fuel is influenced by the scale of production; smaller H₂ production units having higher unit costs. The unit cost of H₂ fuel used in this study comprises the cost of SMR and liquefaction.

The natural gas price used is €4.902/million BTU giving SMR unit H₂ gas price of €0.8556/kg. Research [Ref 25] indicates a unit H₂ liquefaction cost of €0.5366/kg for production rates indicated earlier. The total unit cost for LH₂ production is therefore €1.3922/kg.

Using this value the block period fuel costs can be determined. The LH₂ consumed, for instance, on route 3 is 8251.2tonnes per block/ship, leading to a block fuel cost of €11.5 million. The fuel costs therefore represent 88% of annual operating costs. Additionally, capital depreciation is equal to 5% of operating costs.

Economic evaluation results

The economic evaluation results are presented in Figs 2, and 3, and Table 7. Fig 2 and Table 7 show the results for both zero profit and NPV based on a unit transport cost per TEU. Zero

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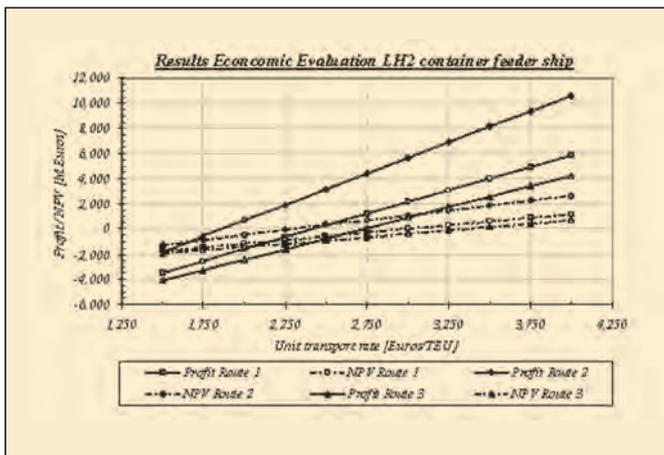


Fig 2. Results economic evaluation Routes 1 to 3.

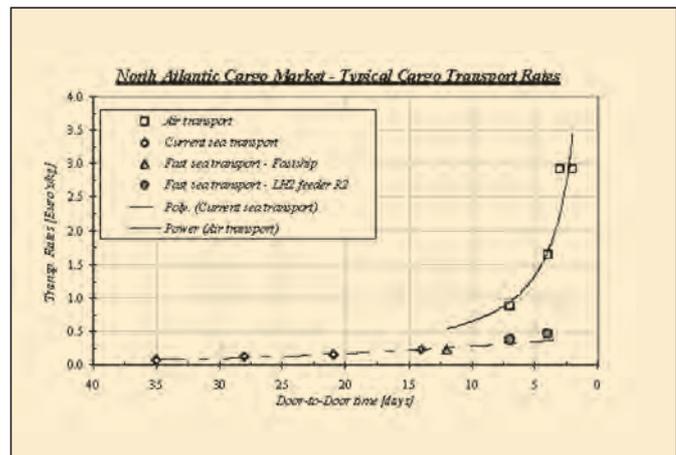


Fig 3. North Atlantic unit transport costs by mass.

profit analysis was utilized previously [Ref 26] to establish unit transportation costs for Fastship, the high-speed sea transport chain concept on route 2.

Fastship zero profit unit costs are €1735/TEU, whilst for a conventional container ship this unit cost is €939/TEU. Table 7 indicates that the proposed H₂ transport chain cost would be €1869/TEU for the same route. These results indicate that there is competitive potential for the H₂ high-speed ship on this route.

The zero NPV analysis (discount rate 10%) enables calculation of the minimum unit transport cost needed to recover investment over the lifespan of the ships (25 years). These unit transport costs are unsurprisingly significantly higher.

Fig 3 shows the unit cost per unit mass transported, allowing comparison with other fast transport modes, such as aircraft. Plotting the unit rates in Fig 3 shows that the H₂ unit mass transport rates are significantly lower than aviation rates for similar door-to-door transit times.

Conclusion

The results of this study show that a hydrogen fuelled high-speed container ship is, in principle, technically and economically viable. Current research indicates that aero-derivative gas turbines can be successfully modified for hydrogen fuelling. Experience already exists with both gas turbines and cryogens (LNG) in a marine environment.

Combining these technologies with hydrogen technology from industrial and aerospace fields is primarily a matter of technology transfer. The development of a hydrogen economy is a high priority for many governments and international agencies because of concerns about fossil fuel reserves and pollution. The proposed H₂ FAC provides the opportunity to demonstrate the potential of hydrogen in the marine environment whilst offering an environmentally and commercially attractive alternative to air transportation for time sensitive products.

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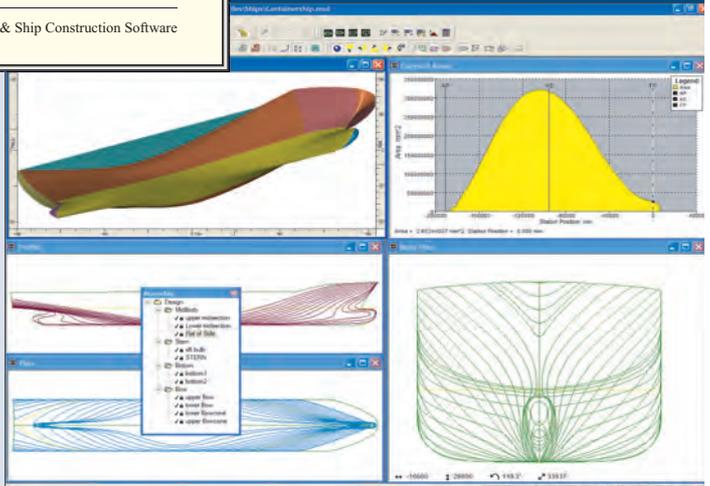
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Cavitation in the wake of a ship

In this article, Takafumi Kawamura and Takayuki Watanabe from the department of environmental and ocean engineering, University of Tokyo, and Shin Hyung Rhee, from Fluent Inc, discuss the accurate prediction of cavitation to ensure efficiency.*

CAVITATION on marine propellers can cause many problems, such as vibration, noise, and erosion on the blades. However, with recent high-speed and shallow-draught ships, it is difficult to avoid cavitation without compromising the propeller efficiency. Propeller designers must therefore control the influence of cavitation rather than attempt to suppress its occurrence.

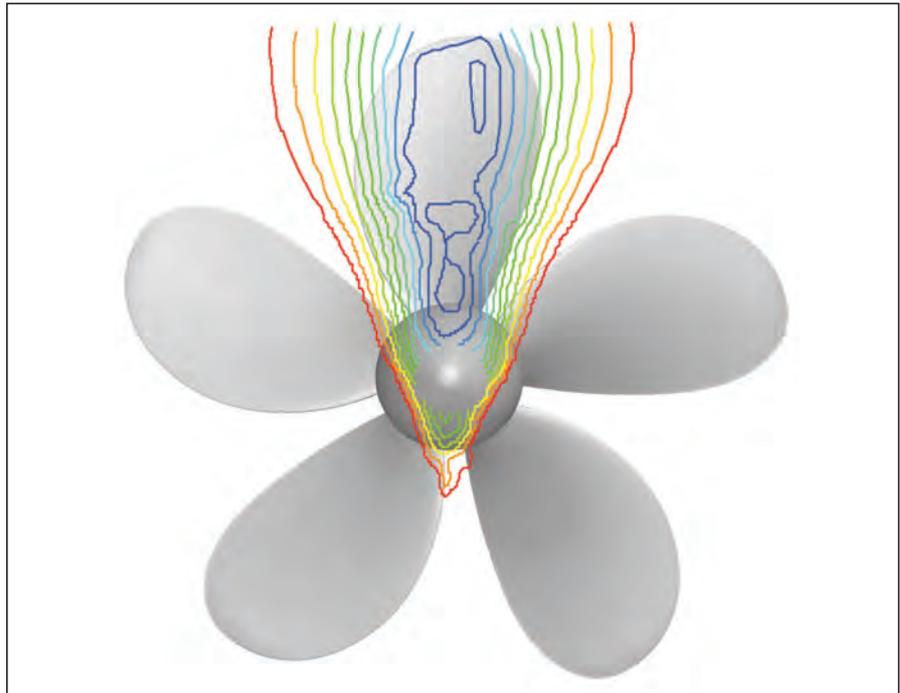
As a result, the accurate prediction of cavitation is becoming increasingly important. While empirical and experimental methods are usually used for practical design at present, a research group in the University of Tokyo has been using Fluent software, from US company Fluent Inc, for the prediction of steady and unsteady cavitation on marine propellers, with a special emphasis on the role that the ship's wake plays in the process.

In a recent study, the sliding mesh and cavitation models in Fluent, along with the $k-\omega$ turbulence model, were used to simulate the cavitation flow generated by a rotating propeller. Approximately 1.8 million cells were used to mesh the computational domain around a five-bladed model propeller, 40cm in diameter. The hybrid mesh with prismatic cells near the propeller surface and tetrahedral cells in the outer region was generated using GAMBIT.

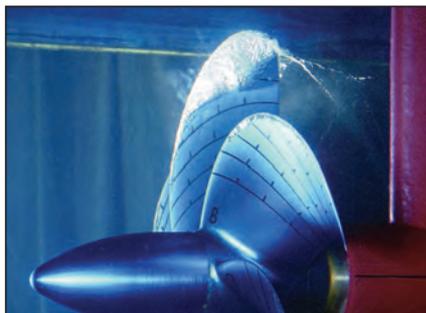
When a marine propeller is operated in the wake of a ship, the angle of attack of the incoming flow relative to the blade varies as the propeller rotates. This causes the periodic growth and collapse of a cavity, and this fluctuating pattern is strongly related to the vibration and noise often associated with cavitation.

In the present study, the measured wake distribution was specified at the inlet boundary using a user-defined function (UDF). When one of the blades is located at the top centre position, it is in the central portion of the wake. The incoming axial flow is the smallest at this position, and the angle of attack is the largest. The wake is assumed to extend around 30deg on either side of the top centre position. Outside the wake region, the incoming axial flow is uniform.

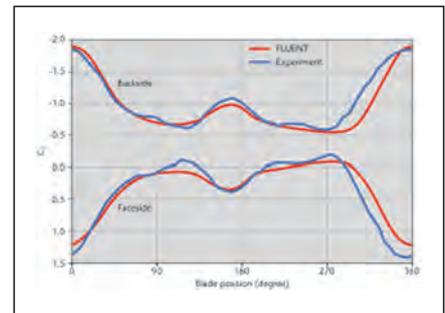
The time-dependent calculation with the non-uniform inflow reproduced the unsteady cavity pattern quite well. When one of the blades enters the wake region, leading edge cavitation is formed over a wide span and grows towards the trailing edge as the blade goes deeper into the wake.



Non-uniform inflow equivalent to a ship's wake; lines indicate the magnitude of the incoming axial velocity.



Unsteady propeller cavitation in the wake of a ship; the wake is generated by a wire mesh placed on the upstream side of the tunnel.



Variation of the pressure coefficient during rotation at a point near the leading edge of the blade.

Subsequently, the cavity shrinks from the root to the tip when the blade exits the wake region. The whole process was captured correctly by Fluent, and the variations of the pressure on the blade surface agreed very well with the measurement. However, some discrepancies were also found. The shrink cavity was too quick, and the maximum cavity volume was about 50% smaller than in the experiment.

Further studies are being conducted for better agreement and improved computational efficiency. The present investigations are focussed on the performance of the cavitation and turbulence models in the cavitation region. The cavitation model in Fluent 6.12 is certainly a state-of-the-art model, and work will continue

to clarify its range of application and limitations for reliable and quantitative predictions of cavitating flow. 

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*This article first appeared in the spring 2005 issue of *Fluent News*, published by Fluent Inc.



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Healthy outlook for cruise ships

IN the wake of the massive September 11 2001 effect on the international cruise market, and more recent escalation in newbuilding prices, a new analytical report suggests that the lack of new vessel ordering in the past two to three years is set to see potential cruise ship shortages emerge by 2008. With demand continuing to grow, there will continue to be a healthy demand for new ships in subsequent years, although the scale of annual requirements is unlikely to match the delivery volumes witnessed at the start of this decade.

In a 240-page detailed report - entitled *The World Cruise Shipping Industry to 2020 - a detailed appraisal of prospects*, the UK-based independent research company Ocean Shipping Consultants Ltd forecasts a strengthening cruise ship market over the next five years, even under a low growth scenario. In the longer-term however, the annual new vessel requirement is expected to average a lower level than the annual average delivery volumes witnessed over the past half-decade.

The world cruise ship fleet has continued to expand at a rapid pace in recent years, with the total number of berths offered on multi-day cruises for vessels of 50+ passenger capacity increasing from around 160,000 at the beginning of 1995 to over 310,000 in 2005. This represents a near-doubling in capacity over the past decade, with aggregate fleet numbers in the interim period suggesting overall expansion since 2000 of over 33%.

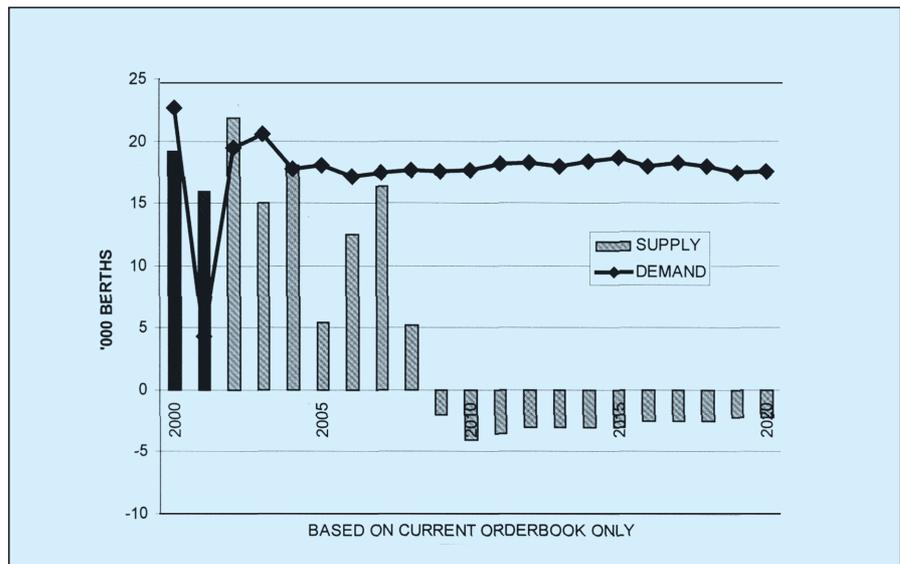
Whilst all size sectors of the fleet have experienced growth, there exist large differentials between different size classes, with generally greater proportional increases for the larger classes. Total capacity for the 1000-2000-berth category has increased by approximately 120% since 1995, and by over 30% since 2000. The most dramatic rise however, has been for larger vessels - with the >2000-berth category increasing in volume by over 600% from approximately 17,000 to 126,000 berths. Most of this expansion has occurred in the current decade, with a 2000 total for this sector of around 45,000 berths.

Approximately 91% of all vessels on order are above 1500-berth capacity - with this size sector representing just 27.5% of the existing fleet - providing further evidence of the strength of the trend towards larger tonnage. Capacity on order represents negligible volumes for vessels of under 1500-berth capacity, with just 10% for 1500-2500 berth vessels, but 74% for larger tonnage. For fleet capacity overall, the current orderbook represents 18% of the total number of berths in existence.

Operator consolidation

Market consolidation by the major lines has accelerated in recent years through further merger/take-over, and the cessation of operations of several smaller lines. Based on the current orderbook, this trend is set to continue to dominate over the coming decade.

In terms of major lines increasing in significance within the world fleet, of the current world fleet, the top 13 cruise lines account for



Annual cruise ship supply/demand growth to 2020.

over 75% in terms of passenger capacity - ie, 236,000 of the global aggregate of 313,000 berths. Significantly, these top lines account for almost all tonnage currently on order - thus suggesting continued consolidation in the near-term.

Demand to 2020

According to the report, cruise demand will continue to be partly supply-driven, with the introduction of new ships, new itineraries, and new themes promoting customer interest and sales. Long-term trends will continue to be subject to short-term factors - but will be linked to underlying trends in international tourism, economic growth, and population development.

After expanding from below 4.4 million to 5.9 million in the first half of the 1990s, and then to almost 10 million passengers in 2000 and an estimated 13.6 million in 2005, the world cruise passenger aggregate is expected to approximate 18 million passengers by 2010, 22.6 million by 2015, and 27 million by 2020.

Total forward expansion approximates 98%, with average annual development approximating 5.75% annually in the near-term to 2010, a little over 4.5% annually in the first half of the next decade, and around 3.75% in the final part of the study period.

Cruise ship fleet and demand to 2020

The level of extra demand of around 18,000 berths witnessed in 2004 and expected in 2005 is set to represent the expected average level throughout the forward study period, although annual levels are expected to vary around a 17,500-berth level for much of the remaining current decade. Annual growth is then set to reach almost 19,000 berths around the middle of the following decade before ending the study period at around the 17,500-berth level.

Excluding further orders, the overall fleet is set to increase from the 313,000-berth total of 2005 to over 352,000 by 2009. This represents an

increase of approximately 12.5%. With no vessels currently on order with a delivery date post-2009, the minimum fleet level is expected to decline to around 334,000 berths by 2015 and 321,000 berths by 2020.

The implication is that, whilst new capacity requirements are likely to exceed new deliveries over the near-term, the extent of this tonnage shortfall will vary greatly, subject to actual new tonnage completion. For 2008, with only a relatively small volume of new capacity expected to be delivered, the shortfall will become highly significant, compounded with a likely net fleet decline in the following year.

There will be a requirement for an extra 72,000 berths for newbuilding deliveries by 2010, with this rising to approximately 179,000 berths by 2015 and 280,000 berths by 2020. These levels are the equivalent of an extra 29 vessels of 2500-berth capacity by 2010, 71 vessels by 2015, and 112 vessels by 2020. To place these levels in an historical context, newbuilding delivery volumes have varied within a 19-30,000-berth range since 2000, with an average level of just under 24,000 berths - equivalent to around 10 vessels (each of 2500 berths). The implication therefore, is for an annual newbuilding requirement at a lower level than witnessed in the recent past.

The overall implication is that the slowdown in new vessel ordering in recent years is set to see a strengthening cruise ship market over the next five years. Even with relatively poor future demand growth, there is likely to be a requirement for around 11 large vessels by 2010 in addition to those currently on order.

This report is available, priced £950 (UK), €1400, US\$1900. More details can be obtained from the Study Sales Dept, Ocean Shipping Consultants Ltd, Ocean House, 60 Guildford Street, Chertsey, Surrey KT16 9BE, UK. Tel: +44 1932 560332. Fax: +44 1932 567084. E-mail: info@OSClimited www.OSClimited.com

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TOP SYNTHETICS

Hybrid ro-ro passenger ferry for Dutch island route

IN July this year *Dokter Wagemaker*, a new ro-ro vessel, ordered by TESO from Damen Shipyards Gorinchem, was handed over. *Dokter Wagemaker* is said to be a highly sophisticated ship, being a hybrid between a ferry and a luxury cruise liner (despite operating a short shuttle service), and is a result of a fleet renewal and capacity increasing programme, which was initiated by TESO.

Dokter Wagemaker will replace *Molengat*, which currently serves the route between Den Helder (mainland) and Texel (one of a series of islands off the north coast of The Netherlands). The initial design and tender documents were developed by the Dutch consultancy firm Bureau voor Scheepsbouw, and the vessel has a very modern interior look, for which the Dutch styling-architect Bas Zonneveld was responsible.

Damen Shipyards Gorinchem was awarded the contract in April 2003. Schelde Naval Shipbuilding, a member of the Damen Shipyards Group, executed the contract and carried out the basic and detailed engineering, subcontracting hull construction, outfitting, testing and delivery of the vessel. Hull construction and pre-outfitting took place at Damen Shipyards Galati, in Romania. The vessel was towed to The Netherlands in January 2005.

Below the main deck *Dokter Wagemaker* has a symmetric hull form constructed out of steel, and forward and aft skegs are fitted for stability. Four ducted azimuth thrusters are positioned forward and aft at port and starboard side.

The hull is divided by transverse bulkheads in the following compartments: aft peak, aft thrusters room, aft engine room, aft switchboard room and aft auxiliary engine room, midship compartment, forward engine room, forward



The 130.40m double-ended ro-ro ferry, *Dokter Wagemaker*, was built by Damen for TESO (Texels Eigen Stoomboot Onderneming) to serve the short route between Den Helder and the island of Texel.



A view of the top deck on *Dokter Wagemaker*.

TECHNICAL PARTICULARS DOKTER WAGEMAKER

Length, oa.....	130.40m
Length, bp.....	127.24m
Breadth, mld.....	22.70m
Depth.....	7.18m
Number of decks.....	6
Draught (design).....	4.05m
Draught (max).....	4.40m
Deadweight (max).....	1840dwt
Speed at design draught (4.05m).....	15.20knots
Speed at max draught (4.40m).....	14.80knots
Bollard pull, transverse.....	80tonnes
Bollard pull, longitudinally	100tonnes
Max number of passengers.....	1750
Capacity.....	lower car deck 704lane metres, max axle load 20tonnes; upper car deck 704lane metres, max axle load 1.75tonnes
Classification.....	Lloyd's Register, + 100 A1 Ferry, Extended Protected Water Service 'Ice Conditions, Riza code R, + LMC, UMS, IFP, PSMR, PCAC 2.2

switchboard room and forward auxiliary engine room, forward thrusters room, and the fore peak. Above the main deck, which is referred to as the lower car deck, there is a bicycle deck (sides only), an upper car deck, a saloon deck, and a panorama deck.

Above the side alleyways on the main deck an intermediate deck is fitted to transport bicycles and mopeds and other wheeled objects, as well as day accommodation for the crew arranged port side. The totally enclosed lower car deck is mainly used for transport of lorries with passenger cars in the side alleyways. The upper car deck is also totally enclosed and serves passenger cars, MPVs, and vans.

Foot passengers can access the ship through gates at ends of the upper car deck and at the bicycle deck. In the middle of the saloon deck a galley with two buffets is situated. Toilet

facilities are located opposite to the galley/buffet. Seating for passengers is located in the forward and aft end on the saloon deck. In the central part of the panorama deck an atrium lounge with a small buffet is situated, which may also serve as accommodation for special occasions such as receptions and presentations.

The muster stations are located at both ends of the passenger lounge on saloon deck level. Disembarkation can be carried out by means of four marine escape chutes, situated close to the muster stations on the saloon deck. Operation of the units is from the saloon deck embarkation stations. Each MES station will be connected to two 100-person and one 50-person open liferafts.

The wheelhouses are designed for maximum visibility both during crossings and



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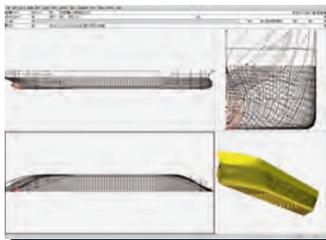
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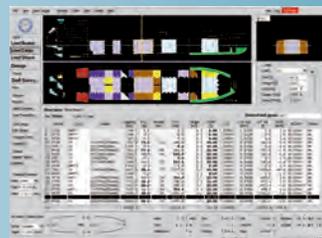
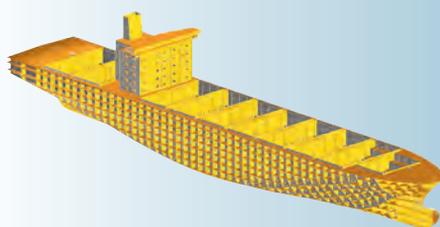
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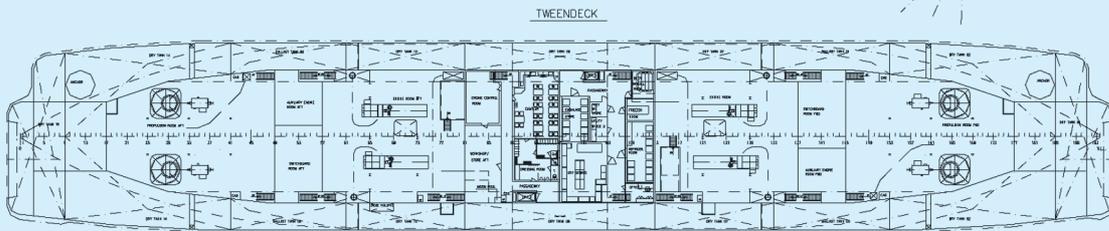
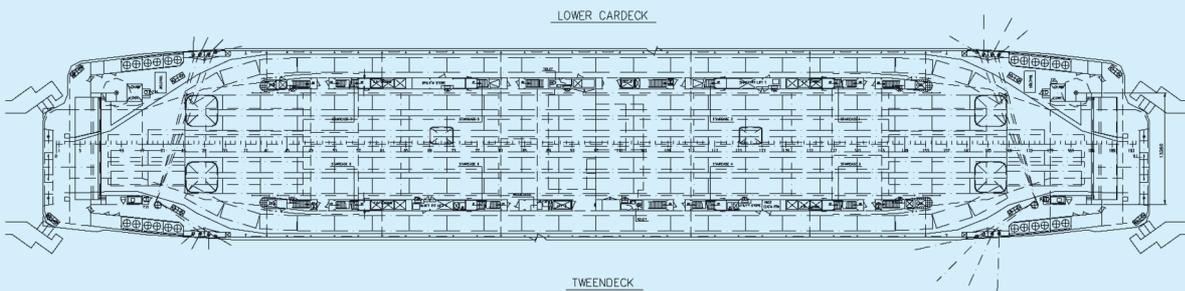
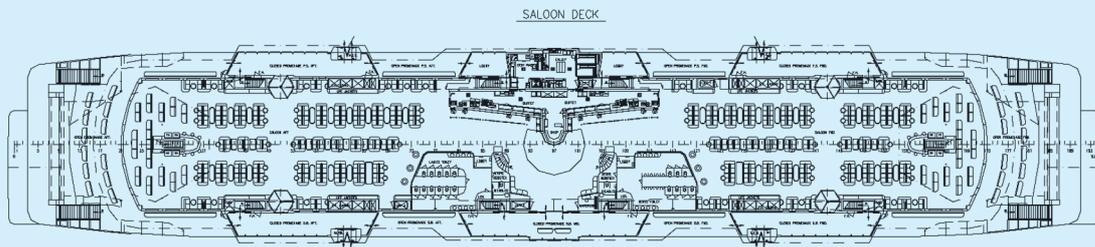
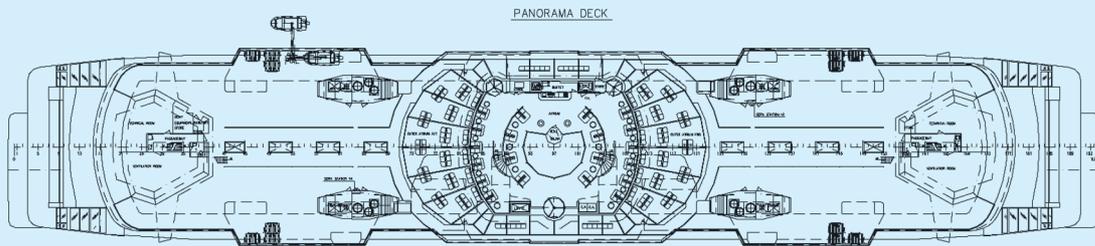
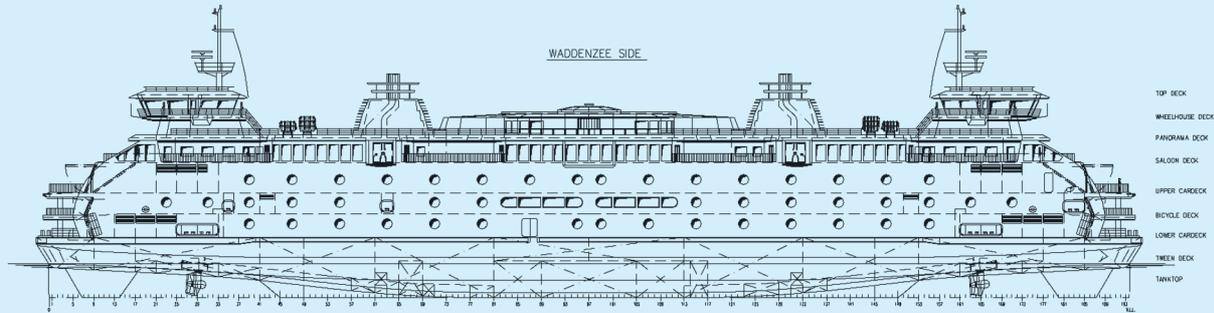
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General arrangement plan of the new ro-ro ferry *Dokter Wagemaker*.





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manoeuvring at the terminals. The wheelhouses have large windows all around and an ergonomic layout as the result of extensive studies including mock-up assessments. Four funnels have been placed on the panorama deck. These are constructed from alloy, and are of modern design, fitted with spoiler plates on top to create airflow against precipitation of exhaust gas.

Propulsion layout

Dokter Wagemaker is fitted with a highly automated diesel-electric propulsion system comprising of four generating sets divided over the forward and aft engine rooms. The sets each develop 2856kW at 1000rev/min. The generating sets are resiliently mounted on base frames. Power is generated at 6kV and transformed to 400V and 230V at 50Hz. Thruster units have been installed in the propulsion rooms with prime movers and associated equipment. The complete electric system was supplied under a turnkey arrangement by Bakker Slidrecht (*The Naval Architect* May 2005, page 16).

Ducted propellers have been installed to obtain a high bollard pull, especially in transverse directions to counteract the high wind loads at the relatively open docking areas. Each thruster is bolted in position, and can be replaced within 24 hours. Hoisting facilities and mounting hatches are fitted to facilitate this procedure. Each FP thruster has a rated input power of 1800kW, and the FP propellers have a diameter of 2.35m.

Special systems

Aside from the usual ship systems some special systems can be found on *Dokter Wagemaker* such as the drencher firefighting system for the car decks. This system, also suitable for use with heavy foam, consists of a distribution piping system divided into several sections. A drencher pump is fitted in each diesel engine room, and the pump capacity is designed to supply 5litres/min/m². The system will be controlled via an AMS system.

For cleaning purposes, a high-pressure 120bar wash-water piping system is fitted, and connected to ring lines on every deck, made from stainless steel. This system has been designed to connect to an external hot-water washing unit on a truck. In addition, in the engine and propulsion room, connections are provided for a portable high-pressure washing unit with supply from the hot water system.

Electric systems

The vessel is fitted with a redundant diesel-electric propulsion and control system. Four generators provide 3078kVA at 1000rev/min. Three generators are normally required to supply the vessel's maximum speed, with the fourth used as stand-by. Sailing at an economic speed, only two generators will be required. Overnight the electrical load will be supplied by the auxiliary diesel generator (350kVA at 1500rev/min).

All the thrusters have frequency-controlled drives, and both the electric motor and the frequency converters are water-cooled. Propulsion control will be from both wheelhouses. The entire ship can be controlled



The seating area of *Dokter Wagemaker* is arranged in groups, with seats of two, four and eight, with tables in between.



This ro-ro ferry has totally enclosed lower and upper car decks.

by a single joystick - a micro pilot. This controls speed and direction of all four thrusters to achieve optimum manoeuvring and sailing modes. The system is fully redundant but in emergencies individual control of the thrusters is still possible.

Interior design

The interiors of *Dokter Wagemaker* are said to create the atmosphere of a luxurious cruise. A bespoke signage system distinguishes clearly the different decks by means of colours and

symbols, and passenger staircases are indicated by means of pictograms, for example by seagulls or a light tower.

Groups of tables are arranged in twos, fours or eights, with tables in between, in the saloon, on the promenade deck. A decorative atrium opening features a light tower, with six circular neon lights in three different colours fitted at the top. Underneath the light tower a small shop/kiosk is situated. A buffet is located at each side of the saloon deck and on the panorama deck. 



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Prediction of ship squat in rivers

Sir - Allow me please to first suggest a short-cut squat formula and then follow with a brief note of thanks.

A senior lecturer of the University of New South Wales, Australia, Philip J Helmore, had an article published in *The Naval Architect* (July/August 2005, page 69). In it, he suggested a formula for the squat coefficient K. The use of this K coefficient was suggested by me (in issues in June 2004 and November 2004) for predicting maximum ship squat in rivers of rectangular cross-section, where:

Squat = loss of underkeel clearance
 $= K \times CB \times V^2/100m$
 C_B = block co-efficient
 V = ship speed (knots)
 H = water depth (m)
 T = static mean draught (m)
 B = breadth of water (m)
 b = breadth moulded of ship (m)
 S = blockage factor = $(b \times T)/(B \times H)$
 K = a co-efficient, depending on (H/T) and (B/b) .

Mr Helmore's suggested formula, via a regression analysis, was:

$$K_{\text{HELMORE}} = 5.0583915 - 0.2569568(H/T) - 1.0814519(B/b) - 0.4883445(H/T)^2 + 0.1306850(B/b)^2 + 0.1240496(H/T)^3 - 0.0057542(B/b)^3$$

He went on to state that polynomials of lower and higher degrees, and inclusion of cross-products, did not improve the 'goodness of fit'.

My formula for K is much shorter. It depends upon the blockage factor S, It is:

$$K_{\text{BARRASS}} = (6 \times S) + 0.40$$

As an aside, in an earlier edition of *The Naval Architect*, I asked readers to supply details of vessels that recently had gone aground due mainly to ship squat in shallow waters. The response has been good.

I now have a database of 44 vessels. Most of them are supertankers, because of their

very large mass. These are followed closely by passenger ships, due to high their service speeds.

Dr C B Barrass, FRINA
www.ship-squat.com

The SD14 standard cargo ship

Sir - I read your appreciation of John Lingwood's book (*The Naval Architect*, February 2005, page 3) with great interest since I was in the management team of the Bartram & Sons yard at South Docks, Sunderland, and I can add to the account of Austin & Pickersgill's yard, at Southwick, and clearly see those fascinating times from that viewpoint.

At Bartrams we had been building six refrigerated cargo ships for Blue Star Line, and then took on three similar, but much larger, reefers for another owner - which caught us out on price (fixed as always) rather poorly - and so a liaison with A&P was sought, and achieved.

Cooperation between the two yards was excellent. Bartrams, at South Docks, was particularly well-versed in very efficient building of general cargo vessels; with its modern machinery and a very willing workforce 'we' produced some five and a half ships annually (that is, 17,000 tonnes of steel) with barely 1000 men in direct labour, for - from memory, about £970,000 in total for each (in 1962).

Bartrams launched the first SD14, but A&P took the first main engine and thus completed its first. I am sorry that the book '*SD14: The Full Story*' does not seem to give full credit to the Bartram record, but that is life! Sadly, I cannot say how many SD14s Bartram's built, but it was a well-balanced partnership effort.

Further, simply for the historic record - because the market generally was drying up and the demand for general cargo ships was falling off as containerisation began to dominate - the weakening demand for SD14s was foreseen and it was decided that the Southwick site be rebuilt for larger ships, and the South Docks site be allowed to run down.

Sadly (again!) even the eventual ship factory at Southwick could not survive the searing heat of competition and the simultaneous Government/EEC/EU fumbling with 'subsidy' and 'intervention', plus foreign competition.

For many years now there has not been any sign that those two wonderful shipyards existed; in 1958 Bartrams was perhaps the most modern and best laid-out shipyard of its type in the world - and certainly the morale of the workforce was quite outstanding; I know, I was the production manager then.

For decades up to 1960 it was still true that 'Sunderland was the biggest shipbuilding town in the world' - yet in around 1990, Sunderland's publicity leaflet emphasised coal mining (one small colliery in the town) and gave very small space to its shipyards (10 in 1955) which dominated Sunderland in every way. How we do forget! But how very fortunate were we who worked in UK shipbuilding in those days.

P H H Rhodes, FRINA,
 Camberley
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New PropCad features

A POPULAR software package from HydroComp for the geometric modelling of marine propellers, PropCad, provides tools for the automatic preparation of 2D design drawings, 3D views, construction data, calculation of geometric properties, and CAD/CAM file export.

New features in PropCad 2005 include:

- the list of CAD/CAM exports now includes DELCAM PowerSHAPE
- offsets and reports are now displayed in HTML format in a browser
- a new Scan Converter 'face/back' option (in addition to current 'face/thickness' option) to allow for entry of 3D scan of both surfaces
- use of New Builder data files for custom section geometry and parametric distributions.

New features which will be released later this year include calculation of 'hydrodynamic effective pitch', using radius-chord integration, and New Builder options. ☺

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First Notice & Call for Papers



There is considerable optimism about the future of the natural gas market. A significant growth in the number of gas carrying vessels is expected, resulting from both an increase in demand and the current programme of scrapping older vessels.

While some companies are looking at the possible economies of scale of larger vessels (in the range of 175,000- 250,000 cu.m.) others are looking to develop options for developing small vessels to exploit shortsea and coastal trades in natural gas.



New alternatives to LNG including compressed/pressurised natural gas (CNG/PNG), where the gas is stored under pressure at ambient or semi-refrigeration temperatures, are also being developed. There is also a growing interest in floating production, storage and offloading systems for offshore oil & gas developments and re-gasification tankers and plants designed to avoid the need to construct huge land-based processing and distribution centres.

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Numerical simulation of yaw effect

The traditional method currently used by towing tanks for ship manoeuvrability predictions is based on calculation of hydrodynamic derivatives of forces and moments with respect to the individual degrees of freedom. These derivatives are then used in manoeuvrability simulation programs to evaluate ship performance in real manoeuvres for design purpose.

The hydrodynamic derivatives are calculated from experiments or using potential flow simulation methods. Potential methods can only be used in manoeuvrability calculations with additional care because of strong viscous effects. Experimentally based predictions are expensive and can be applied only to the type of hulls for which they were obtained.

Methods based on RANS solver have been becoming progressively more popular. In this article*, the application of a RANS method to predict force and flow field around a Series 60 ship model under steady oblique motion is reported by Q Gao, V Shigunov, and D Vassalos, from the University of Strathclyde, UK.

THE flow around a ship hull under steady yaw motion is characterised by complex flow separation, vortex shedding, and strong free-surface effect. There were few successful studies in this area. Longo and Stern [Ref 4] carried out towing tank experiments of yaw effect on ship flow for a 3.048m Series 60 ship model. Forces, wave pattern and model attitude were measured in detail, which were used to explain complicated physics and provide valuable data for computational fluid dynamics validation.

Patel, Ju, and Lew [Ref 1] firstly studied asymmetric effect on flow physics by finite-analytic difference scheme. They validated results on an HSVA tanker and a SR107 bulk carrier. The agreement was encouraging, although there were two main limitations on their numerical method. One is a double model assumption of the free-surface effect and the other is that only the stern part of ship model was included in the simulation.

Cura Hochbaum [Ref 1] presented a calculation of the vessel in steady oblique motion at the 22nd ONR symposium. Three dimensional separation and vortex shedding were captured well and force results were reasonably consistent compared with experiment data. However, free surface and ship attitude effects were not included in the calculation.

Alessandrini and Delhommeau [Ref 3] also presented a paper at the 22nd ONR

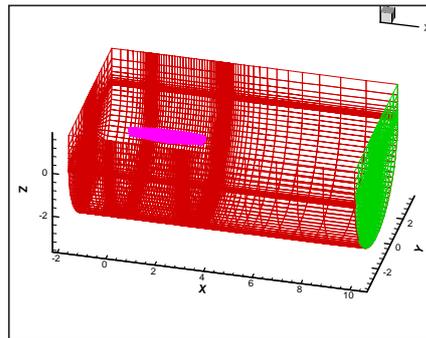


Fig 1. Boundary meshes.

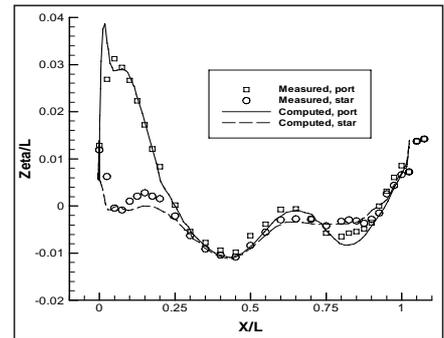


Fig 2. Computed and measured wave profile.

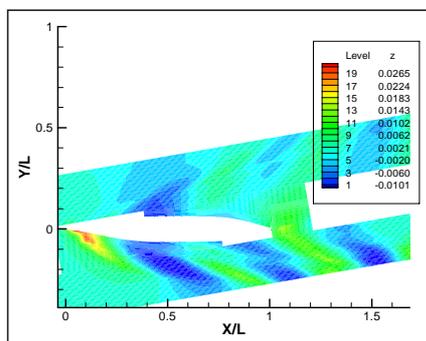


Fig 3. Wave pattern (Measurement [4]).

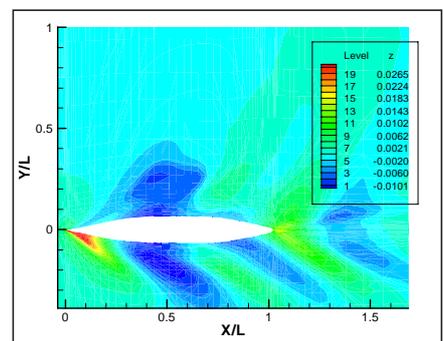


Fig 4. Wave pattern (Calculation case 2).

Symposium on viscous free-surface flow past Series 60 in steady sway motion. Wave pattern particularly for the bow wave shows a close agreement between calculation and measurement. Lateral force was predicted with good accuracy. However, ship attitude effects were excluded in the calculation.

A question arises in the study of yaw effect on ship hydrodynamics: how large is the effect of ship attitude change and free surface? In this article, the effects of yaw angle and attitude change on turbulent flow and ship hydrodynamics were studied by RANS solver FLUENT. The numerical results were given and compared with experimental measurement available from IIHR [Ref 4].

Mathematic formulation

The Reynolds averaged Navier-Stokes equations with turbulence model for closure were solved. The governing equations can be written as follows.

Continuity equation:

$$\nabla \cdot \vec{v} = 0.$$

Momentum equations:

$$\frac{\partial}{\partial t}(\rho \vec{v}) + \nabla \cdot (\rho \vec{v} \vec{v}) = \rho \vec{g} - \nabla P + \nabla \cdot \tau + S$$

Turbulence model:

$$\frac{\partial}{\partial t}(\rho K) + \nabla \cdot (\rho \vec{v} K) = P - \rho \epsilon + \nabla \cdot \left(\mu + \frac{\mu_t}{\sigma_K} \right) \nabla K$$

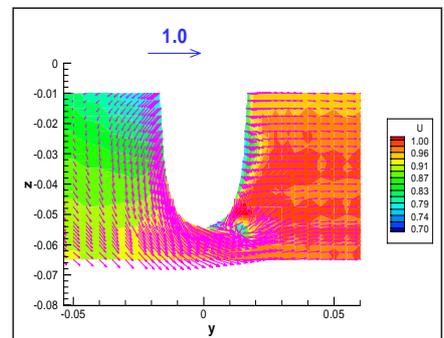


Fig 5. Velocity field at x/L=0.1 (Measurement [4]).

$$\frac{\partial}{\partial t}(\rho \epsilon) + \nabla \cdot (\rho \vec{v} \epsilon) = C_1 \frac{\epsilon}{K} P - C_2 \rho \frac{\epsilon^2}{K} + \nabla \cdot \left(\mu + \frac{\mu_t}{\sigma_\epsilon} \right) \nabla \epsilon$$

VOF equation:

$$\frac{\partial}{\partial t}(r_w) + \nabla \cdot (r_w \vec{v}) = 0.$$

where \vec{v} is velocity vector, \vec{g} gravity vector, P pressure, $\tau = \mu[(\nabla \vec{v}) + \nabla \vec{v}^T]$ stress tensor, $\rho = r_w \rho_w + r_a \rho_a$ mixture density, $\mu = r_w \mu_w + r_a \mu_a$ mixture viscosity, ρ_w and ρ_a water and air densities, μ_w and μ_a water and air dynamic viscosities, S external body force, K turbulent energy and turbulent dissipation rate.

Boundary conditions were prescribed. The inlet is located at half a ship length ahead of the bow where two velocity components were imposed. Velocity components and free surface elevation were given on the side

* Extracts from the paper 'Numerical simulation of yaw effect', presented at The Royal Institution of Naval Architects' conference Marine CFD 2005, March 30-31 2005.

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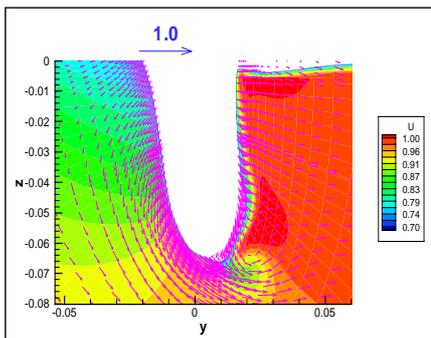


Fig 6. Velocity field at x/L=0.1 (Calculation case 1).

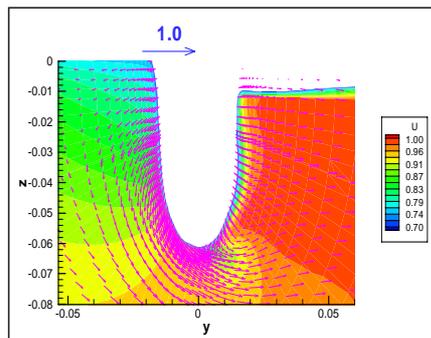


Fig 7. Velocity field at x/L=0.1 (Calculation case 2).

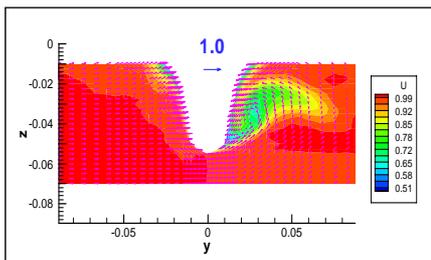


Fig 8. Velocity field at x/L=0.9 (Measurement [4]).

Froude number	Yaw angle	Sinkage	Trim	Heel
0.316	10	Yes	Yes	Yes
0.316	10	No	No	No
0.316	10	Double model		
0.316	7.5	Yes	Yes	Yes
0.316	5	Yes	Yes	Yes
0.316	2.5	Yes	Yes	Yes

Table 1. The list of test cases.

boundary, which is located at one ship length away. Downstream outlet is at two ship lengths behind the stern, where hydrostatic pressure is prescribed. Non-equilibrium wall function was used on ship hull boundary to save computational effort.

Test case

A Series 60 hull form was chosen for validation purposes. Numerical calculation includes study of free surface and attitude change effect as well as yaw angle effect on ship hydrodynamic performance. In all test cases, Froude number was set to 0.316. The computational cases are listed in Table 1.

Numerical results and discussion

Mesh

3D computational grids were generated. The total cell numbers are about 400,000, which were based on the uncertainty study of resistance calculations. The sketch of computational domain and boundary meshes is shown in Fig 1.

Attitude effect

Since the model tests for force measurement were carried out in free condition (with sinkage, trim and heel) and all past numerical calculations were made in restrained condition (without attitude change) or with double model, it is necessary to quantify the influence of free surface and attitude change due to sway motion on ship manoeuvring performance. Therefore, three separate calculations were carried out for Froude number 0.316 and yaw angle 10deg, named as case 1 and 2 for with and without sinkage, trim and heel, case 3 for double model.

Ship wave

The wave measurement was carried out in restrained condition without sinkage, trim and heel. The comparison between measurement and calculation (case 2) was shown in Figs 2-4.

From Fig 2, it can be seen that the general agreement between computed and measured wave profile is good. The port bow wave is larger than that at starboard. However, wave height is very close near the stern on both sides. The magnitude of bow wave height is about 0.035, which is larger than that in straight-forward motion (0.015). Therefore, resistance coefficient in oblique motion tends to be larger than that in straight-forward condition. The first and second transverse wavelength are different from each other and with the Kelvin theory, which is related to the non-linear interactions between the bow, front shoulder, back shoulder and stern wave. The difference of wave height at the bow and stern may be attributed to bow and stern shape, as well as the viscous effect.

The measured and computed wave patterns are given in Figs 3-4. It can be seen that the general wave structure is well predicted by numerical approach. However, the numerical calculation appears to be over diffusive far from the ship hull due to the mesh resolution.

Velocity field

The 3D velocity fields are compared in Figs 4-9 at two cross planes. One is at x/L=0.1 and the other at 0.9. The results from calculation cases 1 and 2 show that there is a significant attitude effect on both boundary layer thickness and cross-stream distribution. Compared with heel, sinkage, and trim has

Case	Ct	Cs	Cm
Exp	7.12	26.78	-1.83
[Error! Reference source not found]			
Case 3	3.85	18.3	-1.08
Case 2	6.91	24.98	-1.45
Case 1	7.01	25.26	-1.81

Table 2. Forces and moments coefficient (*1000).

less effect on cross velocity distribution. The heel angle is large to change the vortex shedding and pressure distribution on the hull surface.

Generally, the calculation results in case 2 are consistent with measurements. However, the computational results have some numerical diffusion, which result in thicker boundary layer and weaker vortex strength. The numerical results could be expected to improve by increasing mesh resolution.

Forces and moments

The definition of force coefficient is given below:

Resistance coefficient:
 $C_t = F_x / (0.5\rho U^2 S)$

Side force coefficient:
 $C_s = F_y / (0.5\rho U^2 S)$

Yaw moment coefficient:
 $C_m = M_z / (0.5\rho U^2 L p p^3)$

The comparison of force and moments at Froude number 0.316 and yaw angle 10deg is given in Table 2. It can be seen that the forces and moments are closely related to the computational conditions.

The computed results from case 1 (with attitude effect) agree reasonably well with experimental data. However, the computational side force and moment from case 2 (without attitude effect) are much smaller than experimental data. This means that the attitude change has a significant influence on the overall ship hydrodynamics and cannot be neglected in larger yaw angle. The computational results from double model calculation are far below experimental results. That means that wave effect cannot be neglected either.

Yaw effect

Based on the above analysis, a series of numerical calculations were carried out by using measured sinkage, trim, and heel. The comparison of numerical and experimental results are given in Figs 11-13.

It could be seen that the agreement between calculation and measurement is generally acceptable. However, computational hydrodynamic forces and moments are slightly underestimated. This is partly due to

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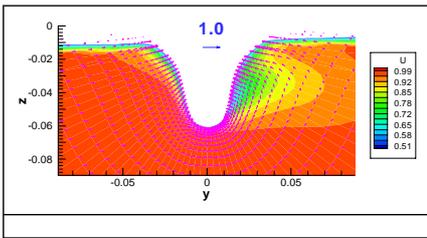


Fig 9. Velocity field at $x/L=0.9$ (Calculation case 1).

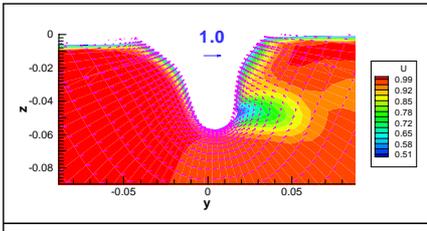


Fig 10. Velocity field at $x/L=0.9$ (Calculation case 2).

limitation of the mesh resolution, and partly due to the turbulence model. The studies of K- and the turbulence stress model are ongoing.

Conclusion

Based on comparison of computed and measured results, the following conclusion could be drawn:

- The general agreement between computational results and measurement is satisfactory. However, increasing mesh resolution and enhanced turbulence models are recommended in future study to improve numerical accuracy.
- The effects of attitude change on hydrodynamics are significant in large yaw angles and should be taken into account in the numerical prediction of manoeuvring motion.

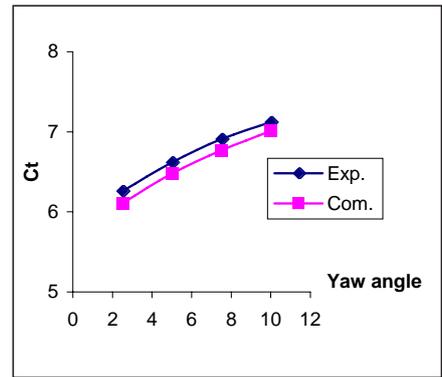


Fig 11. Resistance coefficient.

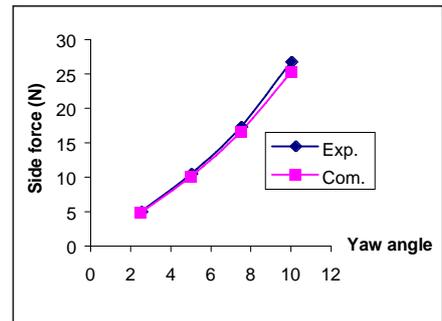


Fig 12. Side force coefficient.

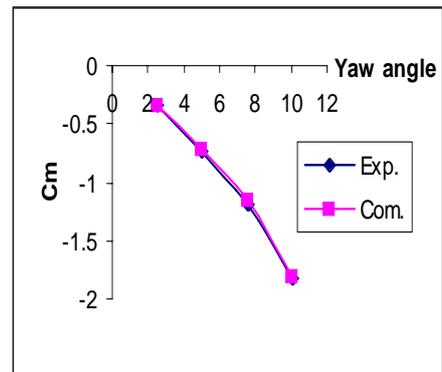


Fig 13. Yaw moment coefficient.

- Free-surface effect cannot be neglected for high Froude numbers.

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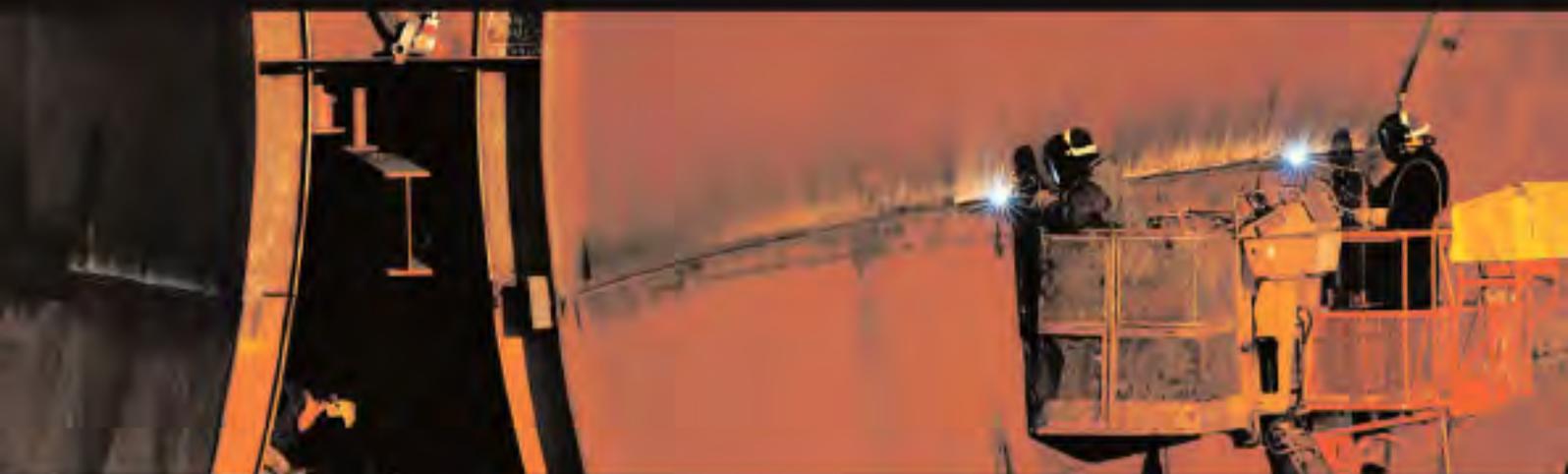
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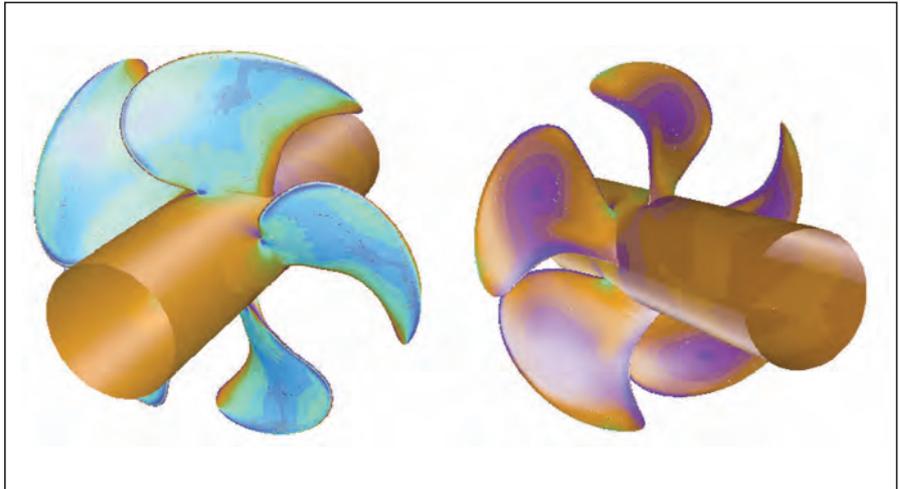
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New upgraded CFD software code released

THE latest version of the CFD software Fluent, version 6.2, has recently been released by international company Fluent. The new release is said to be faster and more accurate than 6.1; in addition, improvements have been made to advanced models, as well as new models that will greatly expand the range of applications for CFD.

Key to the advances in Fluent 6.2 are enhancements made to the core Fluent solver that have given dramatic speed-ups and improved accuracy without, it is claimed, compromising robustness and ease of use. New capabilities mean that all multiphase models can be used in conjunction with species transport and chemical reactions. Free surface and discrete phase modelling are both said to be significantly more efficient, and a new solar radiation model opens up whole new application areas.

Fluent's unique dynamic mesh capability for simulating flows around moving bodies has been enhanced including the addition of a new six-degrees-of-freedom solver. Fluent 6.2 also offers a comprehensive range of turbulence and acoustics models. Fluent's capacity for handling chemically



An example of the images that Fluent's new release can produce.

reacting flows has been expanded with a new, laminar stiff chemistry solver, special models for

engine ignition, and a convenient facility to create custom, re-usable, material property databases. ☺

Shipboard central controls for optimum operations

A NEW type of shipboard control concept, Kongsberg System Technology, was launched by Kongsberg Maritime at Nor-Shipping. By integrating user competence with technological excellence, this new wide-ranging technology platform offers both standard and operational specific functions, all designed to optimise operational and commercial performance. Kongsberg System Technology is being promoted as the key to an entire range of integrated sub-systems based on proven Kongsberg Maritime solutions for:

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- safety, K-Safe.

Within each application, Kongsberg Maritime will offer numerous solutions and equipment types, catering for the same markets and ship specifications for which the company is already well-known. This technology is said to enhance functionality and improve life-cycle support, and is expected to reduce the overall costs of ownership; it is scalable to suit individual needs. The distributed and open design of this technology platform utilises a system-wide standard communication network.

A redundant network facilitates integration of other systems and free flow of information from all sub-systems, with vessel-wide information available on multi-functional work stations. Additionally, real-time processing has been taken a step further with provision of standard distributed process units (DPU) with embedded software; this is said to result in increased reliability and reduced maintenance costs.

The Integrated Vessel Management concept also provided by Kongsberg Maritime supports integration of all control systems. Bridge systems, such as navigation, manoeuvring, propulsion, and thruster controls, can be linked to machinery, cargo automation, and safety systems by means of a communication highway that enables free flow of information within the overall layout.

All operator stations, controllers, and interface units are linked through a redundant communication network and a common-user interface. Though Kongsberg System Technology provides for more integration than ever before, each sub-system is autonomous and not affected by a failure in another sub-system, therefore increasing safety and reducing the risk of possible downtime. ☺

New Kleven Design concept for Stolt-Nielsen tankers

TWO versatile chemical/product tankers on order at the Kleven Florø yard, in Norway, for the leading parcel tanker operator Stolt-Nielsen (briefly reported on page 4 of our May 2005 edition) are being constructed to an interesting philosophy. The bow and stern sections, constructed of traditional shipbuilding steel, have been subcontracted to an unspecified Black Sea yard; upon completion, they will be welded together and towed to Florø. There the two parts will be split and united to the cargo section in the yard's construction dock. The

complete arrangement has been created by Kleven Design, and the vessels are known as the TCOPss43000 class.

The cargo section for each tanker is being fabricated at Florø of stainless steel and zinc-coated tanks to provide 39 cargo tanks in various sizes suitable for IMO Type I, II, and III liquids, with the total volume being 45,350m³. Hull dimensions will be 182.72m length, 32.20m breadth, and 11.70m draught.

Propulsion power will be supplied by an MAN B&W Diesel package, comprising a

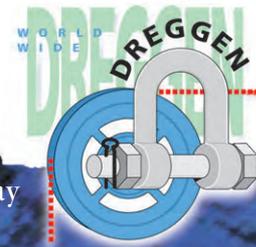
7S50MC-C two-stroke engine - to be built in Japan by Kawasaki Heavy Industries - driving an Alpha VBS1560-ODS CP propeller, and Alphasonic 2000 controls. A tunnel gear will be fitted to each propeller shaft to drive an alternator. Florø has had considerable experience with fitting MAN B&W two-stroke machinery and was notable for fitting the prototype camshaftless engine with electronic controls in the tanker *Bow Cecil*. The engines will be delivered from Japan in February and April 2007. ☺

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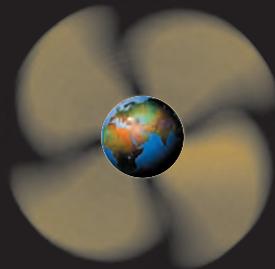
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Promising trials for new spherical-vane steering gear

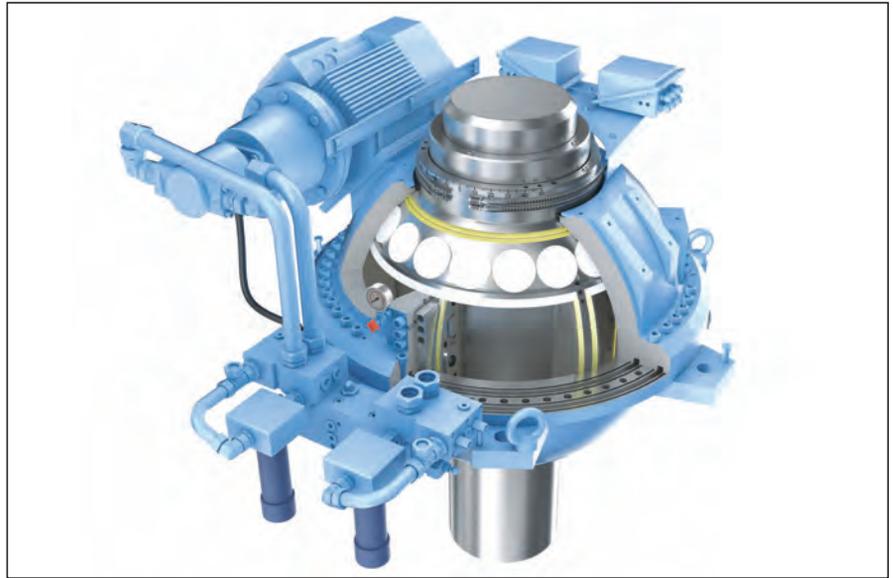
Advantages of a new so-called spherical-vane steering gear developed by Rolls-Royce Marine include fewer parts, a small circumference, low weight, and better reliability. The new design also incorporates optimal seal material to achieve a long life.

Prototype testing has confirmed the potential of this SV type, which is expected to result in a range of manufacturing and operational advantages compared with conventional ram-type steering gear. This development builds on the already successful gears in the Tenford SR and Frydenbö RV series.

Among the key goals of the SV project were to:

- improve the manufacturing process through a better design and by reducing the external dimensions
- strengthen overall competitive advantages in the steering gear market based on total cost installed onboard, and over the lifetime of a vessel
- obtain a better ratio between working torque and weight
- optimise the equipment for today's classification rules
- continue the proven advantages of the SR/RV types.

In the SV-type construction, the vanes are integrated into the rotor, and the dividing segments are placed in a toroid groove in the



This new SV (spherical vane) steering gear developed by Rolls-Royce Marine claims several interesting technical benefits.

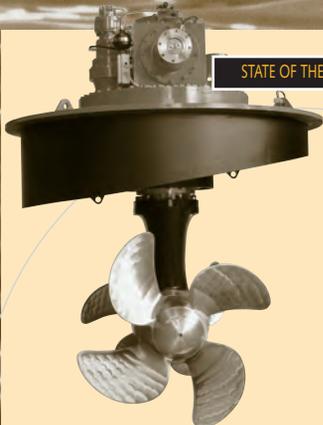
housing. The rotor, also the upper and lower housings, is made of nodular cast iron. The first models in the series cover torque outputs from 430kNm to 850kNm.

The SV is designed for a working pressure of 160bar. The sealing system features well proven polyamide for pressure chamber sealing and polyurethane material for both vane sealing and the dividing segment sealing. The supporting element behind the segment sealing is made of thermoplastic PET.

Thorough testing of the prototype in a special rig, corresponding to around 3000 operating hours at sea, was carried out with manoeuvring across the rudder angle of 2 x 45deg. Leakage was measured at a maximum working pressure of 160bar with very positive results:

- low leakages over the whole test period, increasing marginally during the running-in period and then stabilising at a low level

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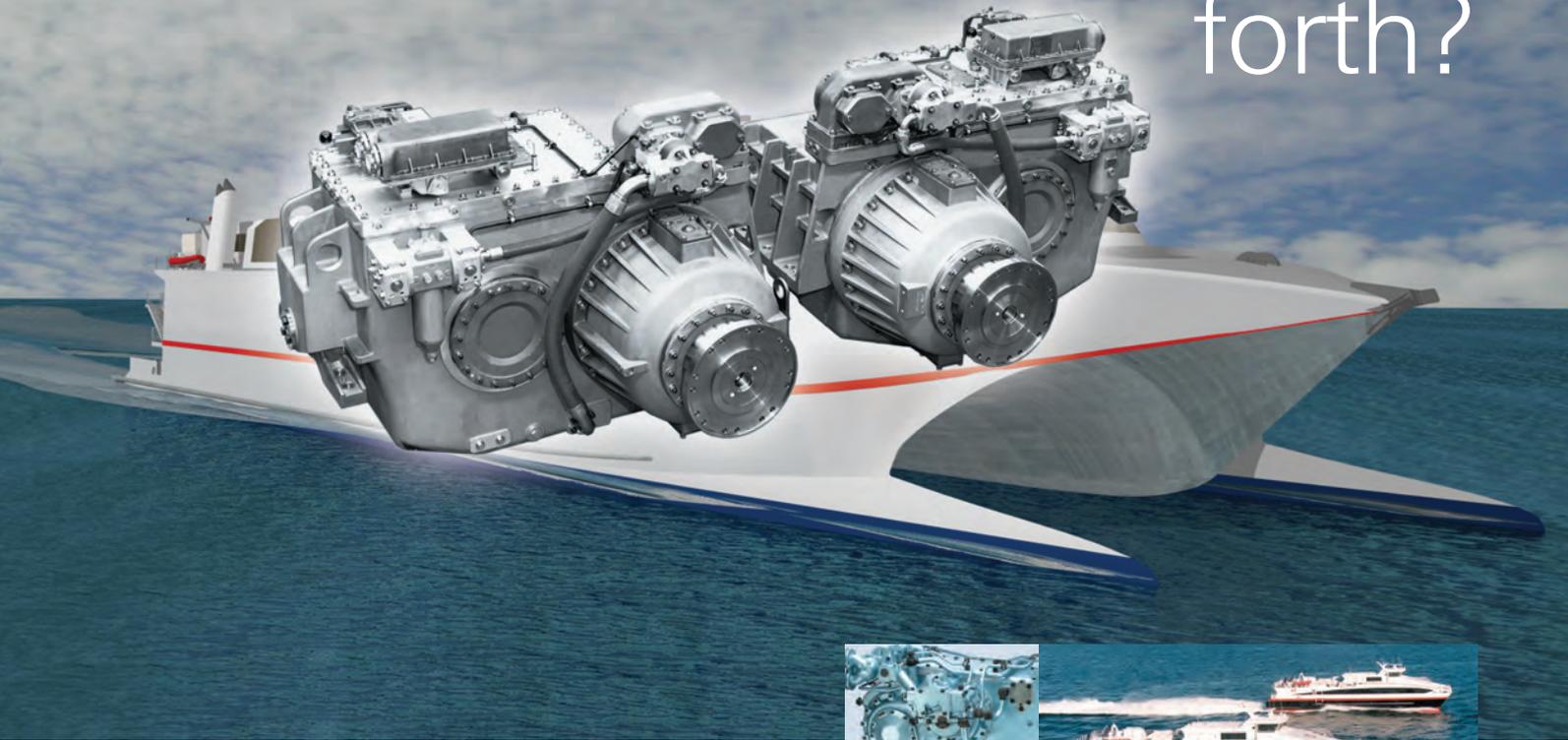


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reduce air pollution from ships. Appendix III of Annex VI MARPOL 73/78 states that the NOx detectors must be of the chemi-luminescent type, with a nitrogen dioxide (NO₂) converter.

Working alongside international shipping companies and fuel producers, ET Marine recently conducted extensive proving trials with its Seanox Chemiluminescent compact continuous emission monitor onboard cruise liners, ro-ro ferries, and tankers to meet the IMO regulations. The Seanox analyser has also been approved and certified by Det Norske Veritas.

Contact: *Duncan Mounsor, ET Marine.*
Tel: 0870 161 3362.
E-mail: duncan.mounsor@et.co.uk

New gas detection systems added to range

International Mining & Marine Ltd has extended its range of specialised safety services for the shipping industry with the addition of the Draeger X-am 3000 and X-am 7000 gas detection systems. These instruments can be included in the IM&M Meter Tracker, an all-encompassing, ongoing maintenance programme offers which is claimed to offer savings in both time and money and also to simplify sensor calibration procedures whilst meeting maritime legislation.

In addition, by utilising Draeger sensor exchange technology, these gas detectors should also minimise problems associated with the transportation of dangerous goods and help

eliminate the need for ship management companies to manage the replacement or repair process.

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The X-am 7000 utilises a combination of more than 25 sensors, and it enables the detection of more than 100 toxic and combustible gases and vapours as well as oxygen. Draeger's sensor exchange functionality means that the X-am 7000 can be reconfigured simply by changing a sensor. The measuring range and target gas of these sensors can also be changed at the push of a button and without needing recalibration.

Contact: *Mark Westerman, International Mining & Marine Ltd, Trident House, Baxter Road, Sheffield S6 1JF, UK.*
Tel: +44 114 285 3040,
Fax: +44 114 285 3049.

Sales boost expected following air pollution regulation changes

A UK company that was set up just a few months ago, ET Marine, has reported great interest in its new Seanox ship air-pollution monitor, which was launched at the Nor-Shipping trade fair in June. ET Marine claims to be one of only two companies worldwide that can provide a monitor that meet new IMO regulations on exhaust emissions pollution.

Annex VI of MARPOL 73/78 legislation - which came into force on May 19 - stipulates that all ships over 400gt or with an engine output exceeding 130kW should monitor emissions of oxides of nitrogen (NOx) to

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Some considerations relating to wavemaking calculations for transom-stern ships

In this article, by George Gadd, MRINA, a number of different calculations for wavemaking are assessed and the results of a new study are discussed.

WAVEMAKING calculations based on Rankine sources distributed over a hull and free surface are widely used, and form the basis of many commercially available CFD codes. The majority of these involve developments of Dawson's method (Ref 1), in which sources are distributed over a 'double model' of the hull reflected in the undisturbed free surface plane, and over an area of the free surface in the vicinity of the hull.

The hull sources are chosen so that the flow everywhere is tangential to the hull surface, as in the method of Hess and Smith (Ref 2), for flows without a free surface. This latter method can give extremely accurate results for well streamlined bodies, and at first sight it might seem that similar accuracy should be attainable, given sufficient computer power, in wavemaking cases. This is not so, however, because of the non-linear conditions that govern free-surface waves.

In Dawson's method, and its derivatives, streamlines for the zero Froude number case, where no waves are generated, are first calculated, and the wavemaking flow is assumed to be a linear perturbation of the velocities along these streamlines. Thus non-linear effects are partially taken into account of insofar as lateral velocities are not assumed to be negligible, as in slender ship theory.

Gadd's method (Ref 3) is similar in that it involves a 'double model' of the hull and sources on the undisturbed free-surface plane. However, for each free-surface panel, vertical surfaces extending from its edges to the true free surface enclose a fluid region for which momentum and continuity conditions are formulated. This set of conditions constitutes a system of simultaneous equations which initially are solved as if they were linear equations.

This procedure would only yield an approximately correct solution if all the sources, or sinks, found were small enough - less than some value δ - in which case the non-linear conditions involving squares of induced velocities would not be seriously violated. In reality, the predictions of this first step solution will normally involve source/sink increments exceeding δ , with the maximum increment on some panel being equal to δ . Then all the predicted increments are reduced in the ratio δ/δ , and starting with this reduced distribution a further set of increments are found, at each step limiting the maximum increment to δ .

Eventually, in a final iteration the maximum increment found will be less than δ , and this is taken to be the solution required at this stage. In both methods special procedures are needed to satisfy the radiation condition, that waves do not propagate upstream. In Dawson's method

this is achieved by the use of an unsymmetrical differencing procedure to solve the differential equations for the flow along the streamlines.

In Gadd's method additional conditions limiting the upstream source strengths are imposed, so that the free stream equations form a redundant set, solved by a least squares fit procedure, with suitable weighting for the upstream source conditions. Although Gadd's method satisfies the free-surface conditions rather more closely than Dawson's (in its original form at least), neither method can be exact, even if wavebreaking effects are unimportant.

The determination of wave crests and troughs involves extrapolating the upwards or the downwards flow field calculated for the region below the undisturbed free surface. Alongside the hull this is open to error, particularly if the hull sections are far from vertical at the waterline.

The problem is worse in transom stern cases where the transom runs dry. Usually additional rows of surface panels starting at the transom and extending at constant width downstream are employed. It has to be decided what starting conditions on the source distributions should be used, analogous to the radiation condition applied to the main external flow.

Dawson originally imposed a condition that longitudinal velocity at the transom edge should correspond to a wave trough whose depth is equal to the depth of the transom. Reed et al (Ref 4) and Nakos and Sclavounos (Ref 5) suggested that the flow directions on the hull just upstream of the bottom edge of the transom should also be matched.

The latter condition simply implies fixing the source or sink density on the most upstream panels of the wake, but the velocity condition there involves the effects of all nearby sources, including those in the external flow. It is open to doubt whether the velocity condition, intended to apply to the bottom of the transom, can be adequately implemented by any way of specifying the source densities on the plane of the undisturbed free surface.

If the true free-surface geometry were known then, in principle, sources distributed over it and the underwater hull could yield an exact solution. There would be no discontinuity between the source densities on the hull and those on the true free surface leaving the transom, if the flow directions were the same. Hence the downstream sources adjacent to the transom would not induce any motion at the transom edge.

However with sources on the undisturbed free surface there is no such balance, and singular behaviour would occur at the upstream sources next to the transom. This suggests that it may be better to impose no conditions on the sources behind the transom, beyond relating the sink density on the most upstream wake panels to the upflow at the hull at the transom, but otherwise merely satisfying the normal free-surface conditions. The

pressure condition at the transom might perhaps best be met by singularities situated on the transom plane itself.

Usually the transom plane is left open, hull boundary conditions being met only on the hull surfaces upstream of it. It would, of course, be inappropriate to close the transom and impose the condition that there is no flow through it, which would give stagnation conditions at the transom. However Reed et al considered the possibility of placing a source distribution on it, producing the required downstream velocity for the transom wave trough, though they retained the free-surface source conditions also.

In the present study the free-surface sources are not so restricted, and normal doublets are used on the transom rather than sources. Such singularities can induce a longitudinal velocity through the transom plane, equal on both sides of the transom. Thus the expression given by Lamb, Article 57, shows that normal doublets of density S distributed over a disc of radius R induce an axial velocity at the centre equal to $S/2\pi R$.

Numerical integration of the effects of closely spaced point doublets on a rectangular region of area A predicts a velocity very close to $S/2\pi R$, where S is the total point doublet strength divided by A and $\pi(R^2) = A$. Although the normal velocity is not uniform over the region, as it would be for a uniform source density distribution, doublets distributed over the transom plane could, if their density is appropriately chosen, give rise to the required Bernoulli velocity at the bottom edge of the transom when combined with the effects of sources on the upstream part of the hull. Doublets have been preferred to sources because the latter induce unrealistically large pressure increases on the hull just upstream of the transom.

It is not suggested that such a procedure provides anything more than a model of the flow behind the transom, to be justified pragmatically if the results it gives rise to resemble the real flow. In the instances to which it has been applied this appears to be so. Thus calculations have been made for the Athena hull form, the subject of an international research programme sponsored by the Resistance Committee of the 16th International Towing Tank Conference.

As its contribution to this programme, Ship Division NPL made wave pattern measurements from which wave profiles along the centre of the wake and transverse to it behind the transom can be inferred. The measurements made covered a range of Froude numbers from 0.28 to 0.65 where the transom ran dry. The present calculation method with doublets over the transom predicts the main features of this flow, with quite realistic estimations of the depth of the trough just behind the transom, and of the distance behind the transom at which the peak 'rooster tail' wave occurs.

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The predictions of the wave height at this peak are of the right order of magnitude, and the calculated transverse wave profiles across the flow field are fairly realistic, as are the wave profiles along the side of the hull. In all these respects the results are better than those obtained without transom plane doublets, where it is attempted to match the required wave trough behind the transom by means of the free-surface sources, in the more usual way. Although the present method gives only an approximate model of the flow, it offers an approach that other workers in the field may perhaps wish to pursue further. ☺

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MasterShip advances

A NEW MasterShip 2005 version, which runs under AutoCAD 2004 and 2005, contains new developments in all Generators and Organiser. A prominent new feature in the Shape Generator is the Assembly Manager.

Assembly Manager can save users work at the start of a project, by automatically generating all drawings of transversal and longitudinal construction. As work progresses, for instance on the 2D frame-drawings, the 3D assembly stays up-to-date.

Other additions to this new version include a new geometrics version, which is a program and user interface of the core program in Shape Generator, while the ShipCreateDeck function enables users to create decks with different rounding parameters. A Parametric template has also been added, stemming from an extension of MasterShip's library, with two templates for flanges and one slot weld template. Stiffener reports have also been extended - three types of report are now available - providing the correct information for the logistic and production process of stiffeners. Finally, NC Simulation has been improved as all information and settings are now in one new designed dialogue box. ☺

New version of MARS

THE new version of MARS - v/6.1, released at the end of February this year, is said to offer many interesting new features. This includes subcontractor enhancements for purchase of work-packages and further improvement of purchase functions such as advanced tracking of purchase order amendments, multi-projects for delivery orders, invoice control based on payment plans, and enhanced calculation of material status.

The patch set 1 for MARS v/6.1 was released in May 2005, and contains new functions, such as the introduction of room/compartments throughout MARS, enhancement of integration points to MARS*Planning, and dynamic export facility from MARS to MS-Excel.

UK shipbuilding group VT shipbuilding, including VT Halmatic, and VT Marine Products, has chosen to implement MARS. The decision was made after a very detailed workshop of MARS and another international ERP solution. The implementation will include all MARS applications: MARS*Material, MARS*Planning, and MARS*Production. As MARS is completely dedicated to the shipbuilding industry, the aim is not only to have a modern and effective solution, but also to further enhance procedures and processes in the companies.

The implementation of MARS commenced in March. During the initial weeks all project members received a two-week MARS training course at VT Shipbuilding's premises in Portsmouth.

Finally, as part of the successful cooperation with CSIT (an IT company which is part of China State Shipbuilding Corp) a new MARS website has been launched to provide Chinese shipyards with MARS. ☺

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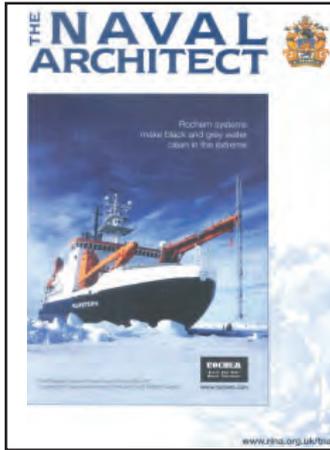
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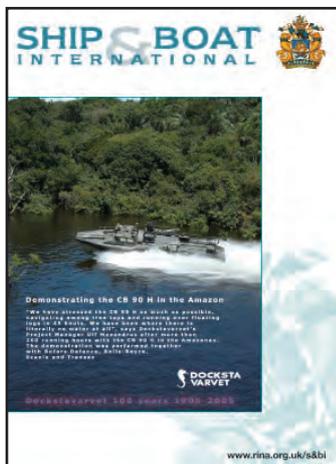


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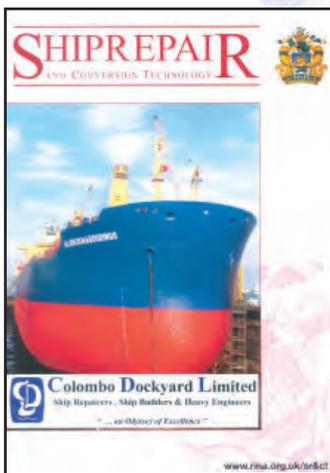


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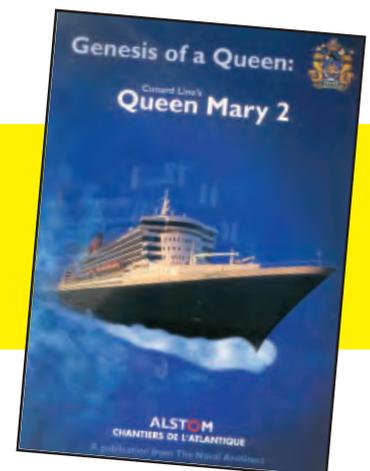
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Interaction of ships - two case studies examined

In this article, Dr C B Barrass, MSc, CEng, FRINA CNI, re-examines two earlier collision cases that may still be of interest to naval architects.

ON October 23 1970, *Pacific Glory*, a 77,648dwt oil tanker, collided with *Allegra*, a 95,455dwt oil tanker. The collision took place just south of the Isle of Wight. Both vessels were travelling from west to east up the English Channel. It was approximately 8pm as the vessels approached each other. It was a clear night with good visibility of about 10nm. Both tankers had full cargoes of oil.

Pacific Glory, on transit from Nigeria to Rotterdam, had been to Brixham to pick up a North Sea pilot. This vessel had a service speed of 15knots and was fitted with diesel machinery. She was on a course of 087deg that changed at 8.30pm to a heading of 080deg.

Allegra had been on route from Libya to the Fawley Oil Terminal, Southampton. She had a service speed of 15.5knots and was fitted with steam turbine machinery. She was proceeding on a heading of 060deg. *Allegra* was larger, longer, and faster than *Pacific Glory*.

At 8.18pm, the vessels were 915m apart. Fig 1 shows the converging courses of these two ships prior to their collision at 8.23pm. The top diagram shows the movements in the five minutes before the collision. The middle diagram gives details one to two minutes before the collision. The lower diagram shows *Pacific Glory* being drawn towards the larger *Allegra*.

Just moments before the collision, the vessels must have been very nearly on parallel headings, each one close to 060deg. The three diagrams in Fig 1 clearly show belated attempts to steer clear of one another. Interaction between the parallel bodies of the vessels caused them to be attracted together and then to finally collide.

Second case study

On May 11 1972 at 5.00am, *Royston Grange*, a 10,262dwt British reefer/passenger ship, collided with *Tien Chee*, a 19,700dwt Liberian oil tanker. The collision took place in the Indio Channel off Montevideo, in the River Plate.

Royston Grange was outward bound, on route to Montevideo and then on to London. She had a static mean draught of 7m and a trim by the stern of 0.30m. Onboard were cereals, butter, and refrigerated meat.

Tien Chee was inward bound, on route to Buenos Aires. She had a mean draught of 9m with a trim of 0.30m by the stern. She was almost fully loaded with cargo oil. Her forward speed just prior to the collision was 12knots.

Both vessels were travelling at forward speed. Each vessel had their pilot aboard. Both vessels were on an approaching manoeuvre, passing port to port, and were in shallow waters. Both vessels were also in the southern part of the channel. It was low tide.

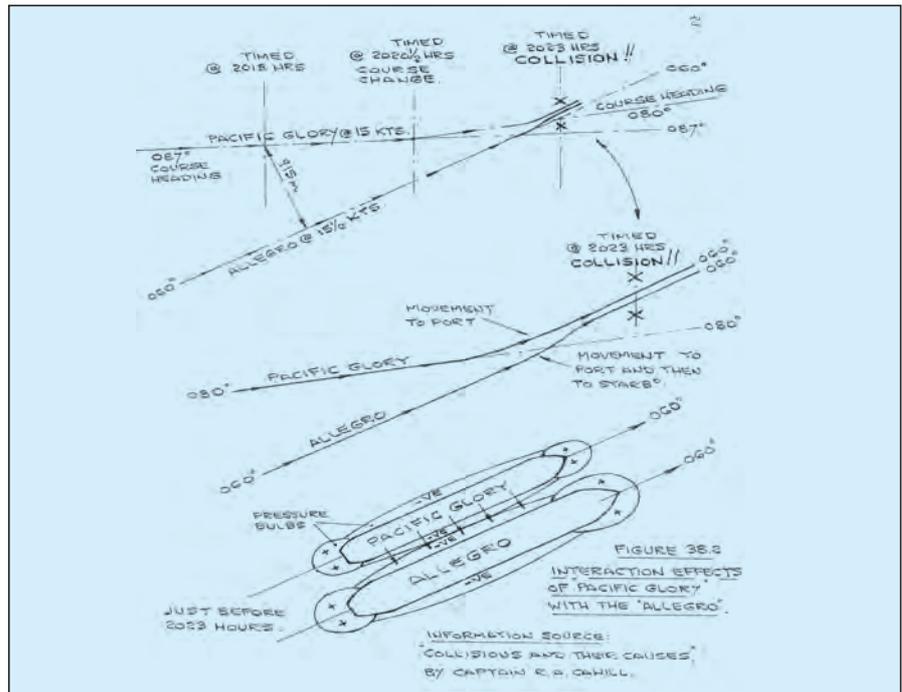


Fig 1. Interaction effects of *Pacific Glory* with *Allegra*.

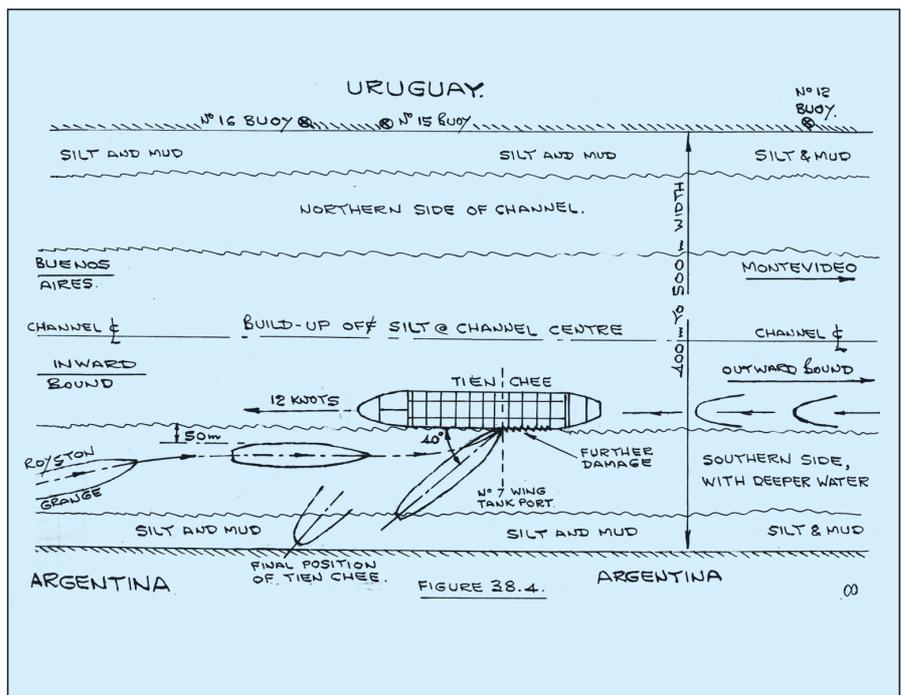


Fig 2. *Royston Grange* hitting *Tien Chee* at an angle of 40deg.

Just after their bows crossed, *Royston Grange* suddenly veered to port and crashed into the amidships port side of *Tien Chee*. Extensive bow damage to the reefer suggests that the vessels must have been travelling towards each other at a fast speed.

My analysis and investigations into the collision came up with the following conclusions. *Royston Grange* hit *Tien Chee* at an angle of 40deg, Fig 2. The first point of contact was at No 7 cargo wing tank port. Damage then occurred at Nos 8, 9, and 10

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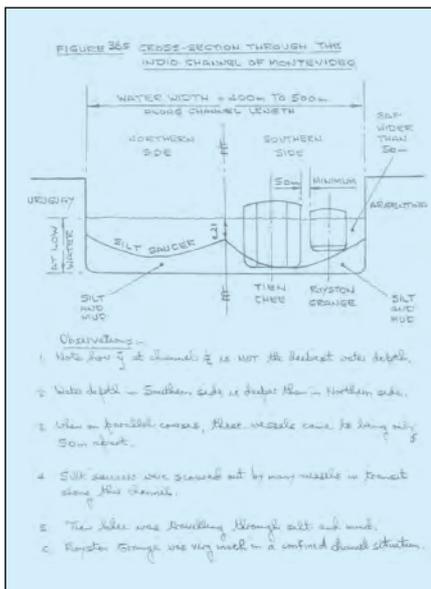


Fig 3. Cross-section through the Indio Channel off Montevideo.

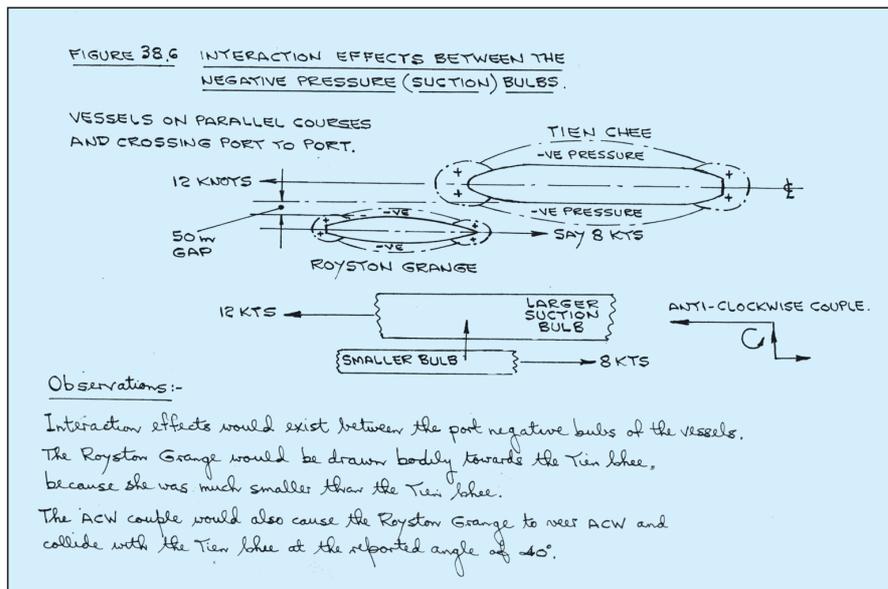


Fig 4. Interaction effects between the negative pressure (suction) bulbs.

wing tanks of *Tien Chee*. Substantial structural damage to the bow structure of *Royston Grange* occurred. Around 800 tonnes of oil was spilled.

The pilot on the bridge of *Tien Chee* made a claim to the master on May 11 1972 that there would be an extra 0.60m of water more than shown for low water. He convinced the ship's master this would be sufficient to proceed upriver without the need to wait. The master agreed.

Tien Chee had been delayed. She was three hours late in arriving at the river. Because of this, her master was in a hurry to take her upriver. Thus a human error of judgement occurred. The approach speed of the *Tien Chee* was too fast. This was another human error.

Tien Chee was ploughing through silt and mud on the river bed. At 12 knots speed the *Tien Chee* had squatted about 0.90m at the stern and she would have increased her trim by the stern. The total trim would then be about 0.66m, thereby drawing her stern further into the mud.

The bow of *Royston Grange* was drawn into the port side of *Tien Chee*. See Fig 2. Just before the collision both vessels were drawn as close as 50m on a parallel course. This is much too close.

The negative pressure bulb of *Tien Chee*'s side-shell was much larger than the negative pressure bulb of the *Royston Grange*'s side-shell. If the forward speed (not given) of *Royston Grange* had been between 6 knots and 10 knots (or an average 8 knots) then the closing speed would have been a very dangerous speed of 20 knots, Fig 2.

A northerly wind present at the time of the collision would have decreased the water depth. This would have increased squat and interaction.

The approach manoeuvre was carried out in the southern part of this channel, ie, confined channel conditions. See Fig 3.

Possible poor dredging arrangements (Fig 4) by the Argentine and Uruguay port authorities probably meant there was an appreciable build-up of mud and silt on the riverbed. The bottom saucers of silt had been built-up by the transit of many vessels going upriver and downriver. This silt and mud would increase the blockage factor. It would also have increased squat and interaction effects.

When the vessels collided it was low tide and was in a narrow part of the river. In these conditions, rudder helm is less effective. The deadweight of *Tien Chee* was 19,700 dwt. The deadweight of *Royston Grange* was only 10,262 dwt. This gives a ratio of almost 2:1. The greater the difference of deadweight between ships in this situation, the greater will be the effects of interaction. The mean draughts of *Tien Chee* and *Royston Grange* were in the ratio of about 1.25:1.00. Interaction increases with greater ratios of draughts, so this would definitely contribute to the collision.

Tien Chee was almost fully loaded; there was evidence she was transiting through mud at 12 knots forward speed. She would have experienced the greater squat effects with her H/T of 1.10 (Fig 3).

Note how in this river the greatest water depth is not on the centreline of the channel. The greatest depth is in the southern part of the channel (Fig 3). *Royston Grange* was turned to

port. This is because the large negative pressure bulb of *Tien Chee* was moving upriver whilst the smaller negative pressure bulb was moving downriver and at the same time towards it. This set up an anticlockwise couple that moved *Royston Grange* from being parallel, to being at 40 degree angle to *Tien Chee* (Fig 4). The parallel body of *Tien Chee* would have been 50% to 60% of her LBP. This represents a long wall of moving water going upriver at 12 knots, almost like a moving riverbank. The greater this percentage is, the greater will be the effect of interaction.

Due to the butter cargo, *Royston Grange* was carrying, oil vapours from *Tien Chee* and sparks from the collision contact all combined to start a disastrous fire. The total complement of 74 people aboard *Royston Grange* lost their lives. Eight people aboard *Tien Chee* also died. Both vessels were later scrapped.

Summary

This case study on interaction effects has clearly shown the perils of allowing the domain of one ship to enter the domain of another. If one ship is overtaking another in a narrow river, and amidships become in line with each other, then it is possible that the smaller vessel will be drawn bodily towards the other ship.

However, if the vessels are on an approaching manoeuvre and transversely close together, then as well as this suction effect the smaller ship may suddenly veer, turn and then run into the side of the other vessel. ⚠

The opinions expressed in this article are those of the author.

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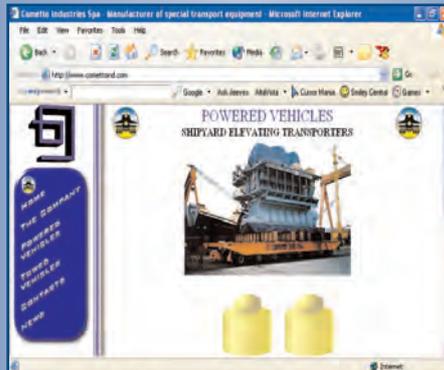
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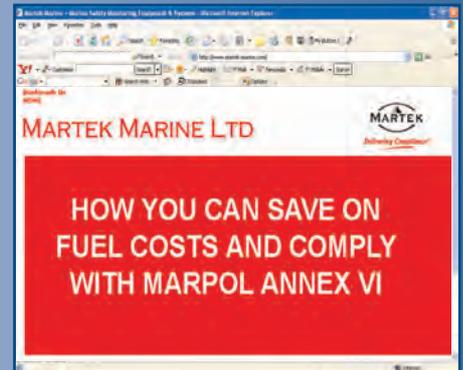
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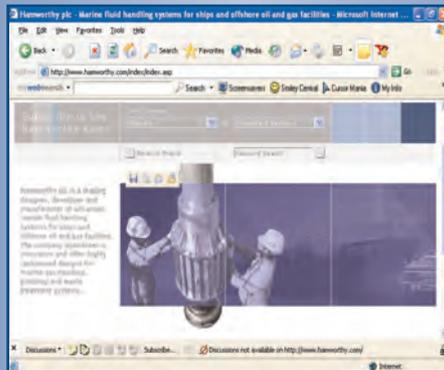
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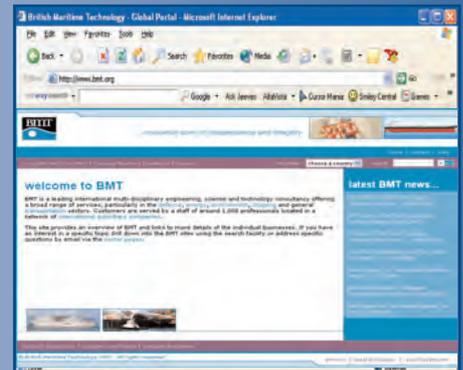
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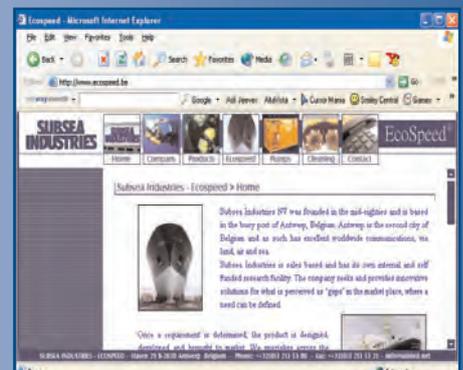
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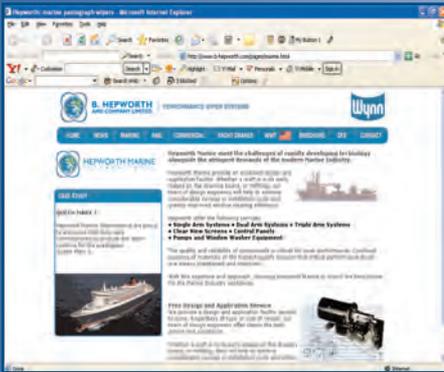
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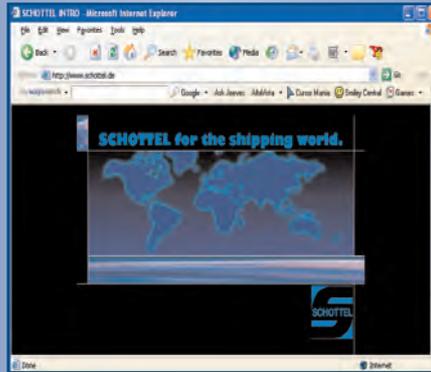
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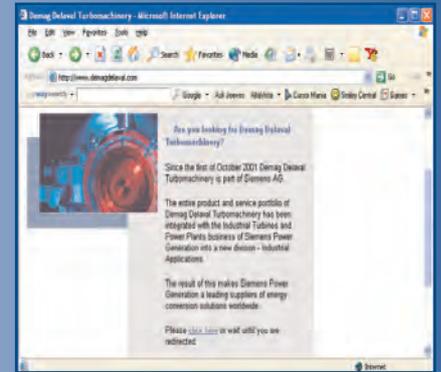
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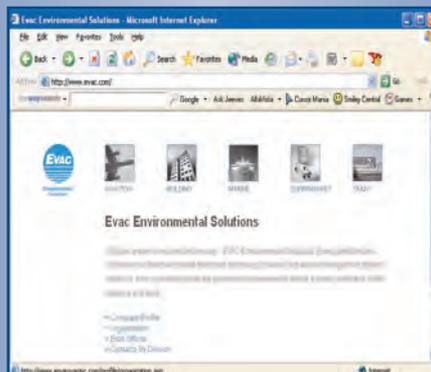
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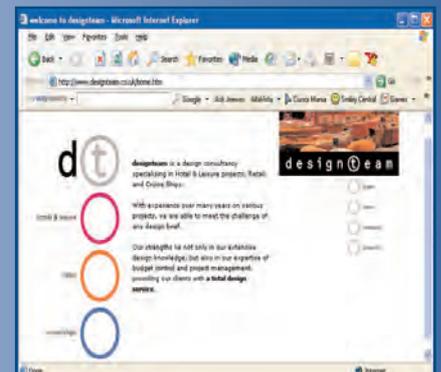
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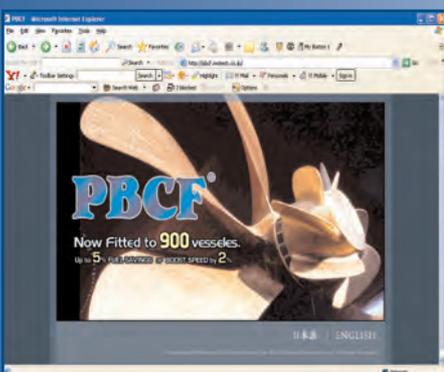
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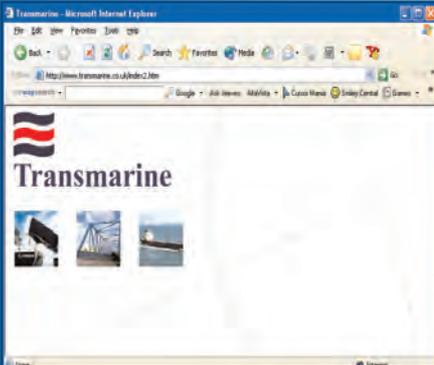
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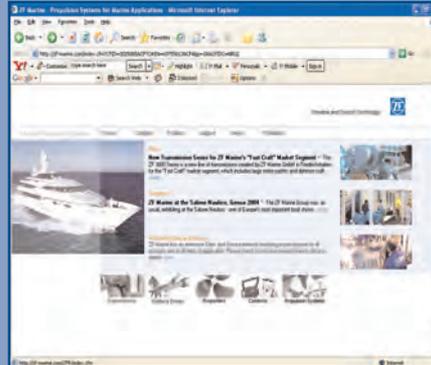
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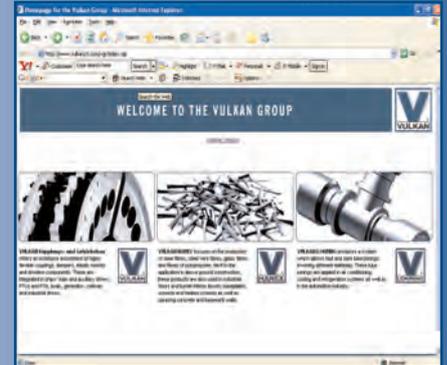
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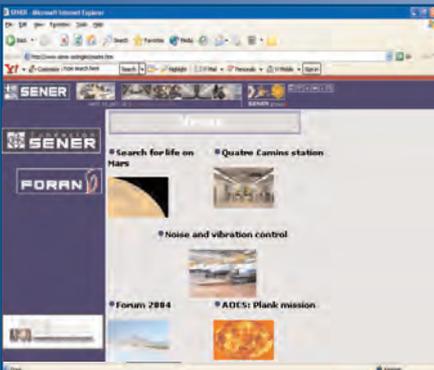
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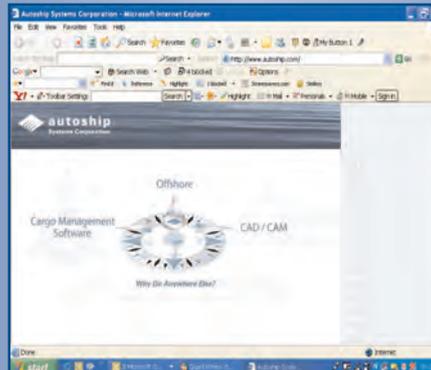
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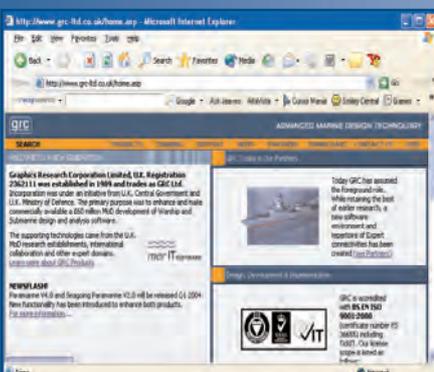
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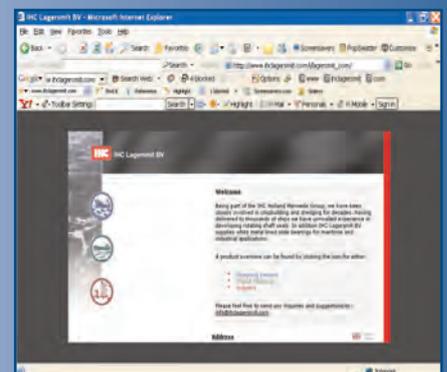
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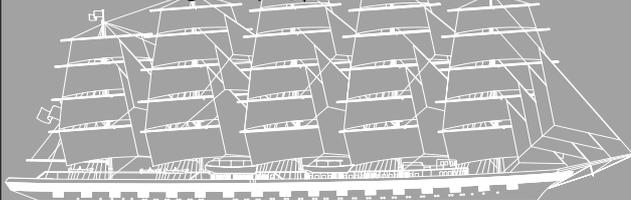
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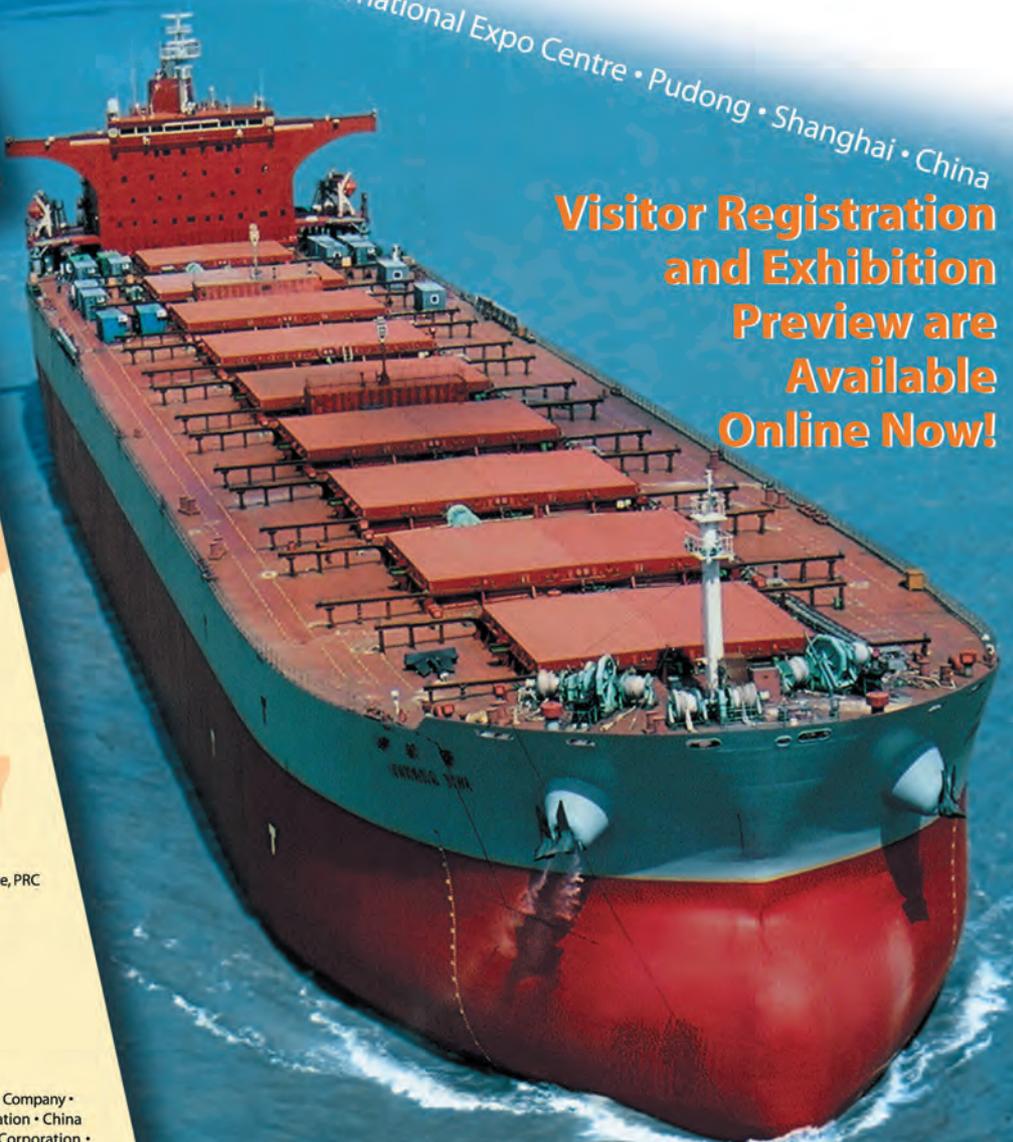
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