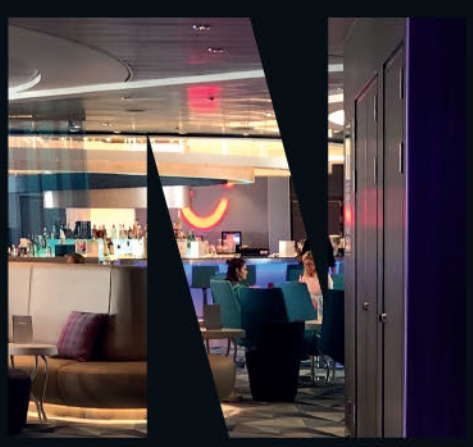
THE NAVAL ARCHITECT
A publication of THE ROYAL INSTITUTION OF NAVAL ARCHITECTS
For more related news please visit: www.rina.org.uk
SEPT 2021

FUTURE FORWARD DESIGN DOWN UNDER

A LOOK AT AUSTRALIA'S LATEST RESEARCH VESSEL



NO

LIMITS

For every conceivable area Bolidt offers innovative decking solutions.

- Environmentally friendly
- Durable
- Cost efficient
- Light weight
- Maintenance friendly
- Unlimited design options

Our specialised application teams work world wide, for new build as well as refit.

Bolidt, no limits!

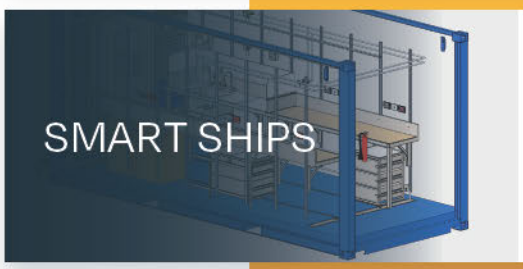
www.bolidt.com

bolidt

CONTENTS

September 2021

FEATURES



THE NAVAL ARCHITECT

Editor: Richard Halfhide
Editorial Assistant: Sophie Collingwood
Production Manager: Nicola Stuart
Subscriptions & Publications Manager: Tasharna Jokotade
Publisher: Dmitriy Ponkratov

Advertising Sales: J P Media Services
Email advertising: jpayten@jpmediaservices.com
Telephone: +44 (0)1737 852135

Published by:
The Royal Institution of Naval Architects
Editorial Office:
8-9 Northumberland Street
London, WC2N 5DA, UK
Telephone: +44 (0) 20 7235 4622
Telefax: +44 (0) 20 7245 6959
E-mail editorial: editorial@rina.org.uk
E-mail production: jmorecraft@rina.org.uk
E-mail subscriptions: subscriptions@rina.org.uk

Printed in Wales by Stephens & George Magazines.

A 2021 subscription to The Naval Architect costs:

THE NAVAL ARCHITECT SUBSCRIPTION (10 issues per year)			
LOCATION	PRINT ONLY	DIGITAL ONLY	PRINT + DIGITAL
UK	£211	£211	£269
Rest of Europe	£222	£211	£279
Rest of World	£237	£211	£295
	Includes P+P	Inclusive of VAT	

The Naval Architect Group (English Edition)
Average Net Circulation 9,763 (total)
1 January to 31 December 2020
ISSN 03060209

EU CLIMATE REGULATIONS TURN UP THE HEAT

By **Richard Halfhide**

As if the frightening temperatures and raging forest fires over the summer weren't evidence enough, then the publication of the the UN's Intergovernmental Panel on Climate Change (IPCC) in August was completely unambiguous: climate change is a reality and it's almost indisputably the fault of humans. In the past half century, temperatures have risen faster than in any equivalent period in the preceding 2,000 years.

What's more, it would likely take centuries, or even millenia to restore those planetary support systems to their pre-industrial state, if indeed they are reversible at all. That the report's findings were swiftly overshadowed on the global agenda by events in Afghanistan shouldn't detract from its significance and it's likely to dictate proceedings at the COP26 climate summit in Glasgow in November.

A few weeks before the IPCC study, the European Commission adopted a package of climate, energy, land use, transport and taxation proposals intended to ensure its policies can achieve a net reduction in greenhouse gas emissions of at least 55% by 2030. Of these, there are two that are particularly significant for shipping.

First, the Emission Trading System (ETS), by which permits for emissions allowances within the EU can be bought and sold, has now been extended to include the maritime sector. Needless to say that this is not a popular move with IMO or the wider shipping community, given that it threatens to undermine initiatives such as EEXI, CII and the proposed International Maritime Research Fund to finance research into low- and zero-carbon fuels. It will expose shipping to the volatility of the carbon pricing market; another variable to be factored into investment decisions at a time when there's never been more uncertainty. There's also the question of how far its regulatory powers will extend when a ship's emissions occur outside of EU waters.

(The British Government, it should be noted, is currently in the process of implementing its own ETS in line with its more ambitious targets of net zero-carbon emissions by 2050, but it remains unclear whether it will be applied to shipping in any form.)

Second, and perhaps even more problematic, is the FuelEU Maritime proposal, whereby ships will be required to reduce the GHG intensity of the energy sources they use onboard. On the face of it there's much to admire; fuel suppliers will be required to provide documentary evidence for GHG emissions and emission factors from well to wake, and document these on the bunker delivery notes. A sliding timescale whereby carbon intensity must be reduced over the next 30 years would provide regulatory consistency, and on the face of it there is no discrimination or favouring of any single alternative fuel per se, since all will be subject to the same exacting

SOURCE: MARKUS SPISKE (PEXELS)

requirements, although some will obviously be better off than others.

The difficulty arises in the onus it places on the shipowner to negotiate these complex formulae, rather than the fuel suppliers. One can well imagine, in an industry of such tight margins, the calamitous consequences of miscalculating their overheads. Nor is it, of course, an internationally agreed methodology for assessing the carbon footprint of fuels, meaning that other regulators may apply entirely different standards. The EU, not for the first time, perhaps hopes that a certain force majeure would take effect, but it's self evident that international consensus would be preferable.

Shipowners and naval architects alike must, to a large extent, work with the regulatory cards they're dealt and plenty of experts are already providing considered analyses online of what this could all mean (hopefully we can return to this subject in the pages of *TNA* in the coming months). However, it surely pays to be wary when it comes to nascent technologies and determining just how sustainable they really are, particularly when those advocating them may have ulterior motives. The growing controversy surrounding the carbon intensity of 'blue hydrogen' (see News, p.7), and allegations that oil companies have deliberately misled the British Government and other parties in order to win billions in subsidies for blue hydrogen projects, is a reminder of the pervasive naivety (to give the decision-makers the generous benefit of the doubt) in this green new world.

I read a comment the other day from a former marine who had been posted in Afghanistan, insinuating that the point had never been so much to train and equip the Afghan people to defend themselves, so much as to hand out lucrative defence contracts. It would be no disservice to that humanitarian crisis to suggest the consequences of such cynical decision making being applied to global warming might be even more catastrophic. Adopting the right tools, for the right reasons, might make all the difference. ■

NEWS

AUTONOMOUS SHIPS

HHI PLANS AUTONOMOUS OCEAN VOYAGE BY YEAR'S END

HHI'S UNMANNED PASSENGER CRAFT AT JULY'S DEMONSTRATION

Korean industrial giant Hyundai Heavy Industries Group (HHI) will shortly attempt the world's first transoceanic 'unmanned' voyage for a large vessel, it has announced.

In June, HHI's recently-established specialist autonomous navigation subsidiary, Avikus, successfully completed unmanned operation of a small passenger boat at a special demonstration event. The craft deployed a state-of-the-art navigation system known as Hyundai Intelligent Navigation Assistant System (HiNAS), which uses advanced navigation assistance systems, special cameras and LiDAR (Light Detection And Ranging), a remote sensing technology to automatically detect objects surrounding the vessel.

Lim Do-hyeong, Avikus CEO, comments: "We are poised to become the world's first to commercialise a self-sailing leisure boat next year, based on our fully autonomous navigation technologies successfully demonstrated." Through continued investments in R&D and talent, we will establish a position as a first mover in the autonomous ships market, which is considered the ultimate destination for future maritime mobility technologies."

The HiNas system has already been proven onboard a 250,000tonnes bulk carrier in another demonstration exercise last year, but Avikus says it is now planning for autonomous voyage of a large merchant ship operated by an unspecified Korean shipping company "possibly as early as in the second half of this year". In July, reports in Korea suggested that a 300m loa LNG carrier, currently under construction by HHI holding company Korea Shipbuilding & Offshore Engineering, had been earmarked for the purpose and a proposed voyage in either the Pacific or Indian Ocean.

Although some reports have suggested the vessel will be unmanned, current international regulations mean it's unlikely there will be no crew onboard and it's more plausible that some remote operations will be sanctioned. At present, there is no information on which classification societies are being consulted on the project.

NEWBUILDINGS

TALLINK SHUTTLE FERRY *MYSTAR* LAUNCHED AND CHRISTENED

Estonian operator Tallink's second LNG-fuelled ro-pax, *MyStar*, has been floated and christened at a ceremony held at Rauma Marine Constructions (RMC) shipyard, Finland, in August.

MyStar is the seventh vessel built by RMC for Tallink and also the largest to be built at the yard to date. The 50,000gt, 212m loa vessel is due for delivery next year and will join Tallink's current flagship *Megatar*, which is also LNG-fuelled, on the high-speed Tallinn-Helsinki route. When completed RMC says it will be the most environmentally friendly vessel to operate in the Baltic.

The event, which took place in accordance with strict Covid distancing protocol and a limited number of guests, was attended by Estonian president Kersti Kaljulaid, who has been honored as *MyStar*'s godmother.

Jyrki Heinimaa, president and CEO of RMC, comments: "We have been working together for over a year, and both Tallink's and RMC's project teams deserve great praise for the work they have done in these challenging conditions. We are excited to proceed to a new stage in *MyStar*'s construction work as the work begins to shift from the exterior of the ship to the interior."

Like many shipyards, RMC has had to weather storms to maintain operations and orders during the pandemic. Delivery of another passenger the yard has built for Finnish operator Wasalines, *Aurora Botnia*, has already been postponed from the planned date of June until the end of August due to delays during the sea trials.

In July 2021, Tasmanian shipping company TT-Line reneged on a Memorandum of Understanding for the building of two car and passenger ferries, putting thousands of jobs at risk. However, in April this year a new contract was signed and work on the two ferries, replacements for the Finnish-built *Spirit of Tasmania I* and *II*, will commence next year. Including four multi-purpose corvettes being built for the Finnish Defence Forces, RMC currently has an orderbook of EUR1.6 billion.

Data drives and connects the entire shipbuilding process in CADMATIC.

In data-driven shipbuilding, digital data streams are consistent, reliable, and reusable across disciplines, project phases, and ship series.

This single source of truth assists shipyards in accelerating the time-to-market, drive down costs, shorten lead-times, and reduce quality issues in design, manufacturing, and supply chains. It unlocks next-level efficiencies, increases productivity, and secures profitability via data-driven processes and decision-making

Project courtesy of Wärtsilä Ship Design Norway AS

CADMATIC

www.cadmatic.com

NEWS

ALTERNATIVE FUELS

SGMF PUBLISHES LNG AS FUEL GUIDANCE

Lobby group The Society for Gas as a Marine Fuel (SGMF) has published new advice intended to improve the safety of LNG-fuelled ships and facilitate greater standardisation in vessel design.

The Technical Guidance Note gives recommendations on the best locations for bunker manifolds or bunker stations on gas powered ships. The notes are intended to complement existing documents on manifold arrangements and promote compatible bunkering operations as a growing array of such facilities come into service.

Additionally, SGMF has issued Operation of ships with Liquefied Natural Gas (LNG) – competency and assessment guidelines, which defines crew competency standards for the preparation, storage, handling and use of gas as a marine fuel, and are intended as a basis for training organisations.

The two publications were both prepared by SGMF working groups and are freely available to the society's members and can also be purchased by other interested parties. Bob Kamb, a member of the SGMF Working Group 6.5, explained: "Seafarers frequently complain that ship designers don't have to sail the ships they build. This guidance alleviates that complaint by providing a decision support framework for optimising bunker manifold location."

There are still just 206 LNG-fuelled vessels in operation worldwide, according to SGMF's own database, but a further 327 vessels on order, including LNG bunkering vessels. Many shipowners remain uncertain about additional capex involved, particularly with growing concerns about the role of methane in global warming and the risk of stranded assets in the event of more stringent legislation.

In August, Japanese operator Mitsui OSK Lines (MOL) said it hoped to have around 90 LNG-fuelled vessels in its fleet by 2030, as part of its 'Adoption of Clean Fuels' strategy. Announcing its agreement with Shin Kurushima Dockyard and Nihon Shipyard for the building of four LNG-fuelled 7,000-unit capacity car carriers, MOL stressed that while it envisaged LNG as the near-term fuel of choice, it remains heavily engaged in developing vessels capable of running on biofuel, ammonia and other alternatives.

Elsewhere, German operator NSB Group has unveiled a concept illustration for a 3,500TEU LNG-fuelled container ship. The vessel has been specifically designed in anticipation of a greater number of reefer containers, with capacity for 940FEU. Capacity has been further enhanced by the use of a forecastle deckhouse, which also separates the accommodation from the Type C LNG tanks.

AWARDS

CEMT AWARD PRESENTED TO RINA FELLOW

The Confederation of European Maritime Technology Societies (CEMT) has presented its annual award for significant contribution to the European maritime industry to RINA fellow (and regular *The Naval Architect* contributor) Professor Rodrigo Perez Fernandez of the Polytechnic University of Madrid.

Perez Fernandez's "significant contribution to the advancement of knowledge in the field of damage ship stability, through his research and publications" was noted by the panel. In particular, his PhD and subsequent research focused on damaged ship stability was highlighted, in which he has proposed several comparative analyses of the different criteria of stability after damage, as well as methods to help naval architects analyse that damage. One such paper received first prize at the 48th Naval Engineering and Maritime Industry Congress in 2009.

Parallel to his academic work, he also holds the position of head of naval shipbuilding at SENER, in which he has partnered several international shipyards.

RODRIGO PEREZ FERNANDEZ

ALTERNATIVE FUELS

BLUE HYDROGEN 'WORSE THAN GAS' WARNS US STUDY

A paper published by academics at Cornell and Stanford universities has delivered a damning verdict on the environmental credentials of hydrogen derived from fossil fuels, suggesting its greenhouse gas (GHG) footprint may be 20% greater than burning gas directly and 60% more than burning diesel.

Around 96% of the hydrogen produced worldwide is still derived from fossil fuels via methane reforming, which is increasingly referred to as grey hydrogen. The upscaling of so-called green hydrogen, where it's instead derived from renewable sources, remains a massive infrastructure undertaking in order for the Paris Agreement and IMO's carbon reduction targets to be achieved. Blue hydrogen, that's still extracted from natural gas but in tandem with the application of carbon capture and storage (CCS) technologies, is often cited as an intermediary solution.

The peer-reviewed Cornell and Stanford study, which was published in Energy Science and Engineering in August, is said to be the first to make a life cycle analysis of blue hydrogen's GHG emissions. It found that while blue hydrogen's CO_2 emissions were lower, the fugitive methane emissions caused by the use of gas for CCS make it worse than grey hydrogen. Despite the concerns around the long-term viability of some CCS solutions, the study worked on the assumption that the CO_2 would be stored indefinitely.

Cornell University's Robert Howarth, who co-authored the study, says: "This is a warning signal to governments that the only 'clean' hydrogen they should invest public funds in is truly net zero, green hydrogen made from wind and solar energy."

According to figures published by the Hydrogen Council in July, the hydrogen investment pipeline is now valued at US$500 billion globally. The majority of these are green hydrogen, however governments and corporations alike increasingly view it as a means of hitting the mandated carbon targets, notwithstanding its value as a bridging technology. In a recent position paper, the British government declared it essential to its net zero ambitions and set out targets of deploying 10GW of blue hydrogen by 2030, with 80GW by 2050.

In Europe, the Port of Rotterdam has announced a partnership with a Norwegian CCS and clean energy company, Horisont Energi, which will explore transporting blue ammonia produced in northern Norway to the Netherlands. Also in Norway, in July, Shell signed a memorandum of understanding with Aker Clean Hydrogen and CapeOmega to develop a blue hydrogen production facility using gas from the Nyhamna processing plant specifically for use as a marine fuel.

NEWS ANALYSIS

BOOM TIMES FOR BOXES AND BACK TO BUSINESS FOR CRUISE SECTOR

By **Malcolm Latarche**, Correspondent

For most of the summer, the headlines have been centred around the buoyant shipping markets and in particular the endless rise in container freight rates and shortage of shipping space. A development that has delighted operators but has seen cargo interests taking their case to the highest level, with the US Federal Maritime Commission opening an investigation into alleged profiteering. The root cause is less to do with lack of tonnage than a shortage of containers and congestion at ports, with large numbers of boxes unstuffed because of the pandemic. In mid-August, it was becoming clear that there is little likelihood of a return to business as usual and that was confirmed when China closed the Ningbo container port due to a new Covid-19 outbreak.

Unfortunately for the shipping industry, the present situation is showing it in a bad light as far as consumers are concerned. With goods prices rising, shippers can point to the fact that they are paying four or five times the freight rate of a year ago, getting a slower service and, in many cases, not even able to secure shipping slots. In addition, ship operators are saving on bunkers because they are slow steaming – no need for speed if a wait at anchor is in the offing – collecting demurrage on boxes in ports and able to charge premiums unseen for years. It remains to be seen what the competition authorities will do, but no doubt the liner sector will lose what little weaponry it had left in opposing anti-trust regulation.

Boxships have not been the only sector to see positive trends. Capesize bulker earnings in August were at levels not seen since 2010 and, once again, the driving factor is port congestion. In mid-August, some 6% of the world bulker fleet was idling off China waiting for a berth to discharge. High freight rates almost always drive a surge in new orders but while the container sector seems to be adopting this path, bulker owners have been more restrained and orders are at a relative low compared to previous boom periods. The majority of boxship orders were made earlier in the year, but the big news in August was that Maersk has chosen the Danish company REintegrate to supply the methanol fuel for a 2,100TEU feeder vessel ordered earlier in the year. REintegrate is to establish a new facility to produce the 10,000tonnes of carbon neutral e-methanol that Maersk's ship will consume annually.

The cruise sector, in which activity virtually entirely ceased for the best part of a year, is experiencing a gradual return to normality. As well as bringing laid up ships back into service, cruise operators have had a busy summer with

MSC SEASHORE

new ships being launched or delivered on an almost weekly basis. In mid-July, SunStone Ships took delivery of the ice-classed 104m *Ocean Explorer*, the second of its Ulstein X-Bow Infinity-class vessels, from shipbuilder China Merchants Heavy Industry. Thereafter the spotlight moved from China to Italy, with Fincantieri delivering MSC's new flagship *MSC Seashore* at its Monfalcone yard. At 170,400gt and 339m in length, the new vessel is the largest cruise ship yet built in Italy. It has also been distinguished with two new class notations from classification society RINA; Sustainable Ship, indicating the vessel meets the strategic sustainability goals adopted by the UN; and Biosafe Ship, a voluntary notation that certifies that the ship is equipped with systems, components, and layout and operational procedures that reduce infection risk. The Biosafe Ship notation was previously given to *MSC Grandiosa* in August last year as an early move by the cruise industry to combat the pandemic.

Within days, it was the Fincantieri Marghera yard's turn to hand over a new ship, delivering HAL's new Pinnacle-Class vessel *Rotterdam*. The departure of *Rotterdam* was followed by the floating out of Norwegian Cruise Line's (NCL) new cruise ship *Norwegian Prima*. The vessel is the first of six ships in NCL's Prima Class, the brand's first new class of vessels in nearly 10 years. Elsewhere in Italy, Seabourn had its newest expedition ship, the 23,000gt *Seabourn Venture*, launched at the Mariotti yard in Genoa. Designed and built to Polar Class 6, the ship is one of a pair and is scheduled to begin operations in April next year.

Another expedition vessel making news was the Vard-built *Le Commandant Charcot*, which was delivered to French cruise company Ponant in early August. *Le Commandant Charcot* is a Polar Class 2 vessel allowing year-round in moderate, multi-year ice conditions. ■

METS TRADE
MARINE EQUIPMENT TRADE SHOW

GET YOUR FREE TICKET
METSTRADE.COM

YOU'RE INVITED!

HOMEPORT OF THE LEISURE MARINE COMMUNITY

16 - 17 - 18
NOVEMBER 2021
RAI AMSTERDAM

The METSTRADE Show is the happening meeting place in Amsterdam where the international leisure marine community gathers. In a hospitable and safe environment, we make you feel at home to meet and mingle with the entire industry. Feel connected and charge yourself to optimise your business.

METSTRADE FEATURES

SYP SUPERYACHT PAVILION
MYP MARINA YARD PAVILION
CMP CONSTRUCTION MATERIAL PAVILION

ORGANISED BY rai AMSTERDAM
POWERED BY ICOMIA
MEMBER OF
OFFICIAL METSTRADE MAGAZINE IBI
OFFICIAL SYP MAGAZINE
OFFICIAL MYP MAGAZINE Marina World

NEWS EQUIPMENT

ENGINES

WINGD LAUNCHES TWO-STROKE ENGINE WITH INTEGRATED NOX AFTERTREATMENT

Swiss engine maker WinGD has launched what it says is the first marine two-stroke engine to carry its own NOx abatement solution, drastically reducing the space requirements and installation cost for shipyards.

The integrated Selective Catalytic Reduction (iSCR) has been incorporated into a six-cylinder X52 low-speed engine and was unveiled at a special event at the Dalian Marine Diesel Co, China, in July. It will be installed on a 50,000tonne tanker currently under construction at CSSC Chengxi Shipyard for Japanese owner Kumiai Senpaku.

SOURCE: WINGD

Because the iSCR's high-pressure reactor is integrated directly with the exhaust manifold, less off-engine auxiliary equipment and piping is required, thus reducing space. By locating it directly upstream of the turbocharger there are also higher operation temperatures which help with NOx removal. At the same time, the iSCR itself has little heat dissipation, while offering easy switching between IMO Tier II and Tier III compliant modes. The technology also benefits from WinGD's latest automation and control systems, including predictive monitoring.

With many shipowners still uncertain about transitioning to low-sulphur fuels, iSCR can still run on high-sulphur fuels, which may translate into additional operational savings. However, WinGD is aiming to make it available as a first step for single turbocharger applications of its diesel-burning X-series low-speed engines, where NOx aftertreatment is also required. However, its successful X-DF dual-fuel engines don't need NOx abatement as these are already Tier III compliant without aftertreatment.

PROPULSION

ABB MARKS AZIPOD 30TH ANNIVERSARY

This year, ABB has been celebrating 30 years since the launch of its Azipod propulsion solution and there have been some notable vessel contracts to mark the occasion.

In late June, *Global Mercy*, the world's largest purpose-built civilian hospital ship, was delivered at a ceremony at Tianjin Xingang Shipyard in China. The vessel is equipped with two Azipod propulsion units, as part of a wider package of connected electric and digital solutions. These include generators, switchboards, transformers and drives, as well as bridge controls for the propulsion system and the ABB Ability Marine Remote Diagnostic System.

Global Mercy will predominantly be based in Africa, where the propulsion system will help the 174m ship to negotiate narrow waterways and shallow harbors that would not otherwise be accessible. Azipods also minimise noise vibrations, allowing greater comfort for patients and crew.

Since they are delivered to the yard fully assembled, installation of an Azipod is considerably easier than shaftline propulsion. Haibo Mao, construction leader of Tianjin Xingang Shipyard, adds that this, combined with earlier successful collaborations with ABB on other passenger ship projects, proved a decisive factor.

There was also news in August that ABB has now received an order for what will become the 300th vessel with an Azipod installation. The vessel concerned is an advanced cable-laying and repair ship currently under construction at Colombo Dockyard in Sri Lanka, and will be used to support offshore wind farms for Orange Marine France.

The twin 1.8MW Azipods have been chosen to meet the shipowner's demand for high transit speeds with maximum fuel efficiency, while providing the 360-degree maneuverability in even the most difficult weather. ABB will also supply the electrical storage system, which will be used to reduce fuel consumption and maintain continuous power in the event of an unexpected shutdown.

SHANGHAI MERCHANT SHIP
DESIGN&RESEARCH INSTITUTE

SDARI

GREEN

- Low Added Resistance In Waves
- Low Wind Resistance
- Alternative Fuel
- Energy-saving Equipemnts

SMART

- DOSS®
  Digital Operation Support System
- S-CUBE
  SDARI Containerized Utility
  Battery ModulE
- Smart Load®
  Loading Computer
- 3D modelling + VR experience

We offer More Than Ship Design

SDARI provides not only ship design featuring big capacity, flexible operation and sustainability, but also energy saving equipments, digital onboard systems and lifecycle data service, making your fleet stronger, greener and smarter.

2633 Zuchongzhi Road, Shanghai, China
086 21 38139388
business@sdari.com.cn
Cecilia Shao
LinkedIn: CSSC-SDARI
Wechat: CSSC-SDARI

CSSC SHANGHAI MERCHANT SHIP DESIGN&RESEARCH INSTITUTE

HULL COATINGS

ELECTRICALLY CHARGED COATINGS COULD BE THE SOLUTION TO BIOFOULING

A research project led by marine biologists from Flinders University, Adelaide, has successfully demonstrated that electrically charged surface coatings can eliminate marine biofouling, potentially opening the way to new hull coatings solutions. The so-called 'active anti-fouling' experiments tested a range of materials, coatings and electrical cycles and compared them to non-electrically stressed samples.

The project was undertaken on behalf of Biofilm Research & Innovation Consortium, a partnership bringing together ASC [formerly the Australian Submarine Corporation], the University of South Australia and the Department of Defense with the aim of putting an end to marine biofouling, which can increase fuel consumption by 30-40%.

Traditionally antifouling solutions have entailed the use of a foul release paint, with a very slippery surface or, biocide-based antifouling paints, such as those using copper, that have implications for the marine environment. Having initially tested their theories in small fish tanks, the researchers used ASC's facilities to test larger samples of electrically charged materials in situ, then leaving them submerged for an extended period to see how much fouling develops.

Professor Mats Andersson, director of Flinders Institute for Nanoscale Science & Technology and theme leader in the Biofilm Research and Innovation Consortium, says that the most recent inspections indicated the research was proving hugely successful: "Our tests have shown that fouling can be significantly reduced and, in some cases, completely eliminated on the surfaces that are coated with a conducting paint and subject to electrochemical stress."

He adds: "To be honest, we are surprised that it works so well. As far as we know, there isn't a lot of this research being done around the world and while our research is specific to the Port River in Adelaide, it could be applied to any surface that is submerged in the ocean."

ENGINES

WÄRTSILÄ SECURES MULTI-ENGINE ITALIAN JOB

Finnish technology giants Wärtsilä have won the contract to supply the engines and fuel storage system for a new Italian ferry designed to operate on LNG, it was announced in July.

The order comprises two Wärtsilä 34DF dual-fuel main engines, two Wärtsilä 20DF dual-fuel auxiliary engines, two Wärtsilä Gas Valve Units, and a Wärtsilä LNGPac fuel storage, supply, and control system.

The 109.98m loa ferry, which is being at the Sefine shipyard, Turkey, for the Milazzo-based operator Caronte & Tourist Isole Minori, will have capacity for 800 passengers and 115 cars across two vehicle decks.

THE NEW FERRY'S LAYOUT, SHOWING WHERE THE WÄRTSILÄ ENGINES WILL BE INSTALLED. SOURCE: NAOS

It will mainly operate between Milazzo in Sicily and the Aeolian islands. Wärtsilä's equipment is scheduled for delivery to the yard in spring 2022, with the vessel's completion expected sometime in 2023.

Wärtsilä's extensive experience with LNG applications across a broad portfolio of products were cited as key considerations in awarding it the contract. Caronte & Tourist's managing director, Luigi Genghi, comments: "We are very familiar with Wärtsilä and rate both their products and their support very highly. When the decision to operate primarily on LNG fuel was made, it became clear that Wärtsilä was the most experienced and qualified supplier to use."

The two companies already enjoy a close relationship, having previously collaborated on the Mediterranean's first LNG-fuelled ferry, *Elio*, a small ro-pax which was also built by Sefine and delivered in 2018. That earlier project was developed under the GAINN4MOS consortium, which developed engineering studies for LNG that developed basic and detailed engineering studies on LNG bunkering stations and ship retrofitting and newbuilding.

In August, it was announced that Wärtsilä will also be supplying the engines and fuel gas supply systems for two new ro-paxes being built for Australian operator TT-Line due for construction at RMC shipyard in Finland (see also News p.6).

CLARKSON RESEARCH SERVICES: HISTORIC AND SCHEDULED DELIVERY

Data extract from World Fleet Register available at **www.clarksons.net/wfr**

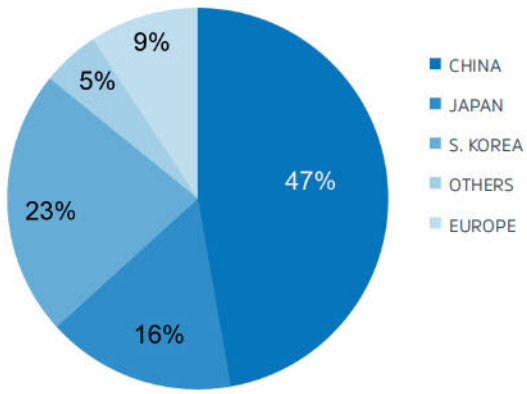
VESSEL TYPE	2010		2011		2012		2013		2014		2015	
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half
VLCC >= 200,000	30	24	35	27	27	22	21	9	14	10	9	11
Suezmax 120-200,000	26	11	26	18	30	15	23	4	4	4	7	3
Aframax 80-120,000	39	31	28	31	30	15	14	6	4	13	22	10
Panamax Tankers 60-80,000	15	16	19	10	9	6	7	5	3	1	2	1
Products 30-60,000	65	46	45	28	27	30	49	29	49	49	60	57
Products 10-30,000	5	7	8	6	13	6	9	4	1	8	4	0
Chem & Spec. 10-60,000	79	59	53	39	39	8	8	13	12	11	36	29
Tankers < 10,000	71	56	56	58	76	41	38	39	32	25	19	23
Capesize > 100,000	101	111	129	122	149	65	63	40	56	38	46	42
Panamax 80-100,000	60	61	81	97	140	94	101	68	62	35	57	41
Panamax 65-80,000	18	33	36	44	53	39	34	42	42	20	19	4
Handymax 40-65,000	168	166	199	198	228	146	147	119	98	102	144	121
Handysize 10-40,000	186	186	186	179	226	117	116	83	97	66	100	83
Combos > 10,000	3	2	3	0	0	0	0	0	0	0	0	0
LNG Carriers	15	12	5	10	1	2	4	13	14	19	16	16
LPG Carriers	18	18	16	14	13	8	22	16	14	14	25	40
Containers > 8,000 teu	29	33	48	30	51	28	51	33	59	42	58	62
Containers 3-8,000 teu	76	41	31	21	39	19	46	29	26	25	18	6
Containers < 3,000 teu	57	26	33	34	37	40	29	19	22	28	27	35
Offshore	20	23	25	19	28	10	11	19	32	30	25	13
Cruise Vessels	9	4	4	2	6	1	6	0	3	2	5	1
Passenger	10	13	11	10	11	8	6	6	12	8	13	8
Other	173	179	183	183	191	99	100	84	72	63	69	48
TOTAL	**1,273**	**1,158**	**1,260**	**1,180**	**1,424**	**819**	**905**	**680**	**728**	**613**	**781**	**654**

DATA INCLUDES ALL VESSELS WITH LOA ESTIMATED AT >100M

THE ORDERBOOK BY YEAR OF DELIVERY ON THIS PAGE IS BASED ON REPORTED ORDERS AND SCHEDULED DELIVERY DATES AND DO NOT NECESSARILY REPRESENT THE EXPECTED PATTERN OF FUTURE DELIVERIES

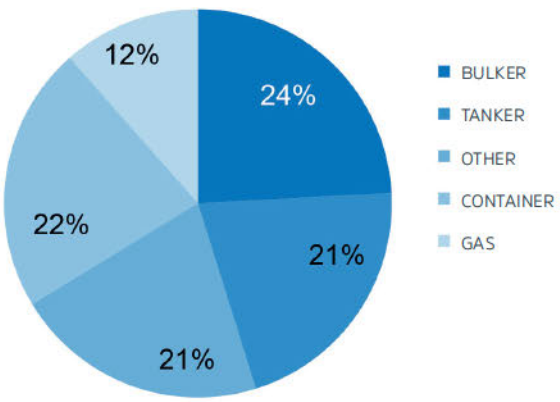
ALL DATA TAKEN AS OF **1ST JULY 2021**

ORDERBOOK BY BUILDER REGION (NUMBER OF VESSELS)

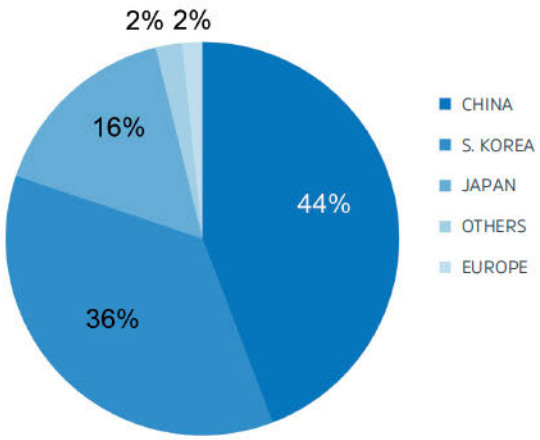


	2016		2017		2018		2019		2020		2021	Scheduled Orderbook		
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2021	2022	2023
	23	24	29	21	21	18	39	29	22	15	22	12	42	25
	8	19	35	22	25	7	23	3	11	19	20	6	34	9
	31	22	36	28	26	24	41	12	12	6	28	28	42	20
	7	11	10	11	7	6	6	7	6	5	2	4	1	0
	60	42	39	25	27	22	50	46	43	29	38	49	43	23
	3	2	6	6	10	8	5	9	5	6	5	8	1	3
	43	38	38	31	45	41	34	28	32	24	24	42	37	10
	23	16	25	37	45	43	26	29	28	25	25	36	21	15
	64	39	55	20	30	21	31	49	64	48	52	34	48	17
	71	40	75	27	39	25	69	64	96	47	65	47	77	36
	1	2	6	1	2	2	1	4	3	0	0	0	4	4
	124	94	125	54	58	33	56	77	93	60	66	74	134	22
	85	46	69	31	47	44	52	40	40	38	64	55	42	6
	0	0	0	0	0	0	1	2	0	2	3	0	0	0
	15	18	20	12	32	23	22	20	16	21	33	37	36	49
	49	33	45	17	26	9	16	13	19	15	21	25	44	68
	37	26	34	36	47	23	27	23	13	22	27	24	49	100
	2	0	2	5	7	3	6	1	1	5	5	1	8	51
	39	27	35	42	50	38	45	55	42	56	53	77	83	64
	24	19	18	24	25	13	9	9	5	5	10	28	31	18
	8	2	7	3	8	4	12	10	6	8	9	17	33	20
	6	16	20	11	11	18	16	16	11	12	17	38	22	10
	50	60	50	54	49	47	56	53	38	63	94	100	115	35
	773	**596**	**779**	**518**	**637**	**472**	**643**	**599**	**606**	**531**	**683**	**742**	**947**	**605**

ORDERBOOK BY SECTOR (NUMBER OF VESSELS)



ORDERBOOK (DWT) BY BUILDER REGION



RECRUITMENT

NAVAL ARCHITECTURE EMPLOYMENT REVIEW 2021

By **Mark Charman**, CEO, Faststream Recruitment

During the summer of 2021, Faststream Recruitment conducted an extensive, global survey. We connected with thousands of naval architects and marine engineers to gain a unique insight into their views, thoughts, and feelings about the future of work. The pandemic continues to impact the world and we have uncovered the trends that have been created by it.

The tides have turned in the battle for retention

Over half of all naval architects told us they are seeking new jobs in the next 12 months. This leaves many business leaders in the predicament of potentially having to rehire half of their naval architecture workforce. But the motivation to change jobs has shifted dramatically from 2020. Of those seeking new jobs in 2020, 63% cited that they were concerned about their job security. In 2021, a mere 4% were motivated to search for a new role because of this concern.

So why are they seeking new jobs this year? The top answer from all global respondents was career progression (44%), followed by better salary and benefits (24%) and better work-life balance (17%). This was an encouraging change in motivation from the previous year. Job seekers wanted to improve their careers and achieve progression rather than carrying concerns that their jobs were at risk.

In my experience, securing promotions and being offered new challenges is at the heart of why many individuals do what they do. Take away a structured career path with clear and specific roles, promotion criteria and benefits, and there will always be a danger of losing these ambitious people to businesses who can offer it.

Of the 46% of respondents who were not looking to change their job in the next 12 months (2% of all respondents stated they were retiring), we wanted to find out what was making them stay with their employer. Work-life balance was voted at the top (28%), followed by a clear progression path with their current employer (23%) and the salary and benefits they were being offered (17%).

Businesses that can offer their employees good work-life balance are winning in the war for talent. Not only can it help attract the best and brightest new recruits, but it can also help to retain them. Allowing employees to work to live, rather than live to work, creates loyalty. Flexible working that embodies popular work practices such as remote working and flexi-time allows employees to fit their work schedules more effectively around their lives.

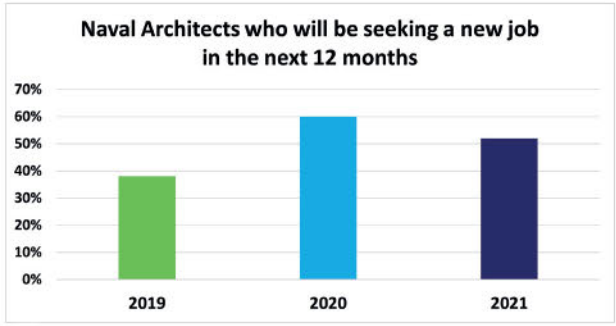


FIG 1: THE PERCENTAGE OF NAVAL ARCHITECTS GLOBALLY WHO WILL BE SEEKING A NEW JOB IN THE NEXT 12 MONTHS – 2019 TO 2021

Employees want shared values

For the first time, we asked naval architects how important an employer's policy on diversity and inclusion was to them. 82% agreed it was either important or very important. 63% of female Naval Architects rated it is as very important, whilst only 40% of males felt the same. It's understandable that in a traditionally male-dominated field females would be more passionate about seeing diversity and inclusion in a business. Many business leaders are now actively trying to attract a more diverse workforce, and this includes a better representation of females across the business.

A naval architect in North America commented on this question and summed up the importance to many in the profession: "All factors being equal, diverse teams offer more varied viewpoints that will ultimately lead to better outcomes for employees and customers."

We also asked how important it was that the respondent's values match with a new employer's. This was more important than diversity and inclusion across all respondents, and 94% agreed it was either very important or important to them. A naval architect working in Europe remarked: "Company cultures can be toxic if you do not share the same values. It is of the utmost importance that everyone's values align to ensure a better experience for all stakeholders."

Re-prioritising employee benefits

The pandemic has created a re-prioritisation of employee benefits. Whilst traditionally many employees and job seekers were attracted to employers who offered better monetary benefits, we have seen that this year, it has switched to an increased prioritisation to lifestyle benefits. We asked, 'What would the top three most important benefits be to you in your next

job?'. Flexi-time and remote working were voted top across all respondents. 49% of both 25 to 34 year olds and 35 to 44 year olds rated flexi-time at the top. Remote working was the most popular benefit for those respondents working in both the UK and North America and flexi-time came out on top for those working in Europe.

Staff events and gym memberships, though quite commonly seen in benefit packages, were rated at the bottom. This will have been impacted by the many who have had to switch to remote working and not been able to enjoy these benefits. Employees will now be seeking other value-adding benefits which we envisage is set to continue to change as new working styles mature over the next five years.

Our final question in this section asked respondents if work-life balance or salary was more important to them. 80% of respondents agreed that work-life balance was the most important. It suggests that ensuring the benefits an employer offers include ways of improving work-life balance, rather than just monetary benefits, could be a real distinguisher in the market as an employer of choice.

Future working styles

Remote working continues to be a hot topic and the future role of the office remains a popular subject in the wider maritime industry. The pandemic forced many teams to revert from traditional office-based working to a new remote working style. We found that before the pandemic 79% of naval architects were working in the office full-time, 14% were working in a hybrid style between the office and remote and just 7% were remote working full-time. When surveyed in June 2021 just 23% of naval architects were in the office full-time, 44% were remote working full-time and 33% were working in a hybrid style. Those working part remotely and part in the office averaged 2-3 days per week working in the office environment.

The pandemic has drastically changed the landscape of working styles but how do naval architects want to work in the future? 73% favoured the hybrid style. Only 15% wanted to work in the office full-time and 12% remotely full-time. It was the youngest (under 24 year olds) and the least experienced (0 – 2 years' experience) who favoured the office environment full-time, whilst those in the age groups of 45-54 years old and 55-64 years old favoured the remote working model the most. Of those who preferred the hybrid model, 74% cited that 2-3 days would be the perfect amount of time in the office. But it won't be an easy decision for any business leader to decide on the working style to offer their employees, whilst also trying to balance this out against local restrictions. Invariably whatever decisions are made may not benefit all employees or match with their preferred style.

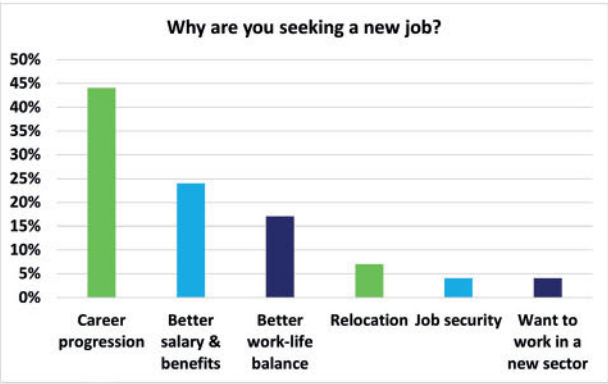


FIG 2: THE REASONS WHY NAVAL ARCHITECTS ARE SEEKING A NEW JOB IN 2021

Leadership in a post-pandemic world

Arguably the world of work has changed forever, but has this, in turn, impacted what naval architects expect from their leaders? 72% answered they believed that the pandemic had changed the way they expect to be led by their leaders in the future. That suggests it would be unwise for business leaders to think that employees hadn't changed the way they expect to be led coming out of the pandemic. I believe employees will have more impact on what leaders do and how they do it. The empowerment created by remote working is making employees more confident to speak up.

When asked what do naval architects want from their leaders in the future and what do they see as the top attributes of future leaders? 31% rated effective communication at the top, followed by integrity (22%) and honesty (13%).

These answers are creating a very clear picture of the behaviours expected from leaders going forward. Communication has risen as the top attribute due to the way many employees have had to confront adaptation and disruption propelled by new business initiatives as well as pandemic-related health concerns. Leaders who can be honest and pride themselves on their integrity are going to create employee engagement, trust and advocacy.

About the author

Mark is the CEO and founder of Faststream Recruitment and founded the company in 1999. He has a wealth of knowledge and experience in recruiting for the maritime sector globally. As a Fellow of the Recruitment and Employment Federation, he is a renowned thought leader in specialist recruitment. Mark's involvement as a speaker, panellist and writer provides a head-hunter's perspective into human factors in the workplace.

Faststream Recruitment

The Faststream Recruitment Group was established in 1999, employs over 100 people and is a global people specialist in maritime recruitment. Faststream Recruitment operates across three maritime locations in the EMEA, Asia-Pacific and Americas, servicing our customers, both candidates and clients, across the world. They source hard to find talent for clients across the globe and offer services including permanent recruitment, contract and interim recruitment, payroll services, executive search, benchmarking and salary surveys. ■

www.faststream.com

CRUISE SHIPS

SMALL LUXURY CRUISE SHIPS AND MEGAYACHTS: PHYSICAL SIMILARITIES, DIFFERENT DESIGN PHILOSOPHIES

By **Kari Reinikainen**, Correspondent

ANNOUNCED IN A FANFARE OF PUBLICITY IN SEPTEMBER 2019, SEA DREAM AND DAMEN'S CRUISE YACHT PROJECT, *SEADREAM INNOVATION*, WAS CANCELLED JUST MONTHS LATER. SOURCE: SEA DREAM

Following the entry into force of the IMO's Polar Code a few years ago, there has been a surge in orders for expedition cruise ships and cruise yachts. Many of these cater for the very top end of the cruise market and – even externally – bear a strong resemblance to large, private mega yachts.

In early 2019, Netherlands-headquartered Damen Group said that it had signed a preliminary contract with Sea Dream to build a 15,600gt cruise yacht for the Norwegian company. This would be much larger than the two 104m, 4,200gt vessels Sea Dream currently operates. However, just before the end of that year, the parties announced they had decided to cancel.

Damen is a well-known builder of megayachts, but Mark Vermeulen, director of its mid-sized vessel division, says a return to cruise ships equivalent to the cancelled Sea Dream project is not on the agenda for now.

"The cruise market – Sea Dream-like vessels – is not our focus area at the moment, given the market situation. An interesting market is the one between charter yachts and small cruise vessels. Vessels of max 36 passengers that you can charter as a vessel or per cabin," he tells *The Naval Architect*.

There are synergies between the construction of expedition cruise ships and cruise yachts on one hand and megayachts on the other, for example in the logistics and spaces, capabilities, functionalities and services onboard.

However, the commercial approach is completely different. "Small cruise vessels are very much capex and opex driven to be able to get a return on investment. A yacht is much more driven by emotion. It is the dream of the owner. For the smaller cruise vessels the big challenge is to find the right balance between functionality and the finish, against the available budget – or the maximum foreseen charter rate," Vermeulen says.

The synergies are why Helsinki Shipyard is interested in expanding its product range from small cruise ships to megayachts.

"Megayachts are often in the 100-120m range in terms of length, which is the same as the expedition cruise ships we are building at the moment. There are also lots of communalities in e.g. the crew and technical areas of both ship types," says Carl-Gustaf Rotkirch, board member of the Finnish shipbuilder.

Finland is well established as a builder of cruise ships and also of large sailing yachts, but megayachts are currently missing from the list, he adds. However, Helsinki Shipyard has a network of suppliers and contractors which are currently working on three expedition cruise liners that will

This has been a tough period for the entire cruise industry.
But our strength and resilience have **allowed us to stay close to all Ship-Owners throughout**.

The day all our ships are back at sea,
we will still be by your side.

FINCANTIERI.COM

FINCANTIERI
The sea ahead

be operated by Swan Hellenic and which could also work on megayacht projects.

There is a significant difference in how an expedition cruise ship and a megayacht project proceed. "Timetable of construction is not always nearly as important in a megayacht project as it is in a commercial project, such as an expedition cruise ship," Rotkirch explains.

As a shipyard cannot tie up its facilities for long periods with one vessel, it is important that the fitting out of a megayacht can be carried out at a berth that does not hinder other production at the yard, he continues.

On the other hand, a cruise ship builder like Helsinki Shipyard could offer a potential megayacht client a shorter than usual delivery time, as working on tight schedules is the norm in commercial shipbuilding.

"There seem to be two types of megayacht owners. Some want the vessel built as quickly as possible. They also often sell the vessel soon after completion and order another one. Others view these projects as highly personal and dedicate a lot of time to ensure that the vessel meets their expectations in great detail," Rotkirch points out.

In commercial ships, expedition cruise vessels included, both capital and operating expenditure of the vessel is high on the agenda and a way to reduce the first named is to order a series of sister ships. This is not the case on the megayacht sector, although some builders with a strong balance sheet build hulls on speculation.

These can then be sold and fitted out to the requirements of the buyer. This approach allows the yard to offer a shorter delivery time and it also means that the more capital expensive fitting out stage of the project is only carried out once there is a client who is paying for it. "Money does talk in the mega yacht business as well," Rotkirch notes.

The market for megayachts of more than 100m in length has remained vibrant in recent years, with about half a dozen such vessels delivered each year. They mainly come from builders in Germany, the Netherlands and Italy, Rotkirch says. ■

SHOULD CRUISE SHIPS SHRINK?

By **Sophie Collingwood**

Just this year, after pandemic delays, Carnival Cruise Line debuted its largest vessel yet – the 340m-long *Mardi Gras*. But do designs for larger cruise ships allow for greater efficiency, or should the sector be considering downsizing its vessels?

A spokesperson from Carnival tells *The Naval Architect*: "Today's newbuilds are more efficient than in years past as well as providing greater economies of scale across the board. The 180,000tonne *Mardi Gras*, our newest and largest ship, is one of the most innovative ships in the world both in terms of onboard amenities as well as energy usage and efficiency."

Mardi Gras is a prototype vessel and the first in Carnival's new Excel-class ship, with plans for another two to be completed in 2022 and 2023, and the company is confident that this class offers much in terms of sustainable operations. "We continue to operate ships in the 70,000-133,500tonne range, however, both of our new ships on order are 180,000tonnes. We believe that our Excel-class of ships provide the amenities that our guests are seeking as well as opportunities to incorporate sustainability innovations that allow us to minimise our environmental footprint."

Carnival highlights that *Mardi Gras* is the first cruise ship in the Americas to be powered by LNG, which provides the vessel's greatest efficiency/emissions benefit, but this is only one aspect of the company's overall sustainability and environmental efforts:

MARDI GRAS SOURCE: CARNIVAL CRUISE LINE

"*Mardi Gras* and other ships offer a wide range of innovations, including advanced wastewater treatment systems, shore power connection capabilities, and comprehensive waste management, recycling and energy conservation programmes."

Repercussions of the Covid-19 pandemic aside, Carnival reiterates that there are some major obstacles the cruise industry still faces in the sector's future: "There are two primary hurdles that we will continue to closely examine going forward – first and foremost, continuing to seek out ways to minimise our environmental footprint is a top priority while at the same time creating spaces on board that aid in dispersion of guests to make the cruise experience more enjoyable." ■

YSA DESIGN AND SHIP PLANNER FOR DIGITAL OPTIONS

By **YSA Design**

Just as the most satisfied hotel guest is one whose needs are anticipated, today's cruise guest is served by sensor technologies that control temperatures, humidity and even lighting to inspire contentment. Chatbots similar to Amazon Echo or Google Home are also becoming a fixture at sea, while wearable technology that functions as ID, room key and payment portal are now a shipboard reality.

"After Covid-19, digital technologies will become even more deeply embedded in daily life at sea, to enable tracking and tracing, Covid-19 passports and even social distancing," observes Kristian Englund, senior architect, YSA Design. Where safety is concerned, the readiness of guests and crew to engage with their own handheld devices will doubtless be used to further enhance ship hygiene, safety and sustainability messaging, he adds.

However, with attraction as well as precaution needed to rekindle cruise brand loyalty, YSA Design has also been focusing on the longer-term opportunities that digital technologies offer to heighten or create guest experiences. Englund foresees a 'new normal' involving phone apps for route finding and table availability at a preferred restaurant onboard, immersive next destination infotainment and AR enriching art installations to include "what isn't really there".

Virtually better than the real thing

It is also a future where movement sensors will work in combination with visual technology that goes beyond headsets/goggles to encompass retinal projection. Together, the techniques could create gaming or augmented daredevil memories to match or surpass 'the real thing'.

"Gaming and entertainment companies are driving the development in virtual reality and augmented reality on a global basis, and clients in the hotel and cruise shipping are adapting the technology as it becomes available," says Englund.

But backing the right digital technologies is a high stakes business for the cruise shipowner, given that a newbuilding will not be entering service for three or more years. Making the wrong call can be costly, not only because of the cost of the unsuccessful attraction, but also because its replacement will require adjusting or rethinking part of the ship's interior layout. Again, designing bar and restaurant interiors for class and chic without considering cashflow is a luxury that even the most lavish cruise ship cannot afford.

"More and more clients are asking for design input on how to optimise services, passenger flows and communication with passengers," says Englund. "They are also seeking ways of bringing entertainment to the guest location and analytics that deliver cost savings and greener solutions."

KRISTIAN ENGLUND

Ship Planner for the future

The need to stay ahead of a fast-changing game has prompted YSA Design's collaborative partnership with Ship Planner, a platform developed to bring rigour to the design decision-making required now that can accommodate what might happen later. Ship Planner provides an analytics-driven methodology for owners to consider the impact digital solutions can have at the ship design stage to assess whether technology will bring measurable benefits and how it can be integrated to best effect, Englund says.

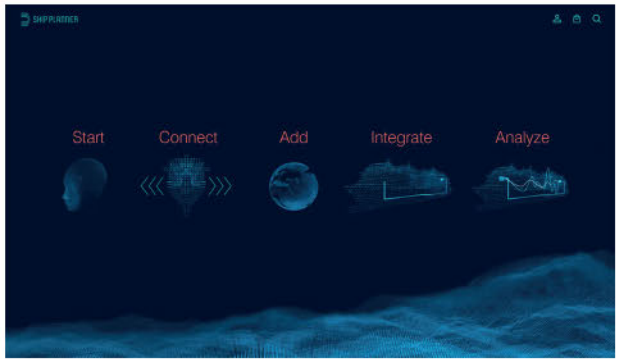
In one early pilot focusing on shipboard utilities, the core Ship Planner analysis was used to devise 'intelligent' water, air and energy management to show an owner how sensor technology would save 60litres of water per person per day and US$73,000 a year in energy use. The methodology also helped the owner decide that plans to install ionisation equipment should be limited.

With the number of cruise operators using sensors as a key tool in analysing passenger flow, both real-time and accumulated data has value, Englund points out. "From the owner's point of view, data is useful for service provision and to minimise queuing time and optimise revenue-earning time. But there is also considerable value for designers continuously seeking to improve solutions."

Ship Planner modules can also help owners explore the potential in deploying digital solutions to make best use of advanced materials, recycling and revenue planning, with Englund further emphasising the growing nature of the ship design resource.

"We can analyse the historical impact of new technology and trends, find patterns on what technologies and trends succeeded and what failed, and why. Design ideas will need to be flexible enough to adapt during the implementation process because client and technology company ideas are also evolving. We can infer what future passengers might be expecting five years after the design is set, and build flexibility into the ship's architecture for more rapid change – in technology and trends."

In a complementary development, YSA Design is currently working to integrate digitalised spatial planning techniques used by land-based architects into the Ship Planner platform.



SHIP PLANNER: AN ANALYTICS-DRIVEN METHODOLOGY FOR EXPLORING DESIGN SOLUTIONS

Data based decisions

"Traditionally, we'd use intuition and experience to boil down our design ideas for ships to a small number of options, for elaboration to the client," Englund explains. "But new tools in land-based architecture use AI to collect data from everywhere – the sun, wind, rainfall and everything that affects the structure. The platform makes millions of calculations to come up with options that consider things that even experienced architects may overlook.

Armed with the right data, Englund says, the architect has greater decision-making flexibility when considering layout, surface properties (smart materials), changes to appearance, sensors and technology integration, lighting, orientation and communication.

"The point of Ship Planner is not necessarily the technology itself, which in many ways is already there, but on how to commercialise it and make it trustworthy and safe enough for the cruise companies to share the information and recognise the value of doing so. Ultimately, the aim is to create an open marketplace to share between owners, designers and technologists, for their mutual instruction." ■

SMART SHIPS

SHIP DESIGN MUST BE FACTORED INTO THE CONVERSATION ON SMART SHIPPING

By **Tapio Hulkkonen**, Director, NAPA Design Solutions

The definition on what makes a ship 'smart' is constantly changing in the maritime industry. Autonomy, artificial intelligence technology and high-speed connectivity are regularly quoted in the maritime press and wider industry as synonymous with making a vessel smart. The rapid expansion of new digital solutions is mostly driven by energy efficiency requirements and demand from owners and operators for ways to reduce costs through optimisation.

While I do not disagree with the value and importance of such technologies in evolving the global fleet, I believe that the conversation around smart shipping must be broader – the processes, tools and consequent output of ship design also factored into the conversation. After all, can a ship really be considered smart if it is designed otherwise?

The design

Efficient vessel design is a holistic expression, incorporating the efficiency of process, methods and the subsequent ship design against its predecessors.

At NAPA, our design team constantly strives to create naval architectural solutions and pioneer new methods to ensure our users are enabled to easily collaborate and push the barriers for efficient vessel design. For example, we recently launched NAPA Viewer, a streaming platform to provide greater access to 3D model-based approval (3DMBA) to all stakeholders working on a ship design. By providing class societies, shipowners and shipyards with visibility of the most current 3D ship model via a browser, the platform accelerates the design process. Enabling designers to iterate faster, adjust more quickly to changes in the design requirements, and potentially even implement real-life performance data from other vessels.

The implementation of NAPA Viewer will therefore not only promote the use of 3DMBA, but also contribute to the wider digitalisation of the maritime industry by increasing collaboration via 3D models; an element that will be of even greater value as voyages become more data driven.

The circle of life

To create smart ships, we must work smartly – and that means that working collaboratively to measure the success of new vessels will be critical for improving initial designs and processes. Cloud-based platforms for analysing operational data, such as NAPA Fleet Intelligence, can provide us with the necessary data to do this, with the delivery of real-time voyage performance data to shipyards vital to better iterate and optimise future vessel design.

TAPIO HULKKONEN, DIRECTOR, NAPA DESIGN SOLUTIONS

We are starting to see this forward-thinking approach to creating smart ships in action. For instance, Shin Kurushima Sanoyas Shipbuilding recently used NAPA Fleet Intelligence to secure performance insights for its vessels in service. More specifically, the software is being applied to analyse data for a bulk carrier built by the shipyard. This is the first vessel to use all aspects of ClassNK's Internet of Ships Open Platform (IoS-OP), which provides the shipyard with essential insights into how its vessels are performing in real-world conditions.

A siloed approach to smart shipping will fail to deliver the fuel, time and cost savings required to ensure the future of our industry. The importance of partnership and collaboration across the industry must be recognised for its value in driving innovation.

With this in mind, we recently partnered with CADMATIC to develop an integrated, intelligent ship design solution encompassing the entire project life cycle. From naval architecture, basic and detail design, through to ship production and delivery, the data driven solution optimises ship design, engineering and production processes and leverages the power of digital transformation to streamline the design process. By effectively consolidating data, creating a greater platform for collaboration across large multi-site projects and enabling the use of digital twins from the beginning of a project, we are providing users with software to avoid working in siloes.

I believe smart shipping is the act of securing efficiencies and optimising operations at every stage of a vessel's life cycle. At the design stage, the processes, application of data and trialling of new approaches will be fundamental to us raising the bar of what is possible for efficient vessel design. ■

A FUTURE FORWARD DESIGN FOR *NUYINA*

By **Sophie Collingwood**

THE AUSTRALIAN ANTARCTIC DIVISION'S (AAD) *NUYINA* SOURCE: AUSTRALIAN ANTARCTIC DIVISION/FLYING FOCUS

The Australian Antarctic Division's (AAD) newest scientific research vessel, *Nuyina*, is set to reach new heights of intelligent voyaging in the Antarctic, designed for now and the next 30 years of research operations.

The 160.3m-long vessel is capable of carrying 1,200tonnes of cargo, 1.9 million litres of fuel and has space for 96 shipping containers in its 5,030m^3 hold. Its shipbuilder, Damen, highlights that the vessel's design is guided by the difficult weather and sea conditions it will face and ice breaking capabilities necessary for voyaging in the Southern Ocean. "The RSV *Nuyina* will operate in a diverse environment from the south coast of Australia down to the Antarctic coastline, from warm water to frozen seas and every time passing the Roaring 40s, Furious 50s and Screaming 60s to move from one to the other. Those together form the key parameters of the hull design, as it needed to be a heavy icebreaker and transit fuel-efficient with good seakeeping capabilities."

Forming the bow and hull

Nuyina is designed to outmatch its predecessor, the 94.9m-long *Aurora Australis*, and this is particularly evident in its icebreaking capabilities. As Rob Bryson, the AAD's General Manager of Assets and Infrastructure, tells *The Naval Architect*: "The *Nuyina* can break 1.65m of ice at a continuous speed of 3knots. It has a maximum speed of 16knots in open water. The *Aurora* could break 1.25m of ice at about 2.5knots, and had a max speed of 16knots. The *Nuyina*'s unique bow and hull design, however, allows it to continuously slice through the ice, unlike the *Aurora*'s backing and ramming approach."

As *Nuyina*'s shipbuilder, Damen, explains, the ship's hull is designed according to typical icebreaker guidelines, but with a bow for bending and breaking the ice layers ahead rather than crushing: "The typical icebreaker bow has a small stem angle from the waterline down to the keel. The verticals in the bow area are designed with similar angles. In the horizontal plane, the waterlines are shaped with gentle curvature until joining the parallel hull. The cross sections in the bow area are also designed with gentle flare angles near the waterline. The hull design reflects these design guidelines very well."

"When moving in ice, the sheet will be forced downward. The bending results in its failure and pieces of broken ice will submerge under the moving bow. The ship's bottom is designed with a slightly raised floor. This helps the broken and submerged pieces of ice sliding aside rather than travelling the hull length. It avoids additional hull resistance and propeller-ice interaction."

TECHNICAL PARTICULARS	
SHIP TYPE	SCIENTIFIC RESEARCH VESSEL
LENGTH (OA)	160.3M
BREADTH (MAX BEAM)	25.6M
CARGO FUEL CAPACITY	1,617TONNES
DISPLACEMENT TONNAGE	25,500
SPEED	12KNOTS (ECONOMICAL), 16+KNOTS MAXIMUM
PASSENGERS	117
CREW	32

To build a ship capable of withstanding the weather conditions in the Southern Ocean, Damen adds that the vessel has been optimised within the design constraints of an icebreaker hull and proven to behave well in heavy seas during sea trials. "In terms of seakeeping, the ship is designed so that helicopter operations can be conducted in up to sea state 3 (1.25m wave height), while davits to deploy watercraft can operate in moderate seas, up to sea state 4 (2.5m wave height). The ship can also transit at 12knots, or conduct stationary scientific equipment deployments, in rough seas, or sea state 5 (4m wave height)."

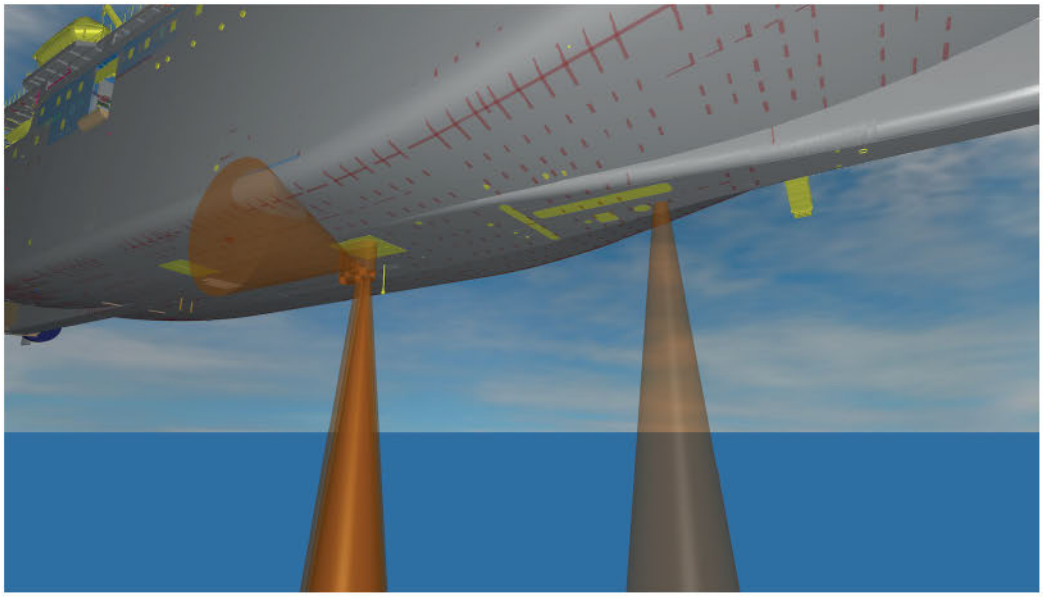
Another crucial aspect of the scientific research vessel's hull design was preventing disruption of its hull-mounted acoustic instruments, which are used for measuring the biomass of marine organisms such as fish and krill, and mapping the seafloor and continental shelf. CFD modelling was used in the design phase to optimise the ship's hull and propeller form, including a wig shaped skeg forward to guide bubbles to the side and away from the area of the ship hull's devices, such as its multibeam echo sounders. Damen comments: "Their shapes ensure any bubbles, formed as the ship moves through the water, don't interfere with the acoustic equipment. We built a 6m scale model of the vessel to conduct physical tests in facilities of HSVA that included calm water tanks, wave tanks and an ice basin. The tests focused on powering, manoeuvring, 'seakeeping' (motion response to waves), icebreaking, and bubble formation and movement."

A question of power and propulsion

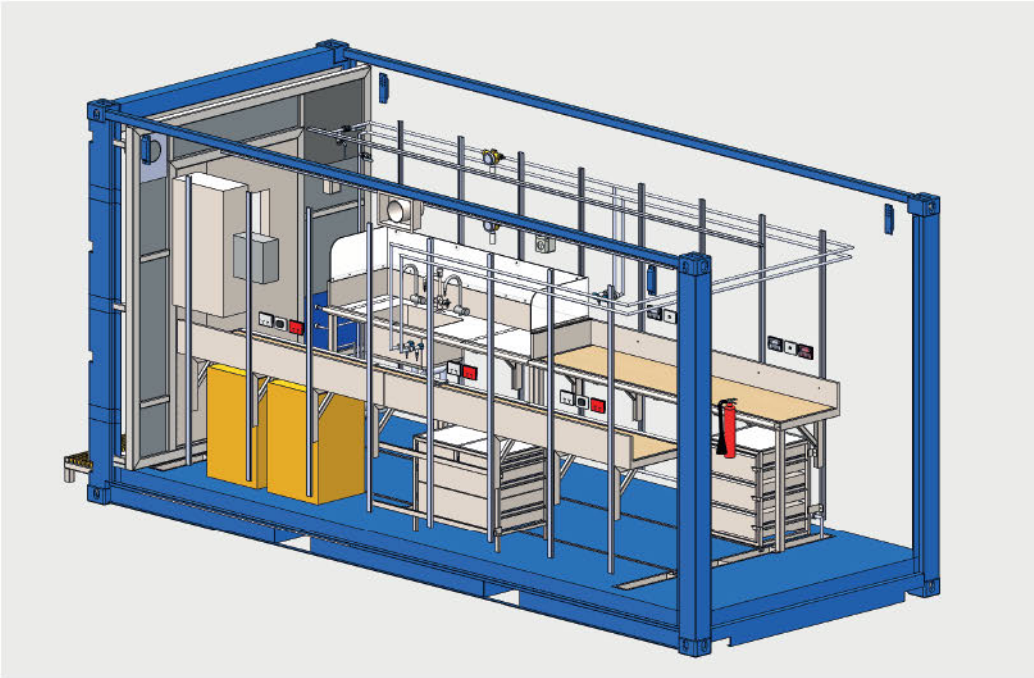
Work on replacing AAD's previous research vessel, *Aurora Australis*, began as far back as 2009, a drastically different time in shipping compared to the current market for greener and cleaner transport. It is safe to say that for newbuild ships taking to the waters today, choosing a method of power and propulsion suitable for the ship's entire life cycle is not an easy one. Bryson comments: "Design commenced as part of the Request for Proposal stage in 2013. At that stage, considerations around alternative fuel and propulsion options were not as advanced as they are in 2021. In addition, preference in working in such a remote and hostile environment as the Southern Ocean is for well understood and tested systems."

Nuyina will use a hybrid propulsion system; the ship has two MAN 32/44CR 16V engines, rated at 9.6MV, and two advanced electric drive (AED) PTIs rated at 3.7MW each, for a combined power of 26.6MW. According to Damen, the propulsion installation consists of two shaft lines with controllable pitch propellers. With a view to save on fuel consumption at cruising speed, each shaft line is driven by an advanced electric drive (AED) and so creating an optimal loading of the diesel generator sets. Each shaft line is also driven by a main diesel engine in combination with the AED, to tackle the higher powers necessary for ice breaking.

Bryson adds that this system is another improvement upon the *Aurora Australis*: "*Nuyina* has an enhanced propulsion system compared to *Aurora*, with two controllable pitch propellers driven by two 9.6MW diesel engines, and six tunnel thrusters (three at the front and three at the rear) for dynamic positioning within +/- 20 m. In contrast, *Aurora* had one controllable pitch propeller coupled to 5,500kW and 4,500kW diesel engines, and one bow and two stern thrusters."



THE HULL'S YELLOW T-SHAPED TRANSDUCERS ARE A MULTIBEAM ECHOSOUNDER, CAPABLE OF MAPPING A SWATH OF THE SEAFLOOR AND CONTINENTAL SHELF UP TO 25KM WIDE IN ONE PASS. SOURCE: ANTARCTIC MODERNISATION TASKFORCE



A MODEL OF THE GENERAL PURPOSE LABORATORY SHOWING OVERHEAD GAS LINES, WET AREA WITH SINK, LABORATORY BENCHES WITH ASSOCIATED ELECTRICAL POWER AND DATA, AND BELOW-BENCH STORAGE FOR EQUIPMENT AND CHEMICALS. SOURCE: STEVE WHITESIDE/ AUSTRALIAN ANTARCTIC DIVISION

Dynamic positioning is of particular importance for *Nuyina*'s operations, Bryson comments: "This (dynamic positioning) allows the ship to continue operating in bad weather (40knot winds and big seas). This means we can continue doing scientific research or a station resupply without having to wait for the weather to improve. It also means if things go significantly wrong – if the ship loses an engine, a switchboard or a motor – it has at least 50% reserve power and it can stay in position with its spare thrusters holding it. This ensures a high level of safety in whatever operation is being undertaken."

The future of research

The ship is, first and foremost, a scientific research vessel, and Bryson highlights that one of the key decisions to equip *Nuyina* for the future was its laboratories' design. "During *Nuyina*'s design process, the AAD engaged with in-house and external national and international Antarctic experts, to look at what research the ship needs to support now, and what flexible design features it needed to support new research and technologies across its 30-year life span. One of the key ways of future-proofing the ship has been the move to containerised laboratories, in addition to more traditional fixed labs. Six containerised science modules are an integral part of the ship's design."

These science modules include a general purpose laboratory, a temperature controlled laboratory for temperature-sensitive experiments, an explosive gas laboratory for the use of hydrogen, two aquaria for krill and fragile marine organisms, and a plant container for the aquaria mechanical equipment.

The ship can support 24 containers (including these science modules), Bryson explains, which all feature standardised service interfaces that connect to pipes and cables on the ship and provide power, water, vacuum and air directly to the modules. Thus, providing flexibility onboard: "The modules provide a 'plug and play' capability in that they can be pre-configured for different needs before they're loaded on to the ship. They can then be plugged directly into the ship's power and alarm systems via their standard service interface."

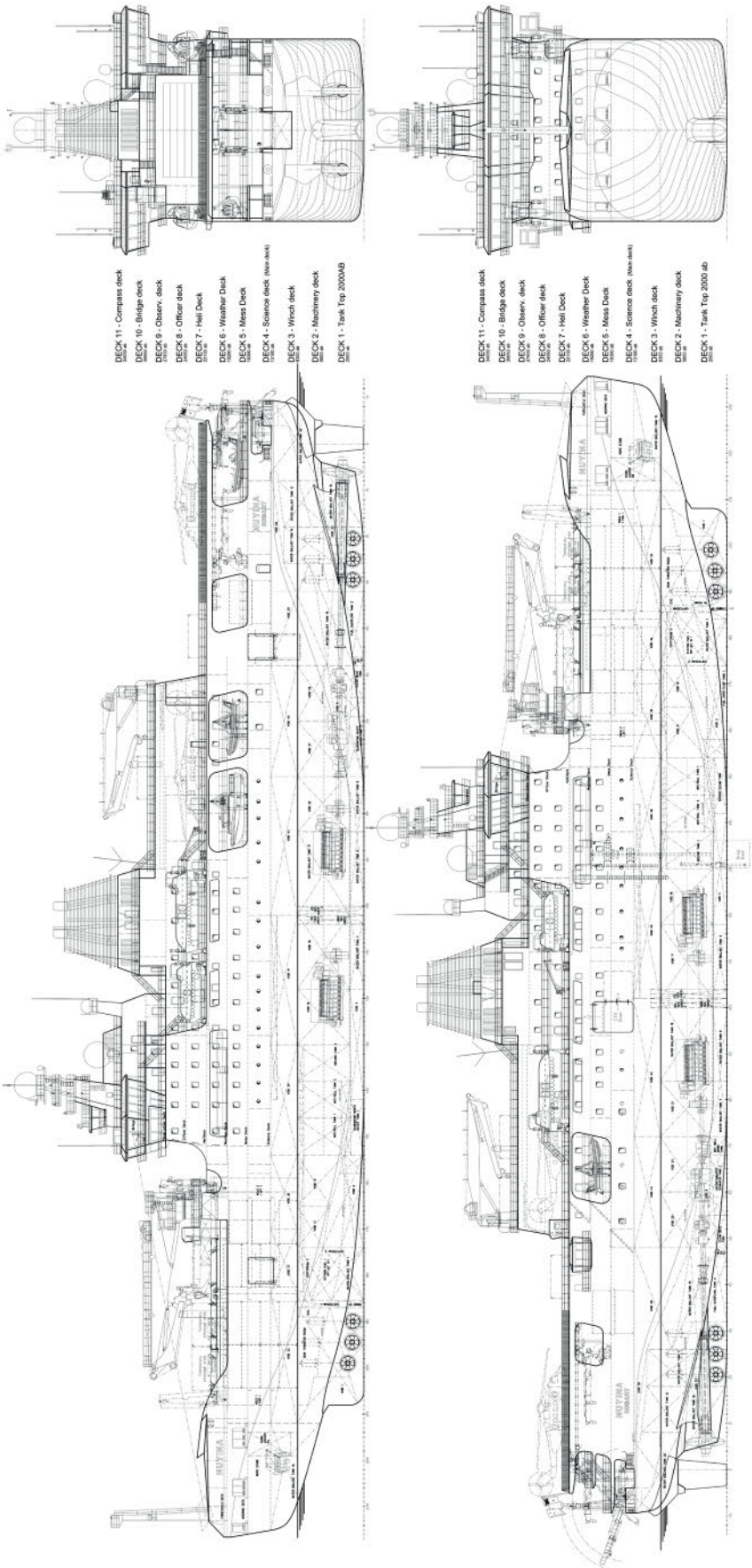
Bryson adds that, in particular, the aft science deck provides support for 11 20ft containers including the six science modules, and six 10ft containers, which are adaptable for new and emerging types of research: "These containers will house specialised scientific equipment, and many have services for laboratories of the future – negating the need to build specialised laboratories into the ship for research that hasn't yet been conceived."

Handling data

Four fibre optic tow and instrument cables will be used onboard *Nuyina*, which include copper wiring to deliver power to cameras, lights, submersible vehicles, acoustic net releases and other instrumentation. Their other purpose, transferring data at speeds of 12Gigabits per second and providing scientists with real-time data and high-resolution video of the Southern Ocean sea floor and water column, down to 6,500m.

Further to this, the ship will be processing large amounts of data fed through onboard sensors and scientific deployments, and Bryson highlights that the ship's project team has developed a science data management system to cope with this: "This logs data in real-time and stores it in a database for future use. The information can be projected across screens throughout the vessel so scientists can monitor the progress of deployments (such as how close something is to the sea floor), and also see any useful context data (such as currents or temperature) associated with their deployments. This information can also be pushed out to PCs and mobile devices, so that people can move on to other tasks while they wait, but still have the ability to make decisions on the fly." ■

GENERAL ARRANGEMENT OF *NUYINA*

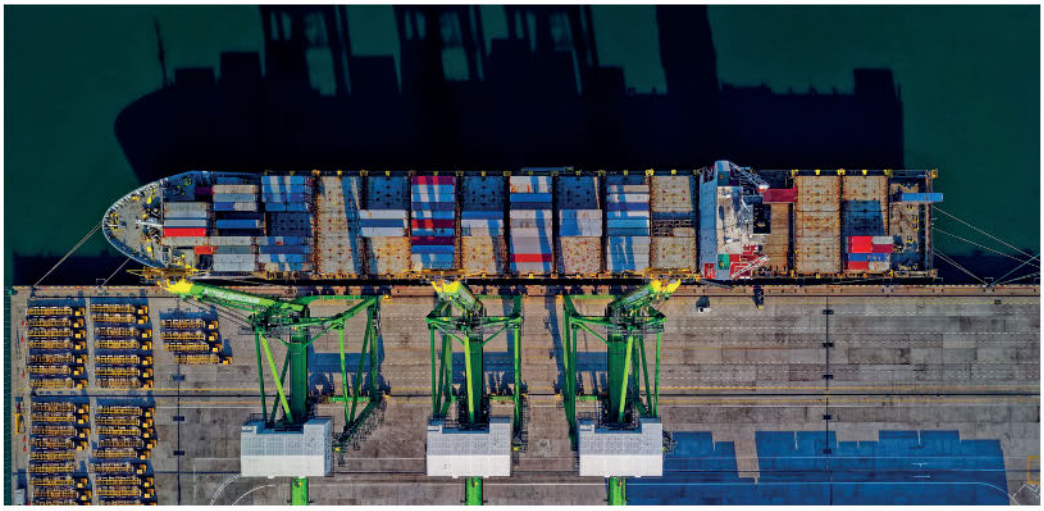


CHINA

SUBVERTING SHIPBUILDING AT THE DOCK

At CSSC Huangpu Wenchong Shipbuilding's 100,000tonne dockyard, a digital dock system is being built and a 3D-printed ship is under trial

By **Ship Economy & Trade**



SOURCE TOM FISK

Such scenes were once reserved for science fiction movies; components built in three-dimensional space closely complemented by 3D graphics on the screen, each action and movement accurate to the design. Today's 3D printer is more like a small digital factory, building materials into the ideal shape according to design drawings. So the goal of 3D printing a whole ship might not be that far away in the future. But how do you expand the 3D printer exponentially to become a 100,000tonne dock, where each section, like a printed material, can be accurately put in place and every move is under precise control?

CSSC Huangpu Wenchong Shipbuilding Co., Ltd., a subsidiary of China Shipbuilding Group Co., Ltd., (CSSC) has been tasked with the challenge of building such a digital dock system.

Bridging dispersed production and digital system

With the continuously developing sophistication of the manufacturing industry, intelligent shipbuilding has progressed from the popularisation of office automation (OA) and design digitisation, into online manufacturing execution systems (MES) and artificial intelligence (AI) networking. That is, advancing from the digitisation of production aspects to the digitisation of production management and production process.

But given a ship section workshop is still considered a relatively closed environment – and the blanking group assembly and intermediary assembly can also be carried out under the monitoring of intelligent production equipment – how can separate production activities at a group site spanning tens of thousands of metres, at a 100,000tonne dock, or even along a 1,800m wharf shoreline, be realised through the use of a digital dock system?

Recently, using accuracy analysis software monitoring, a 120,000tonne bulk carrier and 2,700TEU container ship from Huangpu Wenchong successively completed in-dock mooring to industry standard accuracy, greatly improving operational efficiency. This successful debut of the digital dock shows that the system is both reliable and advanced; a bridge has been established between the of 100,000tonne dock produced in the real world and the digital system in virtual data.

Chief operator Dai Xiaoming, of Huangpu Wenchong Shipbuilding Loading Department's third division support operation zone, is the lead planner for this technology. "Have you ever played computer games? The running movement of characters in the game is actually a series of changes to 3D coordinates. The same is true of digital docks," he explains.

The dock's 3D coordinate system is formed in the virtual system through permanent coordinates set at the dock side, establishing a digital dock. Then, through several measurement and control points set up at dockside, a real-time 3D measurement and control network is established. This is equivalent to installing a 3D scale on the dock, which can collect the 3D coordinates of the dock's sub (total) sections at any time, and all data can be obtained by one measurement. Thus, the dock's 3D coordinate system and the corresponding coordinate system of the ship's 3D design model are unified. Through the comparison between the pre-set coordinate points

ONE OF CSSC HUANGPU WENCHONG SHIPBUILDING'S DIGITAL DOCK MEASUREMENT AND CONTROL POINTS

and the actual coordinate points, rapid positioning, comparisons and adjustments can be realised, and the ship is loaded in sections like building blocks.

The digital twin

According to reports, the digital dock system actually draws inspiration from China's high-speed railway tunnel control network. Across China's complex terrain and diverse landform, the construction of high-speed railway tunnels overcame several obstacles; ship structure and sectional cabin layout are equally complex.

Through the establishment of a 3D measurement and control network of the dock, the dock's digital coordinate system is formed. Hence the ship loading survey can be taken with unified coordinates, which avoids cumulative errors caused by the inconsistency of measurement base points and improves positioning accuracy.

"Today's digital dock is not 'complete'," Xiaoming says, adding that: "When characters are in a game, their movement data is automatically displayed. The next step for the digital dock will also be to develop automatic tracking." There are plans to set up automatic sensory light targets on the sections, and realise automatic real-time display of entire section coordinates through cooperative operation of multiple devices and real-time data transmission via 5G communication. Through the comparison between the dock 3D coordinate system and the ship design's 3D model coordinate system, the sub (total) section loading is faster, more accurate and can even make some loading processes that were impossible to use in the past become a reality. The fact that the 3D measuring of all data can be obtained in one measurement also greatly reduces the workload relating to ship loading data measurements.

When the data is imported into the system, no matter whether you are the designers in the design centre, the managers in the office, or even the project leaders on business trips, with handheld terminals – mobile phones and computers – you can get instant information at any time, and can know the real-time and accurate production trends in the dock at any time, and guide, adjust and manage them at any time. ■

A version of this article was originally published in the Chinese publication 'Ship Economy & Trade'

CCS CHARGES AHEAD WITH BATTERY TECH IN MARITIME

By **Charlie Bartlett**, Contributor

YANGTZE RIVER THREE GORGES 1, THE WORLD'S LARGEST PURE-ELECTRIC CRUISE SHIP, IS CURRENTLY BEING BUILT BY WUXI SAISIYI ELECTRIC TECHNOLOGY CO

Decarbonising the world's capital of heavy industry and manufacturing is easier said than done, but fortunately, China is wasting no time in the doing. Here, where the scaffolding of the global green revolution will actually be made, decarbonisation necessarily requires a pragmatic approach. For example, this might mean using a battery-powered barge to carry coal to power stations, removing one billowing smokestack from the equation in the process. 'Green credentials' are one thing; but green results are better.

Chinese companies today hold an 80% share in the production of battery raw materials, and its unrivalled ability to scale up means not only that is it liable to maintain its leading position for some time but also advantageous for the local application of these technologies.

"In China we have a lot of major battery manufacturers, like CATL, BYD and EVE that make these readily available for ship use," says Huang Zhaoxia, battery innovation lead marine at China Classification Society (CCS). "But the initial high cost of batteries is the main factor slowing the development of battery powered ships. Though the car industry has switched over to battery-powered manufacturing, which brings the price of batteries down, batteries are not as easy to deploy in ships and cutting costs is harder. This is because the battery capacity related to ship propulsion power and sailing distance is so much greater in ships compared with cars. But if we take the operating expenditure of ship life cycle into account, in some segments of maritime, batteries have a price comparable with conventional ship power. For example, earlier this year this was RMB4,000/tonne for diesel oil and RMB0.7/kWh for batteries, making the operating expenditure very comparable."

The demand contribution from the car industry is assisting China's battery production and bringing down the cost so that, in due course, the maritime industry may provide another boost as well. But, Dr. Huang reports, the automotive segment is doing more to benefit electrified shipping than just putting its thumb on the scale.

"Compared with the conventional ship power system, the electric propulsion system eliminates the need for gears and shafting, which saves space and the service and maintenance costs in electric drivetrains are much lower than with oil parts," she says.

"The bearing has to be lubricated, coolant water is changed once a year, and the heat exchanger is maintained once every two years. The bearing is replaced once every 10 years, and the terminal inverter is maintenance free throughout its life cycle. But the lifespan of the batteries is a lot shorter – but more predictable – than with internal combustion engines. In terms of operating expenditure, battery-electric systems represent a distinct advantage. But this is all quite different to the way that traditional shipping has worked."

Health and wellbeing

CCS is putting considerable resources into researching how best to manage batteries, and get the greatest performance and lifespan out of them. Fire safety is an unavoidable concern after a number of high-profile cases, including in early August, when a battery container caught fire at Moorabool, Australia.

Electric car manufacturers have argued that this is a matter of skewed perception. Tesla, for example, says that gasoline-powered cars experience fires for every 19 million miles travelled, versus every 205 million for electrics.

However, CCS says it is not only considering the probability of risk but also the consequences which are different at sea than road given the number of crew, the value of the ship and its cargo. "We have seen some incidents in the automotive industry and also at power storage stations," says Luo Xiaofeng, director of CCS Rules & Research Institute in Wuhan. "For this to happen to a ship, for this danger to be faced by people onboard. That is unacceptable."

Whatever the likelihood of their lighting in the first instance, it is certainly true that battery fires are more difficult to put out. "If you are onboard when a battery fire occurs, traditional firefighting will not be sufficient," says Luo. "Safety measures must go further. For shipping we have an extremely stringent quality requirement, higher than in automotive or in land-based energy storage. The personal fatality probability should be less than one in a million."

"We have united with scientists, manufacturers and designers, and are working extensively to address this issue, and to be able to properly quantify, check, and monitor battery health. We are working on solutions which will inform crew members on battery health at a glance and notify them well before any problem arises."

Point-to-point

He Tun Hao is a 2,000dwt barge, which carries cargo to coal-fired power stations along the Pearl River. The vessel couples banks of lithium-ion (li-ion) batteries with supercapacitors, adding up to a total energy capacity of 2,400kWh – which CCS points out is in the order of 40 vehicles from one of China's main all-electric car manufacturers, BYD.

Over the course of normal operation, the vessel calls at the power stations, and is supplied with

LUO XIAOFENG

charge via shore-power installations while offloading its cargo. The power is supplied directly from the stations themselves.

This operating profile is enabled by the application of supercapacitors in the vessel design. Supercapacitors are no good at holding charge long-term in the same way as the li-ion batteries do, instead, they confer the ability to charge and discharge rapidly. On land, for example in electric cars, supercapacitors are used for regenerative braking, thanks to the ability to transfer vast amounts of power near-instantaneously. This shortens the charging interval for the vessel, enabling it to fully recharge from empty in 10 seconds to 10 minutes.

While the current that drives *He Tun Hao* is derived from coal, there are considerable advantages to using an electrically-driven vessel to deliver the fuel. The most notable is the advantage in terms of operating expenditure, since electric propulsion is far more efficient for applications that involve manoeuvring – for the same reason that the vast majority of offshore vessels are diesel-electric. It performs its dockings with the same two 160kW omnidirectional propellers that it uses for propulsion underway.

But there are reductions in terms of carbon emissions as well, since land-based powerplants – without limitations on footprint, weight, or the ratio of propulsion equipment to cargo carried – can afford much more advanced waste-heat recovery equipment, and often district heating, which brings total efficiency up beyond 85% versus a ship's maximum of 45%. Latterly, it will also be possible to sequester carbon – something likely much further over the horizon for waterborne craft.

JUN LV HAO

THE JIUQUAN WIND POWER BASE SAID TO GENERATE ENOUGH POWER FOR A SMALL NATION

Meanwhile, taking HFO out of the equation means the elimination of sulphur, particulate matter, NOx, and other locally-harmful pollutants from the vessel. In fact, reducing emissions of these compounds in recent years, in no small part by placing new, stringent limits on shipping, has meant that China's cities have dropped out of the top-15 most polluting cities according to the World Health Organisation.

Rest and recharge

All-electric passenger ships are altogether more challenging, since they require enough lighting, heating, and power to support those onboard, while leaving adequate energy for propelling the craft. Nevertheless, development is going ahead, as moves towards emission-free waterways in China and areas of Norway suggest that there will soon be major demand for these types of vessels.

Jianglong Shipbuilding Zhongshan Science and Technology Park is currently working on a twin-hulled, 486-passenger river cruise-ferry, which will feature two banks of li-ion phosphate batteries, together amounting to 2,914kWh. The vessel will have onboard dining, necessitating heat for cooking food, as well as a panoramic window arrangement permitting near total-visibility either side for sightseeing.

Meanwhile, CCS also participated in the design and construction of an all-electric monohull sightseeing vessel for operation along the Yangtze River called the *Jun LV Hao*. The 53m ship is designed to support 300 passengers and is able to run at 7knots for a duration of eight hours before recharging.

In terms of the energy mix for these vessels, each ship would be charged using municipal energy, which comes from a combination of sources including fossil fuels. However, Luo says even the fossil-fired energy sources benefit from increased efficiency, providing an emissions reduction right away, but that over time the vessel will benefit from China's shift toward renewables.

"All this power getting from the grid, the power is mixed," he explains. "Some power stations use coal, some use oil, some LNG – but some use hydropower, our windfarm capacity is growing very fast, and, increasingly, many use hydrogen as well. But the advantage, of course, is when we calculate the carbon footprint, we can say categorically that none are from the vessel itself – it is exclusively from the power industry."

In China, that industry is no slouch. This year, the country completed construction of the world's largest single windfarm in Jiuquan, in the province of Gansu in the Gobi Desert, with 10GW installed. Meanwhile, an offshore windfarm under construction off Yangjiang, in Guangdong Province, surpassed 1GW in July. Wood Mackenzie has forecast that China will add 408GW of on- and offshore wind energy by 2030.

China's Tengger Desert is also home to the world's largest solar plant, which amounts to 1.5GW. China brought 40GW of solar power online in 2020, up from 30GW in 2019. Presently, around 60% of the world's solar panels are manufactured in China, and the government said in December that it is currently targeting 1,200GW of solar and wind energy by 2030. It has also said that its primary energy consumption should comprise 25% non-fossil energy – renewables, biomass, hydroelectric and nuclear – by the same date.

Further, by 2030, China will compel regional grid firms to buy at least 40% of power from non-fossil fuel sources, Reuters reports. This means that the percentage of renewable energy available for powering China's all-electric inland waterway vessels will increase dramatically over time.

The here and now

Decarbonising river and inland waterway traffic, Luo explains, need not necessarily be undertaken with a view to electrifying deep-sea tonnage, but rather, as a worthy goal in itself. While he does not discount the possibility of all-electric merchant ships far in the future, for the time being, fully electrified inland waterway traffic has a vital role to play in meeting China's infrastructure, transport, and tourism needs today – regardless of what its development may enable in the future.

"For the high seas, we will still have to see how we can mix together the available solutions to solve some of these problems," he says. "But for inland waterways, batteries are an obvious solution, since there are predictable schedules and loading/unloading intervals, and plenty of opportunities to recharge along the route.

"It is likely that electrifying ocean traffic will make major strides thanks to the research we are doing today. That is wonderful, but it is not our focus. We are looking at how developments can be made immediately, to decarbonise in the here and now." ■

CRANES, DECK & CARGO EQUIPMENT

SENSOR TECHNOLOGY PROMISES SAFER, SMARTER MOORING

By **Richard Halfhide**

Onboard and ashore, accidents during mooring operations are one of the biggest causes of marine accidents. Figures published by the European Harbour Masters' Committee indicate that 95% of personal injury incidents are caused by ropes and wires, with 65% of these injuries occurring during mooring operations. Predictably, it's an ongoing source of concern for the maritime industry and new guidelines aimed at improving mooring safety for all ships are due to take effect from 2024.

Magnus Dickens, venture lead for the Open Innovation division of equipment supplier Wilhelmsen Marine Products, says reading through the numerous accident investigation reports and insurance claims relating to mooring line incidents was one of the worst aspects of his job. The forces unleashed when a mooring rope fails and recoils, snap back, are often fatal for any crew, passenger or longshoreman who should be in the way.

But, in recent years, a new generation of mooring technologies is creating the possibility not only of gauging rope tension as a warning system to ensure working load limits are not being exceeded, but also collating that data to develop a better understanding of the stresses involved and how it is likely to affect a rope's behaviour and rate of deterioration across its lifetime.

One such solution is Wilhelmsen's Smart Ropes system, which earlier this year won the Maritime Safety Award from the Royal Institute of Naval Architects and Lloyd's Register. First launched at the SMM trade exhibition in 2018, the Smart Rope is a patent-pending battery-powered weatherproof measuring unit that's embedded into the mooring rope itself and transmits key tension, time and temperature information wirelessly back to the bridge or cargo control room to serve as a decision support tool. The product, which weighs just under 1kg and could in theory be used with any 12-strand mooring rope, is currently undergoing its final round of testing onboard a select number of vessels, ahead of full commercial rollout in the near future.

Dickens tells *The Naval Architect* that while there are other sensor-based mooring products, the Smart Rope appears to be unique. He says: "There are some automatic winches with auto tension, but this is more of a theoretical calculation based on the rope diameter and turns of the winch. People don't trust it and it's not that accurate.

"At the other end of the spectrum are the more traditional load cells on the bollards, which you see at some LNG terminals and permanently moored vessels. The problem with these is that the data and the history resides with the port or terminal who operate the bollards, and we think it needs to lay with the vessel, because the real value comes when you can combine this data from multiple port calls and aggregate that.

THE SMART ROPE. SOURCE: WILHELMSEN

"That's the other half of the equation; you have the alarm and safety factor but the eternal question is how long the rope will last and when it should be changed. That very much depends on the life of the mooring rope. The high peak loads will deteriorate the mooring line but it's not always visible."

The benefits of such aggregation can be demonstrated by the example of data collected over a four month period from a vessel with Smart Ropes installed. It was found that for more than 50% of the time two ropes were being used at just 5% of their minimum breaking load (MBL). However, the same two ropes had a high peak load every time they left a specific port, implying that, against guidelines, they were being consistently used to manoeuvre out of port. This would reduce the two ropes' lifespan while other ropes were being underutilised, yet all the mooring ropes would be changed on the same predetermined schedule.

Target markets

Wilhelmsen is focusing its efforts on three segments of the merchant fleet where it sees greatest opportunities. One of those is passenger shipping, where safety is a priority. Last October, it announced that Viking Cruises and ro-pax operator Finnlines had both signed up to trial Smart Ropes and complementary digital mooring solution aboard selected vessels.

At the other end of the spectrum are dry cargo ships, which often berth at very exposed ports where there are large tide variations and draught differences as a vessel loads or unloads, demanding a reliable mooring solution. "What's interesting here is there is pressure not only from the vessel owner but also the terminal, because every time they have an accident – even though usually it's not serious human injuries – a rope parting causes delays. So the ports are incentivising this new technology," says Dickens. Shipowner Berge Bulk has been participating in the pilot studies.

The third segment, and the one which Dickens admits is the most difficult to crack, are oil and gas tankers. He comments: "One of the reasons we haven't done more in that segment is the electronics onboard a tanker vessel have to be specially approved to ensure it's intrinsically safe and can't cause a spark or anything like that. But that is something we're looking at because it's a very interesting market."

Standardisation

While the Smart Rope sensor itself is a sophisticated piece of technology, effectively developed from scratch in collaboration with an engineering partner (Hugg), the real challenge has been developing the system for transmitting the data. Dickens explains: "As well as the sensor there's the IoT [protocol] stack to consider, with an edge device processing the data before it can be displayed to the user. What started as a very narrow focus on getting the sensor working expanded into the entire IoT system.

"We hear a lot of talk in the industry about the IoT but there's very little standardisation. Some of the big players like Kongsberg and DNV are coming up with application and IoT platforms, although it's too early

MAGNUS DICKENS

to say who will be the big winners. That will make it easier for us to focus on the specific user case we want to solve, which is of course the rope safety, and not necessarily tackling the infrastructure."

Dickens is confident that they are now at the stage where the Smart Ropes system is robust and scalable. Much of the focus of the current round of testing is on the system's user interface and gathering feedback from the seafarers who are using it on a regular basis, in order to develop a better understanding of their experience.

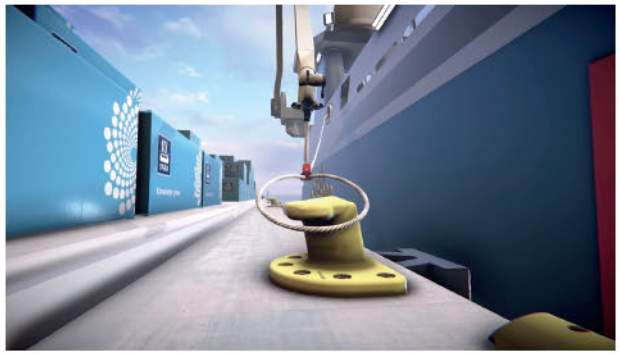
Further ahead, the hope is to begin serious data analysis to the project and gain a deeper insight in mooring rope durability. "We see a lot of potential in understanding better, especially for developing lifetime models of the rope. We have ambitious plans to put this into the system and learn more about the rope's behaviour, how it deteriorates and when it should be replaced. Until now such research has been based on idealised test benches in laboratories." ■

CARGO SHIPPING BOOM OFFERS 'GREAT OPPORTUNITIES' FOR MACGREGOR

By **Richard Halfhide**

It's hard to avoid the resurgence taking place in container shipping at the moment, whether that's soaring freight rates or a glut of new orders. With that comes a demand for improved cargo stowage and loading solutions from equipment suppliers such as MacGregor. But boxships are just one segment in the global fleet that's hungry for innovation as the world slowly returns to a post-Covid normality.

"Containers are a great opportunity where we can offer total solutions when it comes to hatch cover, the lashing bridges and all sorts of lashing gear and so forth," Magnus Sjöberg, head of MacGregor's merchant solutions division, tells *The Naval Architect*. "But we also see good opportunities in the general cargo segment, in terms of how to improve the utilisation of the cargo holds and get more cargo into them. Deep-sea ro-ros, car carriers and PCTCs are picking up as well."



MACGREGOR'S AUTOMATED MOORING SYSTEM FOR *YARA BIRKELAND*

"Of course every vessel is a kind of prototype and there's a lot of close development with the owner, consultant and yard on how to improve the cargo hold and get an efficient flow onboard and off of the

OPTIMISING BOXSHIP SOLUTIONS

Until such a time as there are standardised ship designs, and don't hold your breath, pride and competition between shipowners are always likely to stand in the way of truly optimal solutions. "Everybody wants to do things their own way and thinks they know best... so [there is no] sharing of information and accepting certainly industry standards that are good in practice," says Tommi Keskilohko, MacGregor's head of cargo stowage solutions.

Nevertheless, shipowners do have a common need for ship designs which fit their cargo plans. When it comes to container ships that might mean predominantly 20 or 40ft containers, carrying light or heavier loads, for short or deep-sea voyages. From there, says Keskilohko, developing a cargo solution is a backwards process. "We look into hatch covers, lashing bridges and the lashing system alternatives. Then we create a specific case study and use software to simulate the real life operations."

While there are certain rules of thumb – a 20,000TEU vessel is more likely than not going to be employed on an Asia-Europe route – most shipowners want designs that are flexible enough that they can change those trading patterns in the future. As a company almost unique in being able to provide all key elements of the cargo system, Keskilohko says MacGregor is able to mitigate potential situations such as hatch covers that might allow for more cargo but are limited by the lashing system. While larger vessels are likely to have more varied loading scenarios, and with a range of different lashing patterns, in practice the main principles are broadly the same regardless of whether a vessel carries 2,500 containers or 20,000.

Keskilohko was reluctant to be drawn too much into the ongoing debate concerning container ship safety, but believes it's predominantly three factors: crew and stevedore training, mis-lashing of the containers, and misdeclaration of the weights. MacGregor is helping industry efforts to tackle the problem by participating in TopTier, a two-year multi-partner project led by Netherlands-based research institute MARIN, which is investigating the reasons behind such incidents and what might be done. We will have further coverage of TopTier in next month's *TNA*.

ship, but also how can you store the different kinds of cargoes, like cars, high-end heavy and project cargo."

Unsurprisingly, the trends at the forefront of MacGregor's thinking at the moment are automation and connectivity. It is currently developing a system for monitoring overloads on mooring ropes and chains using automated winches for load sharing, reducing the strain on individual ropes. Sjöberg says the next step will be to further enhance this data from the wind and wave forecasts to enable more effective planning of anchoring and mooring.

The company also is one of the key partners in the *Yara Birkeland* project, which will eventually see the entry into service of the world's first autonomous container ship and for which MacGregor is providing the vessel's automated mooring system. Although Covid has inevitably led to delays on such a complex undertaking, it should begin its operational life very shortly.

Another project that has been hindered, first covered by *TNA* in November 2018, is MacGregor's self-discharging bulker crane, a collaboration with operator ESL Shipping. Sjöberg says that it's still not been possible to set the cranes up in full autonomous mode, although this is expected to take place in the near future. He adds that the same technology is being explored for a couple of R&D projects in the container segment and that several other customers have expressed an interest. Furthermore, it is also working closely with fellow Cargotec subsidiary Kalmar to find synergies in the automation of port operations.

In 2019, MacGregor launched its performance monitoring and predictive maintenance service OnWatch Scout. "It's an important tool for us and helps the owners, but in the data we gather we see a lot about how the owners and operators use our equipment. Sometimes we see that they overload our equipment to some extent and don't use it as it was specified," Sjöberg comments. However, while it has seen a steady uptake among more progressive shipowners, he admits there are plenty not willing to pay the additional cost of connectivity, despite the advantages a proactive approach can bring in terms of reduced downtime.

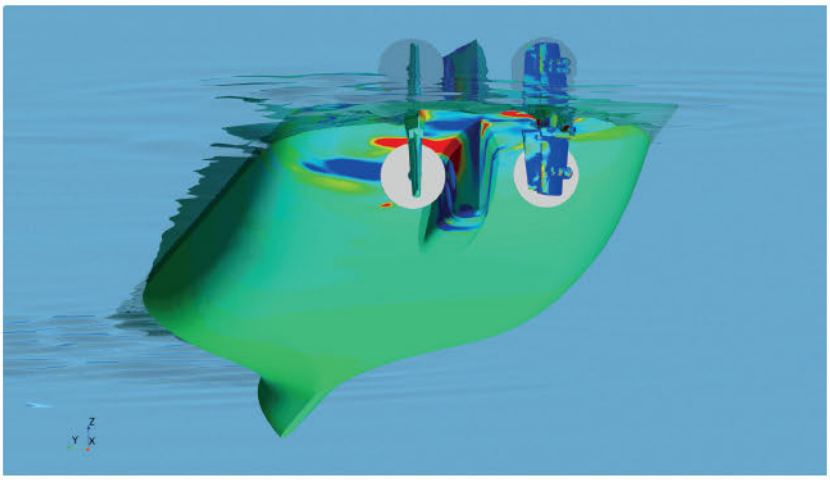
Needless to say, developing truly integrated equipment solutions depends heavily on the supplier being consulted as soon as possible, preferably in the early design stages. Shipbuilders themselves can sometimes be a recalcitrant element when it comes pushing forward the boundaries, often being content to repeat the same ship designs with minimal variation unless specified by the shipowner. As a company, MacGregor is used to serving yards and owners alike, but Sjöberg says the most efficient solutions invariably mean liaising directly with the end users.

"If you're not in there and designing efficiently then it's very difficult to make the changes afterwards. Similarly, when you have an integrated solution inside a ro-ro or ro-pax you have to fight for space with all the other subsystems. So it's important to work closely with the owner and their consultant even before they start talking to shipyards," he concludes. ■

CFD & HYDRODYNAMICS

TIME TO STOP SIDESTEPPING CRABBING TALK WITH CAPTAINS

By **Foreship Oy**



PROPELLER ACTUATOR DISC MODELS WERE USED TO SIMULATE HARBOUR CONDITIONS. SOURCE: FORESHIP

In two recent cruise ship projects, work by consultancy Foreship to optimise vessel crabbing included a review of some of the ship response assumptions on which naval architects base their design advice. Some of the results demonstrated what ship captains have suspected all along: sometimes, there really is no substitute for experience.

However, with other parts of the modelling also revealing room to optimise even time-honoured ship handling methods, Foreship head of hydrodynamics, Janne Niittymäki, says latest computational fluid dynamics (CFD) analysis should open a new dialogue between captains and naval architects. Better aligning physics and the physical world can only benefit both, he says, especially since the simulators captains train on before taking over a new ship use crabbing inputs that are far from realistic.

"It is inevitable that a captain basing his manoeuvring decisions on experience with an individual ship will believe his/her handling is 'more correct' but there is no reason why one skill should not inform another. Advances in CFD make it easier than ever to add data to simulations, either to verify what the captain is saying or to model ways of fine-tuning operations."

Crabbed dialogue

A necessary dialogue on crabbing has been sorely lacking, Niittymäki says. "Crabbing specifications use rule of thumb calculations based on windspeed limits and deep-water. This takes no account of the realities of applying side forces in shallow waters or the interaction of different thrust forces."

A captain will be aware of the ship's general specifications, but will make adjustments in harbour conditions based on trial and error, rather than bridge simulator training.

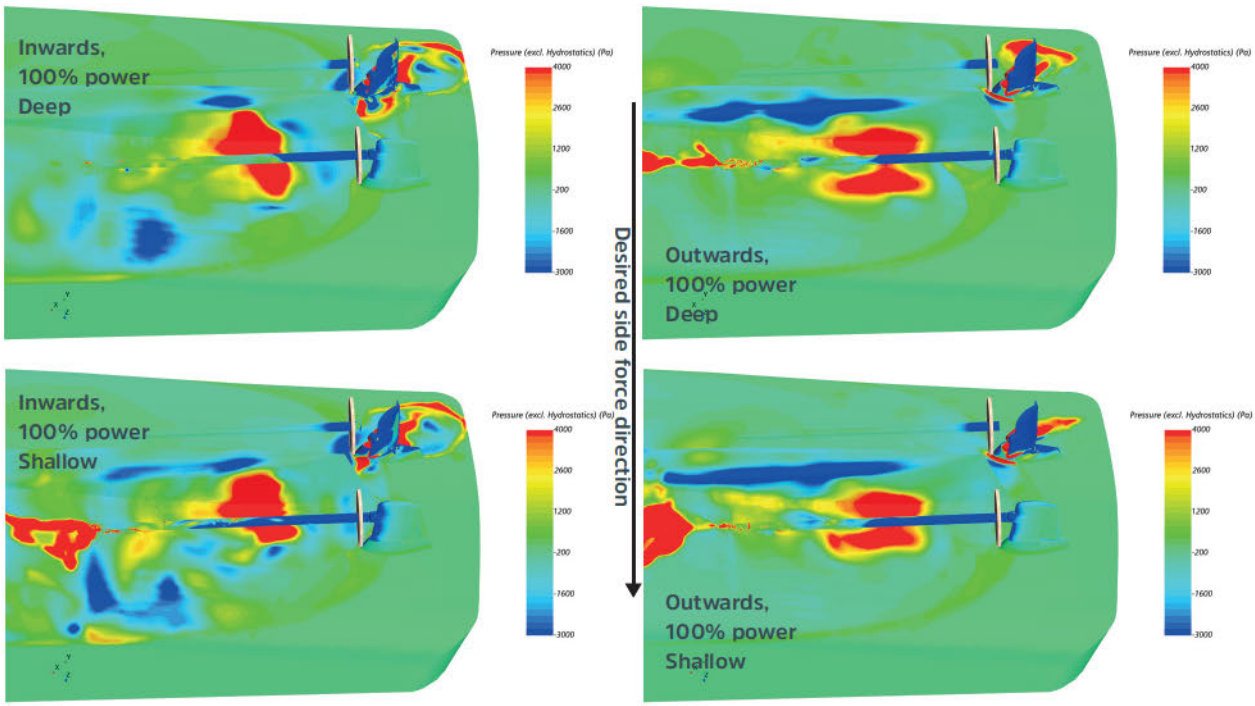
"Actually, underwater forces in harbour manoeuvring can now be determined reliably and quickly using full scale CFD simulations," says Niittymäki. "What is new in our method is that interactions between thrusters, main propellers, rudders, pods, etc is considered automatically. This is useful for dimensioning or positioning equipment, but also suggests a discussion between the naval architect and the captain would be beneficial at the design stage – especially the shipowner."

Outputs could also be useful to captains seeking to make better use of installed equipment, comments Niittymäki. For owners, cutting manoeuvring time in the harbour could support more cost effective slow steaming.

Meat of the matter

The new modelling from Foreship use state-of-the-art CFD methods included in Star-CCM+ software, simulating only acting forces to establish new levels of wake field accuracy in the propeller plane. Using propulsion actuator discs to create disturbance on the water that are tuned based on real propeller open water curves (Kt & Kq), simulations are applied to harbour conditions to provide a realistic picture of force interactions in crabbing operations.

Niittymäki explains that knowing the level of power needed for crabbing mode will allow the owner to make accurate decisions on the number and combination of thrusters needed and the wind limit for entering and leaving piers at specific harbours. The ship operator can harvest detailed guidance – on the optimal manoeuvring set up, for



example, or on whether to use stern thrusters alone or in combination with the main propeller and rudder. Shipyards and suppliers are also better informed on crabbing power needs and how to locate stern thrusters to minimise negative interactions, or what type of rudder to apply.

Propulsion pincer movement

In a favourable turn of events where breadth of experience is concerned, the two simulation projects involved one example of a ship using a conventional shaft line and another evaluating podded propulsion.

In the case of podded propulsors, simulations modelled pod angles when crabbing with one or two pods. Niittymäki reports positive feedback from a captain consulted that were in line with manoeuvring expectations for different ports. Where twin pod use was simulated, modelling offered guidance on the optimum combination for side and longitudinal forces in crabbing mode, as well as operational range recommendations and restrictions to avoid possible damage or unnecessary noise and vibrations.

In the twin shaft line propulsion set-up, simulations set out to consider whether propellers should rotate inwards or outwards over the top, and to consider whether using the port or starboard side rudder would optimise side force. Here, Niittymäki is candid enough to admit that simulated manoeuvres for leaving the pier and unrestricted manoeuvres in shallow and deep waters confounded the expectations of naval architecture and confirmed nuanced views often heard from captains.

"On the face of it, the best way to leave the pier is not obvious, as assumed by most naval architects. The owner said it had been experiencing issues on this topic for five years and would have had fewer grey hairs if this type of tool had been available all along."

Potted crab optimisation

Olli Somerkallio, chief operating officer, Foreship, says the modelling procedure is entirely new and could be developed for crabbing optimisation for any ship, with non-typical hull forms likely to secure particular benefits.

"In the case of non-conventional hull forms, like double-enders, crabbing performance can be difficult to predict using conventional methods. What are the consequences of increasing thruster power or the torque of the main propellers, extending the central skeg, increasing the rudder area or adding rudder end plates? We can also model the impact of increasing side force by 10% on the rudder. This could potentially support better decision-making or provide an additional training tool for harbour manoeuvring."

Niittymäki says that their simulations also show when seafaring instincts can be 'wrong'. "In the case of ferry manoeuvring, for example, we know that captains generally prefer to rely on stern thruster alone, when using the high-lift rudder is more efficient. These simulations can prove it to them."

Longer term, greater accuracy in harbour manoeuvring would seem to be a prerequisite to support the wider use of automated docking systems, Somerkallio observes. "It's critical to understand how propulsion and manoeuvring systems interact with the hull: automating this part of operations needs to be based on physics, not on gut feeling."

One very useful human characteristic is the ability to change tack if the original approach is not working, Niittymäki concludes. "As CFD modelling advances, it is no problem if the simulations show that I am wrong and that the captains are right: why wouldn't I believe them? But every ship is different and there is always something more that can be optimised; captains can be 'wrong' too.

"I believe we are the first – and for now the only company – offering this analysis. We are also ready to open what we consider to be an important new dialogue." ■

TWO DECADES OF SIMULATION-DRIVEN DESIGN: REVIEW AND PERSPECTIVES

By **Mattia Brenner**, Friendship Systems

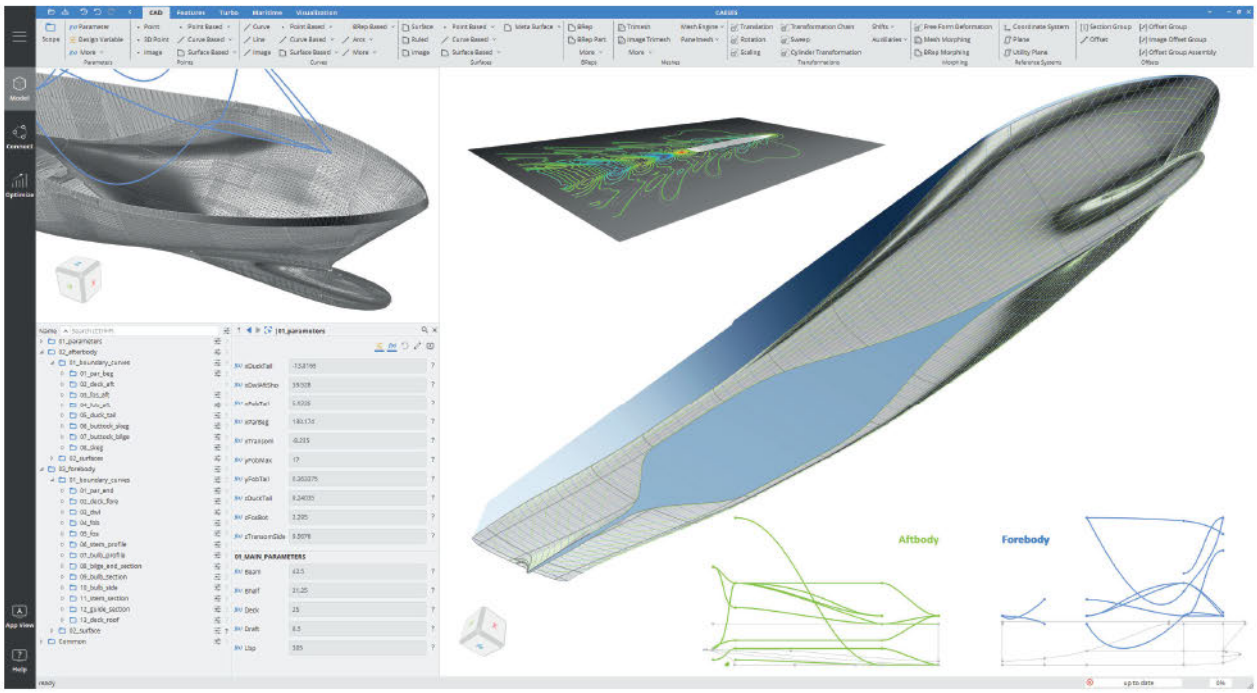
The last two decades have brought about game-changing developments to the design of ship hulls and other marine systems. In particular, the so-called simulation-driven design approach has revolutionised how ships are designed and has been crucial in finding superior performing hull shapes with an excellent balance of cost, internal arrangement, structural integrity, hydrostatics, and hydrodynamics.

Simulation-driven design is a logical evolution of simulation-based design. While the latter consists of checking and comparing the performance of a few manually created variants with simulation, in lieu of experiments, so to speak, the idea of the former is to let the simulation say what the optimal shape should look like, making it the new driver of the design process. Basically, this is the ultimate implementation of the popular saying that "form follows function".

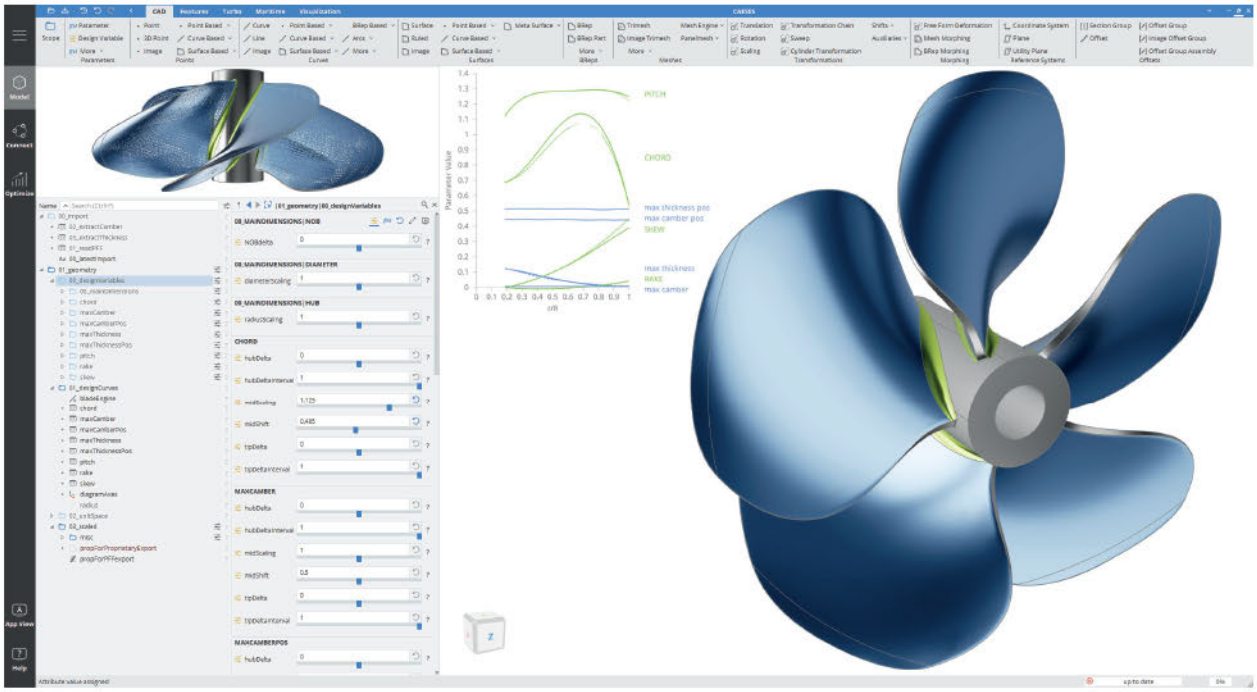
In practical terms, simulation-driven design typically means running automated design studies or optimisation processes, where geometry variants are generated based on sets of parameter values prescribed by an appropriate algorithm, analysed with one or more suitable simulation codes, and assessed on the basis of given objectives and constraints.

When Friendship Systems set out to establish simulation-driven design for ship hulls 20 years ago, simulation had already started to gain a strong foothold as a decision-support tool, but its use was mostly limited to simulation-based design. Simulation-driven design could only reasonably be applied under a clear set of constraints: available solver technology and computing power limited the approach to be carried out with potential flow codes and for a limited set of operating conditions, often a single point, say, one speed at one draft. This, in turn, inherently limited the scope of work to ship forebody optimisation with respect to wave resistance, i.e. to faster vessels like container carriers, ferries, and cruise ships. Due to the expenses and the required expert knowledge, the approach was mostly embraced by large companies producing large ships, and primarily contracted out as consultancy services.

Apart from the aforementioned consultancy, Friendship Systems worked on its first software development, focused on tackling the crucial task of geometry variation, i.e. the robust generation of suitable hull variants for simulation-driven design with as few parameters as possible. This early tool, the Friendship-Modeller, was based on methods to generate ship hull forms directly and automatically from a small set of parameter values, typically important properties of the ship hull such as displacement, and its distribution, as an input. This was contrary to the traditional approach of modelling a hull shape interactively within a CAD tool and analysing it afterwards for hydrostatics, as



LAUNCHED IN 2007, CAESES HAS EMPOWERED USERS TO ACHIEVE SMARTER OPTIMISATION AND PARAMETERISATION



THE GRAPHICAL USER INTERFACE FOR CAESES' PROPELLER DESIGN TOOL

was common in the 1990s. The geometric modelling process was – and still is – viewed as an optimisation problem in which fairness criteria are employed as measures-of-merit and form parameters are treated as equality constraints. The developed geometric modelling techniques are well-suited for interactive as well as fully automatic design work, since generated shapes directly fulfil two key requirements: desired geometric and hydrostatic properties are accurately met and fairness is intrinsically maintained. Relevant form parameters can be modified independently. The underlying parametric models in the 2000s, however, had to be produced by experts, typically hard-coded in a programming language.

Over the following years, better solver technology and more powerful computers facilitated much more simulation-driven design, and allowed for using viscous flow solvers for optimisation purposes and the inclusion of more complex operational profiles. This opened new applications such as the optimisation of slow sailing vessels like bulk carriers and tankers, that typically have a low contribution of wave resistance, as well as the optimisation of appendages, propulsors, and energy-saving devices in the wake of the vessel.

Complete simulation

In 2007, Friendship Systems released its first complete simulation-driven design platform, initially called the Friendship-Framework and later renamed CAESES (Computer Aided Engineering System Empowering Simulation). This includes parametric modelling, a comprehensive optimisation environment, and interfacing to external simulation codes. Apart from migrating the technology into additional applications such as turbomachinery and powertrain development, in more recent years, Friendship Systems has mainly been working on the development of smarter optimisation and parameterisation techniques. The aim, to reduce the user effort and the expense of simple to complex optimisation tasks, as well as on the integration of several additional disciplines in the optimisation process, like intact and damage stability calculations, seakeeping analysis, investigations of environmental impact and/or structural integrity. Since its introduction, CAESES has allowed parametric models and geometry variation to be flexibly set up by designers as non-experts of parametric modelling, which opened up its use to in-house design teams, medium-sized companies, as well as smaller craft, like battery-powered boats, where every kg counts. For further information, visit: www.caeses.com/applications/marine/.

The upcoming tasks that Friendship Systems sees for the next years, especially due to its involvement in various national and EU-wide research projects, are holistic design, where all relevant disciplines of the ship "design spiral" are synthesised in one all-encompassing simulation-driven design process, as well as smart models that combine geometry and performance information, e.g. a parametric hull form that includes a numerical set-up and/or series data.

In any case, simulation-driven design has risen to the status of industry standard for the design of most state-of-the-art vessels worldwide, and is likely going to further its status and importance in the next decade. Aside from reducing the fuel bill for the vessel's operator by improving energy-efficiency, often between 3-5% when compared to good parent designs, a very important additional effect now receives more and more attention: The tangible decrease of emissions. ■

Reference

Harries, S. "Practical Shape Optimization Using CFD: State-Of-The-Art in Industry and Selected Trends", Whitepaper, Conference on Computer Applications and Information Technology in the Maritime Industries (COMPIT 2020), Pontignano, Italy, August 2020

CLASSIFICATION

CAN MODELLING AND SIMULATION UNLOCK A SAFER, MORE EFFICIENT INDUSTRY?

By **Patrick Ryan**, VP technology, ABS

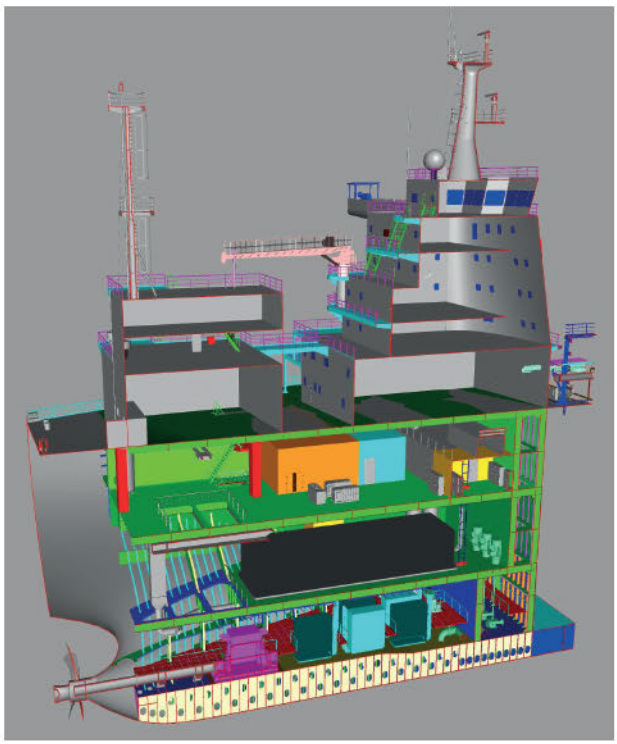
For more than a century and a half, we've relied on paper documentation to accomplish the ABS class mission. Paper has its uses but the limitations of its functionality in a digital environment have long been apparent.

To take a simple example, it is no longer cost effective for designers to produce designs on a drawing board. They're created in CAD programs and managed in complex product models. As recently as the early 2000s, it was still not possible to leverage CAD on the shipyard platen, or drydock, or deck plate.

But that started to change about a decade ago. And not just with additive manufacturing and robotic welding – but with people too – using tablets and mobility, smart devices, laser scanning and augmented reality.

The reason for this change is value. It is less expensive to produce only the 3D model, and not the drawings. Building from CAD is likewise less costly and even less risky than from drawings if you do it correctly.

This upstream disruption in design and construction is creating a need for change downstream. If the drawings used to support construction are never produced, how does Class Plan review happen? Why not in the same 3D CAD system that was used to design new vessels in the first place?



CAD MODELLING OF THE SUPERSTRUCTURE AND INTERIORS IS INCREASINGLY JUST ONE FACET AMONG A HOST OF DIGITAL SIMULATION SOLUTIONS

Beyond design methods, the equipment and components themselves – software and firmware, controllers, and smart machines aboard a ship today – all have a digital element. Software is not developed on a clipboard and it has evolved to become vitally important to the performance of safety related equipment.

A better way

The search for a 'better way' leads us to speculate if there were a way to put ourselves into the digital world in which that software exists.

Simulation can deliver all of the minimum requirements required by Class in a virtual mode and as of 2016, IACS' unified requirements allowed this alternative for several important events. We believe that tests that previously may have posed hazards to the equipment may be reduced or eliminated with the use of simulation, and further that we can take cost and risk out of commissioning by moving many of these tests to earlier in the process by doing them virtually. This is not intended to replace the human, but to supplement our capabilities in the digital domain.

It's important to stress that simulation in this context does not mean 3D Finite Element Analysis, Computational Fluid Dynamics or other tools we use to solve boundary value problems. When we talk about modelling and simulation, we are talking about multi-physics tools that can leverage data, first-principles mathematical models and original software control systems themselves.

In a digital environment, these tools can be used for design purposes, for test and qualification and also for Class verification. ABS recently released its Class Guide for Hybrid Electric Power Systems including provisions for simulation-based testing as an alternative for the first time.

Today there are three primary use cases for modelling and simulation in the process as we see it from the Class perspective.

More are under development – techno-economic modelling for example – but today we think modelling and sim will help us with studies around decarbonisation, validation of performance of complex software-driven systems including autonomous functions and virtual

testing or commissioning of systems that are highly software affected.

Simulation sits at the centre of a wheel containing familiar engineering topics such as control system analysis, kinematics, power distribution systems, and interface design. There are tools available on the market today that connect each of these disciplines to one another as well as to our more familiar 3D tools like FEA and CFD. For that reason, we often call them 'multi-physics' modelling or multi-physics sim.

These tools can be connected in the real world through data or connected to physical systems in a test environment or used entirely digitally. And we also believe that the ABS Rules can likewise be included inside the same model to help designers, Class Engineers or Surveyors evaluate the performance of these multi-physics and inter-connected systems against Class requirements.

Multi-physics modelling and simulation can deliver three things:

- It connects multiple engineering domains;
- It complements physical testing;
- It adds rigor and confidence to the class process.

Decarbonisation

There are several energy initiatives and technologies that could potentially contribute to the decarbonisation of shipping; for example, improvements to the energy efficiency of ship designs will be required by the next phase of the IMO's Energy Efficiency Design Index (EEDI). Closing the emissions gap between 2030 and 2050 will require a combination of physical and operational measures.

With all the available options – and especially with different technologies at different levels of technical maturity – there are challenges for designers offering advice, and for owners to make planning decisions.

The first is diversified selections: the portfolio of different energy saving technology options is large and works on different principles to reduce fuel consumption or emission levels. Alternative fuels have direct impact on the type of emission, which can be the most effective in carbon emissions reduction. Other technologies like hull design optimisation and energy saving devices improve the hydrodynamic efficiency of the vessel. Technologies like solar and wind bring additional energy sources to the vessel for propulsion.

In order to consider the available technologies, it is important to have an evaluation method that can be scaled to consider the combined effect of different technologies or design or operational approaches. There is a lot of risk in making these decisions early in the process that will affect the owner for many years.

At ABS we have been working to develop a multi-disciplinary approach that connects the performance of the vessel in different aspects, which provides a systematic evaluation of the vessel's performance. The decarbonisation Simulation Model can be used to analyse the fuel savings and carbon footprint for a vessel considering tradeoffs between different design features and operational measures.

Using this tool, we can evaluate the impact of many combinations of technologies and help owners validate some of the claims being made by the designers – whether the designer is using modelling and simulation or not. We can include the timing of the upcoming regulations to see the vessels predicted performance against these requirements over time and can help the designers understand their constraints as well.

Testing and commissioning

We should already know that testing of system automation is an essential practice today.

But it is an expensive process and economically risky as it often cannot happen until late in the build cycle when a system is installed and connected. This makes the concept of virtual testing to supplement physical testing a very attractive concept.

In simulation-assisted automation testing, the application is connected to a dynamic plant system model which can be used to verify the functionality of the automation system before connecting it to the actual process.

This has several benefits when compared to traditional testing methods; in particular the whole automation application can be tested with real system-like responses before installation.

These tests can also include scenarios which would be impossible to carry out at the site because of high risk or cost. Tests made beforehand can significantly reduce the time required for the site acceptance test or onboard testing.

Closing the loop

Modelling and simulation also have a role to play in one the most used – perhaps overused – terms of the digitalisation revolution: the digital twin.

In an industry increasing employing streaming data and machine learning to better understand the real-time condition and performance of a vessel, this approach could help close the loop on the digital twin.

What I mean by that is that modelling and simulation can be used to train the machine learning algorithms in ways that are otherwise far too expensive to test for accuracy. Modelling and simulation can likewise accept streaming data to validate the accuracy and performance of the process itself, closing the verification loop and giving us confidence that the data from the digital twin is accurate and actionable.

Given the increasing amounts of time and resources being expended on understanding the condition and performance of remote assets, the prospect that a true digital twin could be realised using modelling and simulation is an exciting indication of this technology's potential. ■

RESEARCH

IJME ANNOUNCES NEW ASSOCIATE EDITORS

By **Richard Halfhide**

While *The Naval Architect* has this year been celebrating its 50th anniversary, it still has a way to go before it can rival the longevity of RINA's longest-running publication, the *International Journal of Maritime Engineering* (*IJME*), which can be traced back to the Institution's conception in 1860. Originally known as *Transactions of the Institution of Naval Architects*, it assumed its present name in 2003 but *IJME*'s remit, to provide a peer-reviewed forum for the reporting and discussion on technical and scientific issues associated with the design and construction of marine vessels and offshore structures, remains essentially unchanged.

Published four times a year, it continues to welcome contributions in the form of technical papers and notes on all aspects of maritime engineering, together with discussion of the issues raised. Among the varied contributions in the most recent edition were 'Simulation of VOC Emission During Loading Operations in a Crude Oil Tanker', 'Numerical and Experimental Analyses of a Variable Buoyancy System for a Autonomous Underwater Vehicle' and 'English Narrowboats: From Industrial Revolution to the Urban Housing Problem'.

With the start of a new academic year, *IJME* has recently undergone a change in its editorial structure. Longstanding editor (and regular *TNA* contributor) Professor David Andrews of UCL will continue to have oversight as Editor-in-Chief, but will now be able to call upon the support of a group of volunteer Associate Editors from across the globe.

Henrique Gaspar

An Associate Professor in Ship Design at the Department of Ocean Operations and Civil Engineering at NTNU (Norway), Gaspar is programme coordinator for the MSc in Naval Architecture and MSc in Product and Systems Design at NTNU. He is currently involved in research and coordination on Fabrication (FabLab) and Design and Operations labs at NTNU's Ålesund campus. He teaches BSc, MSc and PhD courses in ship design and systems engineering.

Gaspar received his own PhD in Marine Engineering from NTNU in 2012, part of which was developed at the Systems Engineering Advancement Research Initiative (SEAri) at MIT. He was a visiting lecturer and research collaborator with the Marine Research Group at UCL in 2016 and 2019 and spent two years as a senior consultant with DNV (2012-2013). His formative years were spent with the oil and gas industry in Brazil, having completed a MEng and Diploma in Naval Architecture and Maritime Engineering at the University of São Paulo.

Xianbo Xiang

Professor Xiang is Deputy Dean of the School of Naval Architecture and Ocean Engineering at the Huazhong University of Science and Technology (HUST), China. Xiang's research interests include marine robotic vehicles and intelligent marine systems and he will act as the *IJME*'s Associate Editor for Control and Autonomy.

He has published more than 130 peer-reviewed journal and conference papers since receiving his B.Eng and MEng degrees in automatic control and marine engineering from HUST in 2000 and 2003, respectively. His Ph.D. in System Automation and Mircoelectronics was awarded by Montpellier 2 University, France, in 2011.

Between September and December 2006, Xiang was an EU Erasmus Mundus Visiting Scholar at the SpaceMaster Project. From February 2008 to March 2011, he was in the European Project FreeSubNet as an EC Marie Curie ESR Fellow at LIRMM, CNRS UMR 5506. In 2018, he served as General Chair for the IEEE 8th International Conference on Underwater System & Technology. Currently, he leads the research lab of Advanced Robotic Marine Systems (ARMs), building collaborative connections with researchers in Croatia, France, UK, USA and others.

HENRIQUE GASPAR

XIANBO XIANG

Paola Gualeni

Professor Gualeni is based at the University of Genoa, where she herself graduated in Naval Architecture and Marine Engineering. Gualeni teaches Ship Hydrostatics and Stability at the MSc course in Naval Architecture and Marine Engineering at the University of Genoa, as well as Yacht Stability (in English) at the MSc course in Yacht Design at the same university's La Spezia branch. She also tutors PhD students and sits on the national and international examining board for thesis discussions.

Gualeni's main research interests are in ship hydrodynamics and ship safety, although more recently she has developed a new interest in the field of innovative ship design methodologies and tools for ships with high levels of complexity. Over the last 15 years, Gualeni has also been involved in IMO activity as adviser for the Italian administration, with specific focus on ship buoyancy and damage stability criteria. From 2008 to 2017, she was representative for Southern Europe in the Stability in Waves Committee of ITTC (International Towing Tank Conference).

Since 2014, she has been a member of the Scientific Council of the National Technological Cluster on Transport, representative of the Maritime Transport sector. That same year she also became a member of the Scientific Committee of DLTM (Liguria Cluster of Marine Technology) and currently serves as president.

PAOLA GUALENI

Jung Kwan Seo

Jung Kwan Seo is a Professor and faculty member of both the Korea Ship and Offshore Research Institute (KOSORI) and the Department of Naval Architecture and Ocean Engineering at Pusan National University (PNU) in South Korea. Much of his academic life has been spent at Pusan, although after completing his PhD in 2007 he spent two years as a lecturer at Queensland University of Technology in Australia.

Seo serves as Vice President of the KOSORI at PNU (www.kosori.org), which has been a Lloyd's Register Foundation Research Centre of Excellence since 2008. He has also been a member of specialist committees for Experimental Method, Subsea System, Risers and Pipelines of International Ship and Offshore Structures Congress (ISSC).

JUNG KWAN SEO

His research interests include nonlinear structural analysis and design; advanced safety studies; limit-state-based design; quantitative risk assessment and management; fire, explosion, collision, grounding, dropped object and impact engineering for lifetime healthcare of engineering ships and offshore structures. Seo has authored or co-authored more than 100 articles, many of which for SCI/SCIE journals.

Evangelos Boulougouris

Evangelos Boulougouris is the RCL Professor of Safety of Marine Operations at the Maritime Safety Research Centre and Research Director of the Maritime Transport Unit of the Department of NAOME at the University of Strathclyde.

A Chartered Engineer in the UK and Greece, and a Fellow of RINA, he received his MEng and PhD as Naval Architect and Marine Engineer from the National Technical University of Athens. His main research interests are focused on the safety of ships and marine design optimisation. He is also a member of RINA's IMO Standing Committee and a member of the 29th International Towing Tank Committee (ITTC) Technical Committee on Stability in Waves.

Professor Boulougouris has published more than 170 scientific articles in journals, international conferences and chapters in books, covering the safety and survivability of ships, multi-objective marine design optimisation and hydrodynamic performance of ships. He has been the principal investigator in many EU, UK and industry funded research and knowledge exchange projects during the last 25 years. ■

EVANGELOS BOULOUGOURIS

ADVERTISERS INDEX

If you would like to receive further information on the advertisers featured within The Naval Architect please contact:
JP Media Services at **jpayten@jpmediaservices.com**

CALENDAR

What's happening next?

SEPTEMBER 15-16, 2021
WIND PROPULSION 2021
RINA/IWSA conference
Hybrid event
London, UK

OCTOBER 19-22, 2021
CONTRACT MANAGEMENT
RINA conference
Online

NOVEMBER, 2021
GREEN SHIPPING
WEGEMT/RINA course
Online

DECEMBER 1-2, 2021
WATERJET PROPULSION 2021
RINA conference
Onilne

For more information please visit:
www.rina.org.uk/RINA_Events

SEPTEMBER 15-22, 2021
INTERSESSIONAL WORKING GROUP ON THE REDUCTION OF GHG EMISSIONS
IMO International forum
Online
www.imo.org

SEPTEMBER 20-24, 2021
TECHNICAL CO-OPERATION COMMITTEE (TCC)
IMO International forum
Online
www.imo.org

SEPTEMBER 21-24, 2021
NEVA
International conference/exhibition
St Petersburg,
Russia
www.en.nevainter.com

OCTOBER 4-8, 2021
MARITIME SAFETY COMMITTEE (MSC)
IMO International forum
Online
www.imo.org

OCTOBER 18-22, 2021
INTERSESSIONAL WORKING GROUP ON THE REDUCTION OF GHG EMISSIONS
IMO International forum
Online
www.imo.org

OCTOBER 21-22, 2021
SMART & GREEN TECHNOLOGY FOR SHIPPING AND MARITIME INDUSTRIES (SMATECH)
International conference
Online
www.asranet.co.uk

NOVEMBER 8-12, 2021
IMO COUNCIL
Extraordinary session
IMO International forum
Online
www.imo.org

NOVEMBER 19-20, 2021
ICSOT INDONESIA
International Conference
East Java, Indonesia
icsot.ppns.ac.id

NOVEMBER 22-26, 2021
MARINE ENVIRONMENT PROTECTION COMMITTEE (MEPC)
IMO International forum
Online
www.imo.org

NOVEMBER 24-26, 2021
SAFETY, RELIABILITY OF SHIPS, OFFSHORE & SUBSEA STRUCTURES (SAROSS)
International conference
Glasgow, UK
www.asranet.co.uk

DECEMBER 6-15, 2021
IMO ASSEMBLY
IMO International forum
Online
www.imo.org

DECEMBER 16, 2021
IMO COUNCIL
IMO International forum
Online
www.imo.org

JANUARY 10-13, 2022
NOR-SHIPPING
International exhibition
Lillestrøm, Norway
www.nor-shipping.com

JUNE 26-30, 2022
INTERNATIONAL MARINE DESIGN CONFERENCE (IMDC)
International conference
Vancouver, Canada
imdc2022.org

JUNE 15-17, 2022
INTERNATIONAL CONFERENCE ON SHIPS AND MARINE RESEARCH (NAR)
International conference
Genova, Italy
www.atenanazionale.org/nav/nav2022

CR OCEAN ENGINEERING **MARINE SCRUBBER**

THE **SMART** CHOICE

While Meeting the 0.1% or the 0.5% Challenges.

The CROE Marine Scrubber — **MARPOL Annex VI compliance** without the restrictions and cost of low-sulphur fuel.

- Available in Open Loop, Closed Loop or Hybrid
- For Newbuilds or Retrofits
- Individual or Multistream designs

CR Ocean® Engineering

For more information go to: **www.croceanx.com**

Or write to us: **nconfuorto@croceanx.com**

CR Ocean Engineering, LLC. Six Campus Drive, Parsippany, NJ 07054 USA

PALFINGER

YOUR PARTNER FOR MARINE SOLUTIONS

PALFINGER is your global partner for innovative and reliable deck equipment and lifesaving appliances that fulfill standardized as well as customized demands and the most stringent safety regulations.

We offer solutions to all major maritime segments, including Offshore | Oil and Gas, Merchant | Cargo, Passengers | Cruise, Governmental, Wind and Aquaculture. Customers worldwide benefit from our global PALFINGER service network of experienced and certified specialists.

– CRANES, WINCHES AND HANDLING EQUIPMENT
– SLIPWAY SYSTEMS AND ACCESS EQUIPMENT
– BOATS AND DAVITS
– SERVICE SOLUTIONS

PROUD SUPPLIER TO
CRYSTAL ENDEAVOR

PALFINGERMARINE.COM