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MIND THE SKILLS GAP

By **Daniel Johnson**

Since taking over as editor of *TNA*, I have been approached by a number of RINA members requesting that the magazine does more to cover the area of offshore wind, so I'm pleased that we are able dedicate a feature to it in this issue. As ABL Group's Jake Anderson points out in his article (page 31), it's a sector that's booming with opportunities for naval architects, whilst also providing the satisfaction of helping to solve some of the challenges of the climate crisis – which can be a decisive factor for the next generation of talent entering the industry.

Deloitte's 2022 Gen Z and Millennial Survey provides some interesting insights on what motivates this new wave of young professionals – the survey puts cost of living and climate change as top current concerns overall. And while work/life balance, learning/development opportunities and salary and benefits are the top criteria when selecting an employer, the societal and environmental impacts of organisations were also shown to be key aspects; many who responded said they would turn down a job if it failed to align with their personal values.

Jake also highlights how the sector is facing stiff competition from other industries for new recruits, and how ABL has adapted to the changing ways of working and the training and development of staff, all of which makes for absorbing reading.

According to the Offshore Wind Industry Council (OWIC), the UK offshore wind industry will need to fill almost 100,000 skilled job positions this decade if the government's current target of 50 gigawatts of offshore wind by 2030 – a fivefold increase in the current capacity – is to be met. This will mean attracting a diverse range of talented people into the sector, so it will be important for industry and government to work together to address an obvious skills shortage.

This skills shortage is by no means unique to the offshore wind industry. Making sure that more opportunities for people to train and upskill will be essential to providing the UK shipbuilding industry with the talent pipeline it needs if it is to see any kind of renaissance. To this end, the UK's first Shipbuilding Skills Taskforce (UKSST) was announced a year ago as part of the cross-government National Shipbuilding Strategy (NSbS). Made up of members from across the UK and providing coverage from industry including SMEs and larger organisations, training providers and trade representative bodies, it has been looking at the existing and future shipbuilding skills supply chain to identify any additional upskilling and reskilling requirements, particularly those related to new and emerging technologies and zero-emissions shipping.

An update on the progress it has made over the last 12 months will be given in a few weeks' time at the National Shipbuilding Office Symposium in Edinburgh, ahead of the Taskforce's report which is due later this year.

THE FLOATING OFFSHORE WIND SPACE PROVIDES ELECTRIFYING OPPORTUNITIES FOR NAVAL ARCHITECTS. SOURCE: PRINCIPLE POWER

Globally, regulatory pressure to decarbonise is triggering seismic shifts in the maritime industry, with new, complex technologies to help maximise efficiency being developed at an unprecedent pace. As the uptake of these technologies increases, the skills shortage is likely to become even more challenging – with the industry facing the mammoth task of recruiting and training workers up to the high standard required to implement digitised solutions safely.

Many analysts expect to see a shifting of job roles and hiring priorities in the industry, with companies focusing on bringing in talent from adjacent sectors to access the data and IT and sustainability specialists necessary to keep up with the pace of change – as the father of two teenage gaming enthusiast who doesn't always look favourably on the amount of time they spend on their chosen recreational pastime, it was encouraging to see a video published on social media by Angel Donchev, technical lead at Maersk, in which he said the company is keen to hire more gamers to help accelerate its digital transformation efforts. Donchev argues that gamers often have sought-after skills, such as the ability to process vast amounts of information, that can be essential in the workplace.

Another thing the video highlighted for me was that the industry will have to find more targeted, creative ways to reach out to younger talent pools to raise awareness of the array of opportunities on offer. I've heard it suggested, dare I say it, that the maritime industry needs to work on its "sex appeal" for new, digital-savvy recruits by making it appear more high-tech and less steeped in tradition.

Whatever the answer to the skills shortage is, one thing is clear. Action must be taken now if the challenge is not to become a crisis; attracting and training fresh talent takes time. ■

NEWS

SMART SHIPS

STANDARDISED NOON REPORT DATA FORMAT LAUNCHED

A standardised vessel dataset (SVD) for noon reports has been launched by the Smart Maritime Council following the completion of a proof-of-concept project involving vessel operators OSM Maritime, Thome Group and V.Ships, offering a non-proprietary list of standard data points that can be freely applied by any maritime industry stakeholders to simplify data collection and analysis.

Working from a standardised list created by the Smart Maritime Council in collaboration with Stolt Tankers, the project saw noon report data from individual vessels operated by each of the three ship managers mapped to the central standard and then exported as XML data files in the same common format.

The standardised data from the different companies was shared with Lloyd's Register, acting as the technology partner on the project, and uploaded into one of its software platforms adapted to accept the standard format for analysis, eliminating the need to run a separate translation procedure for each individual operator.

With this step, the proof-of-concept project was successfully completed, delivering a standardised set of data points covering common items within the noon report that allowed information from three different shipping companies to be collected in a standard format and successfully imported into a software application for analysis without any further customisation.

"Thome Group has supported this industry initiative from day one, as we believe that, along with onboard inventory control, the lack of a standardised noon report is one of the most consistent problem statements from our fleet colleagues and performance analysts," says Peter Schellenberger, vice president supply chain, Thome Ship Management.

The SVD for noon reports has now been made available as an open list of standard data points for vessel operations, freely available to download and apply by any maritime industry stakeholders via the Smart Maritime Council website.

SAFETY

INVESTIGATION REVEALS MV *ESTONIA* SANK DUE TO FATAL DESIGN FLAWS

A fresh probe into the 1994 sinking of the ferry MV *Estonia* in the Baltic Sea, which resulted in the death of 852 people, has revealed fatal flaws in its design.

An international team of investigators from Sweden, Finland and Estonia told a press conference held in Tallinn, Estonia, in January that the vessel should not have been ruled as seaworthy, stating critical issues with the *Estonia*'s bow visor were missed during its certification which could have contributed to the sinking.

THE MV *ESTONIA*. SOURCE: ESTLINE AB

"If the inspection, following regulations, had been carried out, the flaws of the visor construction could have been discovered and the accident would probably not have occurred," according to the investigators.

The ferry sank in the Baltic Sea on the night of 28 September 1994 as it was headed to Stockholm, Sweden, from Tallinn. The vessel had been working the route between the two cities for Estline AB for 18 months prior to the sinking. Only 137 people onboard survived the tragedy.

Speculation about what caused the sinking included a collision with another vessel or object and an explosion inside the ship. However, the new investigation has not found any evidence to justify either claim. Surveys of the wreck have not revealed any penetrating damage of the hull below the water line.

The 1997 investigation into the disaster concluded that the ro-ro ferry sank after her bow shield failed, damaging her loading ramp, and allowing the car deck to flood.

ALTERNATIVE FUELS

MOL, MITSUI GET AIP FOR AMMONIA-FUELLED BULK CARRIER

A joint bulk carrier project developed by Mitsui O.S.K Lines (MOL) and Mitsui & Co. (Mitsui) has received approval in principle (AiP) from ClassNK.

As expectations for ammonia as a marine fuel increase, Mitsui and MOL say they will promote the expansion of net-zero emission ocean-going vessels and play a role in society's overall efforts to achieve decarbonisation. Both companies have determined the size and specifications of the 210,000dwt cape size vessel, and its design has been entrusted to Mitsubishi Shipbuilding Co.

The design calls for a main engine fuelled by ammonia, which emits no CO_2 when burned, thereby achieving zero CO_2 emissions during the voyage. The vessel will also feature two ammonia fuel tanks on deck to maximise the cruising range for various routes and to make the most effective use of cargo space.

CG RENDERING OF THE AMMONIA-FUELLED BULK CARRIER. SOURCE: MOL AND MITSUI

ClassNK will also conduct a Hazard Identification Study Note (HAZID) to confirm that no unacceptable risks exist at the basic design stage and to identify necessary safety measures precautions that need to be taken during the design, taking into account the toxicity of the ammonia fuel.

NUCLEAR POWER

RUSSIA ANNOUNCES THREE NEW NUCLEAR VESSELS

The Russian government has given the go-ahead for the construction of two new nuclear-powered icebreakers and a nuclear maintenance vessel.

This will take the total number of nuclear-powered icebreakers in the country's Arctic fleet to seven, the highest number since the 1989.

The increase in ships built for the Russian Arctic fleet was announced as part of a plan to grow investment in the Russian Arctic Zone.

In a government decree, 70 billion rubles, nearly US$1 billion, have been allocated for investment in the project, titled Project 22220. 60 billion rubles of this will be allocated to the construction of the icebreakers which will operate on the Northern Sea Route, escorting vessels carrying raw hydrocarbon materials from northern Russian to the Asia-Pacific.

Each icebreaker will have a capacity of 60MW each, a length of 173.3m, and a displacement of 33,500tonnes. They are planned to be completed by 2028 and 2030.

Three nuclear-powered icebreakers are already operational in the Arctic while two more are currently under construction. The news follows a decision to cancel an order for LNG-powered icebreaker vessels after Western sanctions hit Russian shipyards.

The construction of the maintenance ship is due to be completed in 2029. Its main task will be to ensure the recharging of reactor plants that are used in Project 22220 nuclear icebreakers.

FERRIES

INCAT POISED TO DELIVER WORLD'S LARGEST LIGHTWEIGHT, ZERO-EMISSIONS FERRY

INCAT'S CONCEPT FOR THE FERRY. SOURCE: INCAT TASMANIA

Australian shipbuilder Incat Tasmania reports it is in discussions to deliver "the world's first large, lightweight, zero-emissions ferry".

The ferry will carry a total of 2,100 passengers and 226 vehicles for the company's long-term South American customer Buquebús, which will operate the vessel between Argentina and Uruguay.

Currently under construction at Incat's shipyard and due for delivery in 2025, the 130m vessel was originally intended to be powered by LNG. However, Buquebús has asked Incat to replace the LNG powerplant with a battery-electric solution.

Incat says the move will help to cement the company as the world leader in zero-emissions and lightweight shipping.

Group chairman and founder Robert Clifford says: "Obviously, there needs to be sufficient energy supply in the ports that the ship would visit but we understand that this is progressing positively. The batteries and electric motors are being worked through with our suppliers, to ensure they can deliver the technology required in the timeframe we need them."

Despite the change in propulsion occurring midway through the build the company is confident it will not present new challenges.

Clifford adds: "This is just swapping one method of propulsion for another: it will however have significant environmental benefits and open up a whole new market for these types of vessels."

Peter Gutwein, former Tasmanian Premier and Incat's strategic adviser, says: "The world wants large, lightweight zero-emission ships and we are already scaling up our workforce and production facility in readiness for what will be a significant expansion."

WIND PROPULSION

CORSICA FERRIES INVESTS IN WIND-POWERED RO-RO

Corsica Ferries has announced it is to invest in French startup Neoline Armateur in order to build a ro-ro cargo ship powered mainly by wind.

The 136m-long Neoliner, which will connect St-Nazaire in France to the American East Coast, will be propelled by sail thanks to a Solid Sail rig from Chantiers de l'Atlantique. The rig comprises two 75m masts with 3,000m^2 of rigid sails, allowing for a commercial speed of 11knots. Self-supporting and automatically controlled, it can be oriented 360°.

Corsica Ferries estimates that the new ro-ro will save more than 80% of fuel compared to traditional vessels. It is the company's largest current maritime transport project and will offer a capacity of 1,200 lane metres, 400 cars or 265 containers, representing up to 5,000tons of goods.

According to Pierre Mattei, president of Corsica Ferries: "New options are opening today with green hydrogen and the sailing propulsion. As a responsible shipowner, we have a duty to support the energy transition by backing these forward-looking solutions, which are true laboratories for the propulsion of tomorrow's maritime transport."

THE RO-RO CARGO SHIP WILL CONNECT ST-NAZAIRE IN FRANCE TO THE AMERICAN EAST COAST. SOURCE: NEOLINER

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NEWS ANALYSIS

CHINA STAYS TOP AND WINS BIG ON LNG CARRIER ORDERS

By **Malcolm Latarche**

After two years when global trade was disrupted by the pandemic, 2022 was supposed to be a year of recovery. That was never going to be the case once hostilities began in Ukraine bringing the threat of global recession and an energy crisis so instead 2022 has been more a year for taking stock.

Newbuilding activity was expected to continue its upward trajectory in 2022 after a busy year of ordering in 2021 when port congestion and other factors combined to send freight rates soaring in the container sector and to a lesser extent in other sectors too. However, it had become apparent through 2022 that the trend was in fact to go into reverse.

SHIPBUILDERS ENJOYED A SIGNIFICANT ORDERING SPREE FOR LNG CARRIERS IN 2022. SOURCE: SHUTTERSTOCK

Clarksons' review of shipbuilding in 2022 shows that orders were down in every sector but one. LNG carrier ordering in terms of cubic metre capacity jumped 78% from 19 million m^3 in 2021 to 33.7 million m^3. By contrast, tankers were down 64%, bulkers down 54%, containerships 40% and other ship types around 20%. A changing trade route dynamic in the tanker trades could result in this sector having a good year in 2023.

Overall, in deadweight terms newbuilding orders dropped 39% and in ship numbers by 36% to just 1,384 ships. Thanks to the high number of gas carriers which are a highly sophisticated ship type, the drop in terms of CGT was limited to 20%. Despite the lack of new orders in all but gas carriers, the global orderbook at the end of 2022 was virtually identical in deadweight terms as at the end of 2021 standing at 225 million dwt. Car carrier (69 vessels), FPSO and wind-related offshore types also did well.

The rate of LNG ordering was due to a variety of factors such as greater demand for natural gas both for power and marine fuels but without doubt the need to replace pipeline gas from Russia to Europe was a major factor. Russia will also need to find extra shipping capacity to switch its export market for gas from Europe to other areas not connected by pipelines. Regardless of the reasons, the 182 gas carriers valued at US$39 billion ordered in 2022 sets a new record for the sector.

For the second year in a row, it was China that came out on top of the order league garnering 49% of all orders for the year. South Korea followed and Japan in third place – although Japan does sometimes report orders later than other countries so some late orders for 2022 may not yet have made it into the figures.

South Korea's dominance in LNG carrier building did however allow it to hold the fall in terms of CGT to just 9% with China down 21% and Japan 50%. LNG carrier and container ship orders accounted for 65% and 27% of the South Korean companies' new contracts, respectively. And with the average price for a 174,000m^3 LNG carrier rising 18% from US$210 million to US$248 million, Korean yards can be quite satisfied for the short term.

However, the orders for LNG carriers are likely to keep South Korean yards busy until 2026 so demand for deliveries before then will probably go to China in a trend that accelerated in 2022. From 21 gas carriers on order at the end of 2021, Chinese yards finished the year with 66. Hudong-Zhonghua Shipbuilding was previously the only Chinese yard with experience of the ship type but Dalian Shipbuilding Industry and Jiangnan Shipyard have secured orders from domestic LNG operators in 2022 and China Merchants Heavy Industry and Yangzijiang Shipbuilding were granted licences to build LNG carriers in 2022 and are in a good place to pick up orders.

Looking ahead to 2023, Clarksons is projecting that global yard output will start to tick up around 6% in 2023, dominated by container and LNG (41% of 2023 scheduled deliveries, rising to 58% in 2024) and that South Korean output share will tick upwards. On the container ship front, MSC has taken over the largest operator title from Maersk thanks to several new orders in 2022. It is looking to consolidate that lead with a further order for 10 11,400TEU ships from China's Zhoushan Changhong International Shipyard in January 2023.

The impact of the last major economic crash in 2008 on shipbuilding is still evident in the number of active yards. Today only 131 yards are active compared to 320 in 2009 leading Clarksons to say that shipbuilding capacity is around 40% lower than a decade ago. ■

NEWS EQUIPMENT

CAD/CAM

CADMATIC AND CONTACT SOFTWARE PARTNERSHIP BRINGS SHIPBUILDING-SPECIFIC PLM SOLUTION TO SHIPYARDS

CADMATIC CEO JUKKA RANTALA (LEFT) AND CONTACT SOFTWARE CEO KARL HEINZ ZACHRIES. SOURCE: CADMATIC

Cadmatic and CONTACT Software have entered a strategic partnership in which Cadmatic will utilise the CONTACT Elements platform and its apps to deliver a broader scope of shipbuilding-specific digitalisation solutions.

The agreement aims to enhance the full lifecycle of shipbuilding projects from design and engineering to prefabrication and production, as well as maintenance and operation, by integrating CONTACT Elements apps with Cadmatic's design, engineering, and information management systems.

This integrated offering will bring the first shipbuilding-specific PLM (product lifecycle management) solution to the market and deliver quality and time efficiency gains throughout the full shipbuilding project life cycle, according to Cadmatic.

"Shipbuilding is a unique industry with unique needs and levels of complexity," says Cadmatic CEO Jukka Rantala. "Our PLM and digitalisation solution will come with in-built shipbuilding intelligence with the facilitation of data use and management to effectively support the life cycle of complex engineering systems at shipyards. It will reduce the need for consultancy and implementation services that are typically required for general PLM applications on the market."

"CONTACT and Cadmatic are two leading experts whose products and industry experience complement each other perfectly. With this partnership, shipbuilding companies worldwide will benefit from future-proof solutions to drive their digital transformation, meet growing market and customer demands, and integrate sustainability into their value creation," adds Karl Heinz Zachries, CONTACT Software CEO.

CARGO AND DECK EQUIPMENT

MACGREGOR LANDS K LINE PCTC CONTRACT

MacGregor has secured an order from K Line for the supply of ro-ro equipment for two Pure Car and Truck Carriers (PCTCs).

The company will design and supply several key parts of each vessel, including a stern ramp, a side ramp, three sets of movable ramps, a ramp cover and a mobile deck lifter. It will also provide installation assistance.

The two 6,900CEU PCTCs will be built at Shin Kurushima Toyohashi Shipbuilding in Japan. The first vessel is scheduled to be delivered to K Line in the first quarter of 2025 and the second in the second quarter of 2025.

"MacGregor has a long-lasting and good relationship with Shin Kurushima that we are very proud of. Our close co-operation will help smoothly advance the design work and eventually the on-time delivery of the equipment," says Magnus Sjöberg, senior vice president, Merchant Solutions, MacGregor.

K LINE'S NEW PCTCS WILL BE BUILT AT SHIN KURUSHIMA TOYOHASHI SHIPBUILDING. SOURCE: CREATIVE COMMONS

BATTERY SYSTEMS

LECLANCHÉ SUPPLIES BATTERY SYSTEMS FOR NEXT-GEN HYBRID FERRIES

Lithium-ion cells and energy storage solutions company Leclanché has received orders for 22.6MWh of battery systems from Stena RoRo and Brittany Ferries for their next generation of hybrid ro-pax ferries.

The two 195m-long E-Flexers will be powered by Leclanché's latest Navius MRS-3 battery system produced at its German and Swiss factories and are claimed to be the world's largest hybrid vessels.

SAINT-MALO FERRY CONCEPT. SOURCE: LECLANCHÉ

Scheduled for delivery in 2024 and 2025, the ferries will be chartered by Brittany Ferries on a 10-year lease and operate between Portsmouth in the UK and the French ports of Saint-Malo and Caen.

The vessels' hybrid propulsion system will be capable of operation using both liquified natural gas (LNG) fuel and Leclanché's Navius MRS-3 onboard battery energy storage system (BESS). This will greatly reduce the environmental impact of ferries and improve sustainability, according to Leclanché.

The Navius MRS-3 uses the company's state-of-the-art 3rd generation lithium-ion battery systems, each with a capacity of 11.3MWh and a maximum of 940volts. The system is guaranteed for 10 years of continuous operation and is the result of several years of real-life operation and optimisation, Leclanché says.

The BESS uses a highly redundant structure with 46 battery strings.

Delivery is scheduled for the fourth quarter of 2023.

SCRUBBERS

FILTREE SYSTEMS PICKED FOR NEWBUILD CONTAINER SHIPS

Purus Marine and Nordic Hamburg have placed an order with Dutch company Value Maritime for four emissions-reducing Filtree systems, including clean loop system and 30% carbon capture.

The systems will be installed on four newbuild container vessels to be operated by BG Freight Line.

According to Value Maritime, the contract marks a milestone for the company as it is the first time the product has been ordered for installation on newbuild container vessels. BG Freight Line previously ordered two Filtree systems with carbon capture for container vessels *BG Onyx* and *BG Ruby* in 2022.

The 12.5MW systems will be delivered between September 2023 and February 2024 and will be installed at Value Maritime's berth in Rotterdam.

The Filtree system is based on technology that filters sulphur, CO_2 and 99% of ultra-fine particulate matter from vessels' exhaust streams. This will enable BG Freight Line to significantly reduce emissions while continuing to sail on high sulphur fuel, says Value Maritime.

With its clean loop mechanism, the system is also able to filter oil residues and particulate matter from its own washing water, giving the water a neutral pH value, which contributes to reducing acidification of seas and rivers, the company adds.

VALUE MARITIME WILL FIT ITS FILTREE SYSTEM ON VESSELS TO BE OPERATED BY BG FREIGHT LINE

The Filtree systems to be installed on the newbuild container vessels will additionally feature a modular CO_2 capture and storage system. This technology captures CO_2 from exhaust emissions and uses it to charge a CO_2 battery where it is stored and transported to shore. The CO_2 is discharged on shore, after which the battery is returned to the vessel to be recharged.

Laurens Visser, container vessels specialist at Value Maritime, says: "Cleaner, more sustainable shipping has risen on the agenda of many maritime companies over the past years. We are now seeing companies proactively looking to reduce their emissions not only retrospectively but from the very outset of operations. This is a welcome development that shows the seriousness with which the industry is taking up the challenges of climate change and the energy transition."

DECARBONISATION

PARTNERING ON THE PATHWAYS TO TOMORROW

By **Alan Johnstone**, Correspondent

Knut Ørbeck-Nilssen, CEO Maritime, DNV, says that while progress towards industry decarbonisation should be applauded, it must be accelerated. Shipping needs to work together, in tandem with other sectors and stakeholders, if we're to stand a hope of reaching our most ambitious, and necessary, goals.

It's difficult to know what's going to happen in the next 10 days, let alone the next 10 years. So, how are shipowners and operators, eyeing investments with timescales of 25 to 30 years, expected to make optimal long-term decisions, especially regarding fuels?

And how can an organisation like DNV make the right decisions to advise them? Surely it's impossible to navigate a landscape that's yet to take shape? Isn't it?

"That's why big decisions can't be taken alone," Ørbeck-Nilssen replies. "Everybody needs partners; no one can prosper, or change, in isolation, and that's especially true when we consider an energy and technology transition of the scale facing shipping. We need one another to navigate the future, now more than ever."

Ørbeck-Nilssen isn't just being nice here. This isn't a platitude; it's a cornerstone of his, and DNV's, vision.

He's been quoted over the past year or two as noting that "collaboration is the true fuel of the future" and 2022, with its unpredictable geopolitical, economic and environmental challenges, seems only to have deepened that conviction.

He talks of "significant barriers" that have to be overcome together, but before addressing the future wants to dwell on the present – recognising achievements so far.

"It's encouraging to see that some of the key issues highlighted in past editions of our Maritime Forecasts and Reports have been picked up by the industry," he comments, referring back to previous statements identifying LNG as arguably shipping's "most feasible transitional fuel".

"If we look at newbuild ordering there's now an established trend for alternative dual-fuel propulsion, with LNG as the dominant fuel, especially amongst the larger, deep-sea segments. A third of the vessels on the orderbooks, by gross tonnage, are being built to operate on alternative fuels, with LPG and the first hydrogen-fuelled designs also generating interest.

"So, we can see concrete proof that the transition is gathering pace, with regulatory pressure, access to investment and capital, and cargo owner and consumer demands as the key drivers. But is it moving fast enough? Well, that's another question."

KNUT ØRBECK-NILSSEN, CEO MARITIME, DNV

And the answer, he implies, is 'no'.

Ørbeck-Nilssen says that "substantial investment" is needed – "and quickly" – in terms of researching safe and economically feasible carbon neutral fuels, as well as developing the optimal technologies to utilise them.

However, that will be in vain, he stresses, if the main hurdle to progress can't be overcome, namely, fuel availability: "According to our recent Maritime Forecast to 2050 report, we need to produce 5% of shipping's total energy consumption from carbon-neutral fuels by 2030. That requires huge investment... and it's just the start.

"And if the IMO strategy is revised in 2023, pushing for full decarbonisation by 2050, then we require the means and infrastructure to deliver around 270 million tonnes of alternative fuels, according to our research. That is a massive challenge, and it requires action, now."

He continues: "It goes without saying, this is an issue that shipping cannot resolve alone. We need to see collaboration in the industry, for sure, but beyond that we have to work in unison with energy producers, infrastructure developers, ports, and, not least, national and international authorities and organisations to enable such fundamental change.

"This goes beyond working within our 'tribes' – it's a global issue of critical importance."

But, of course, it's difficult to know where to place bets when it comes to that fuel. Should a shipowner today invest in assets running on natural gas for tomorrow, or will it pay to be an early mover on hydrogen, ammonia or any other emerging alternative?

This, Ørbeck-Nilssen retorts, is where DNVs 'pathways' come in.

Arguably, DNVs core strengths lie in its neutrality and acknowledged expertise and networks in a broad range of industries and disciplines. It has teams spanning maritime, oil and gas, carbon capture and storage, renewables, technology, and more, in addition to strong links with academia, authorities and other key societal stakeholders. As such it can understand the "big picture" and see how pieces of the transitional puzzle might fit together, helping mitigate risk, enhance safety and facilitate development.

It's pathways – again, featured in the latest Maritime Forecast to 2050 – detail likely scenarios on the journey towards decarbonisation, considering factors such as fuel availability, costs and the apparent lack of one "silver bullet" solution.

"There's so much uncertainty," Ørbeck-Nilssen stresses. "The only things that are certain are that we need to change, and that the future fuel mix, at least in the near-term, is going to get more complex, with a wide variety of energy choices emerging. That creates obvious challenges for the industry.

"The pathways address that, helping plot potential routes to decarbonisation."

As an example, he picks an owner opting for LNG today.

"Now, they know this isn't a perfect fuel," he explains, "but it enables substantial gains over conventional heavy fuel, utilising proven technology. So, on the 'gas pathway' they use LNG as the first step, before switching to bio-gas and then later transitioning to synthetic gas. That's an over-simplified example, but it shows how you create clarity as you move ahead with business strategy and investments."

This "clarity from confusion" wouldn't be possible, Ørbeck-Nilssen notes, without an understanding drawn from close relationships throughout the industry and beyond. It all comes back to partnership.

A further example of that, and of DNV's role as a key enabler for an industry in transition, is the recently unveiled Nordic Roadmap initiative.

This follows on the back of the Clydebank Declaration at COP26, where shipping "green corridors" were identified as a key tool for accelerating change. In a bid to position the region at the vanguard of developments, the Nordic Council of Ministers, with support from all the Nordic nations, set up the project as a "cooperation platform" creating unity of purpose. The result is a joint public and private initiative aiming to bring together diverse stakeholders to enable green corridor infrastructure, start pilots, share knowledge, build alternative fuel experience and, Ørbeck-Nilssen says, "set an example for other regions to follow."

DNV has been brought in as project manager, recently hosting the first meeting at the company's Høvik HQ in Oslo.

"When you look at the industry in its entirety, the scale and complexity of change needed can seem overwhelming," he notes. "But if you take separate regions, and look at establishing individual green corridors, it makes the challenge more manageable. Then, when you bring together diverse partners, it's suddenly possible to work towards concrete, achievable goals – goals that can form a blueprint for the industry in general. ■

CLARKSON RESEARCH SERVICES: HISTORIC AND SCHEDULED DELIVERY

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

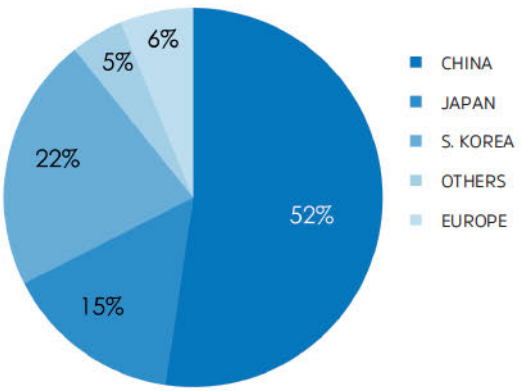
VESSEL TYPE	2011	2012		2013		2014		2015		2016		2017
	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half
VLCC >= 200,000	27	27	22	21	9	14	10	9	11	23	24	29
Suezmax 125-200,000	18	30	15	23	4	4	4	7	3	8	19	35
Aframax 85-125,000	31	30	15	14	6	4	13	22	10	31	22	36
P'max Tankers 55-85,000	10	9	6	7	5	3	1	2	1	7	11	10
Products 25-55,000	28	27	30	50	29	49	49	60	57	60	42	39
Products 10-25,000	6	13	6	10	4	1	8	4	0	3	2	6
Chem & Spec. 10-55,000	39	39	8	6	13	12	11	36	29	42	38	38
Tankers < 10,000	57	76	41	38	39	32	25	19	23	23	16	25
Capesize > 100,000	122	149	65	63	40	56	38	46	42	64	39	55
Panamax 80-100,000	97	140	94	101	68	61	35	57	41	71	40	75
Panamax 65-80,000	44	53	39	34	42	42	20	19	4	1	2	6
Handymax 40-65,000	198	228	146	147	119	95	97	136	118	123	90	121
Handysize 10-40,000	182	227	117	116	83	101	71	110	86	87	51	73
Combos > 10,000	0	0	0	0	0	0	0	0	0	0	0	0
LNG Carriers	10	1	2	4	13	14	19	16	16	15	18	20
LPG Carriers	14	13	8	22	16	14	14	25	40	49	33	45
Containers > 8,000 teu	30	51	28	51	33	59	42	58	62	37	26	34
Containers 3-8,000 teu	21	39	19	46	29	26	25	18	6	2	0	2
Containers < 3,000 teu	36	39	40	30	19	22	29	28	35	41	28	35
Offshore	20	29	10	12	19	31	31	25	13	26	20	18
Cruise Vessels	2	6	1	6	0	3	2	5	1	8	2	7
Passenger Ferries	10	11	8	6	6	12	8	13	8	6	16	20
Others	184	191	99	99	84	72	61	70	48	50	59	50
TOTAL	**1,186**	**1,428**	**819**	**906**	**680**	**727**	**613**	**785**	**654**	**777**	**598**	**779**

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

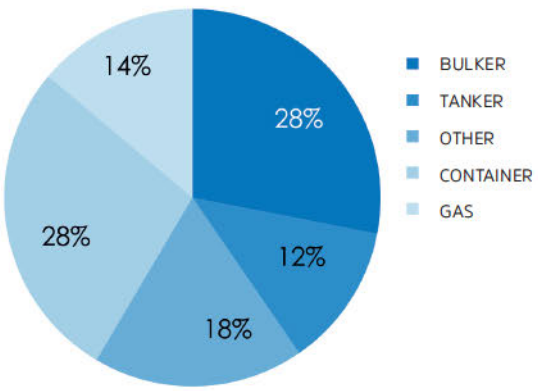
ALL DATA TAKEN AS OF **1ST JANUARY 2023**

ORDERBOOK BY BUILDER REGION (NUMBER OF VESSELS)

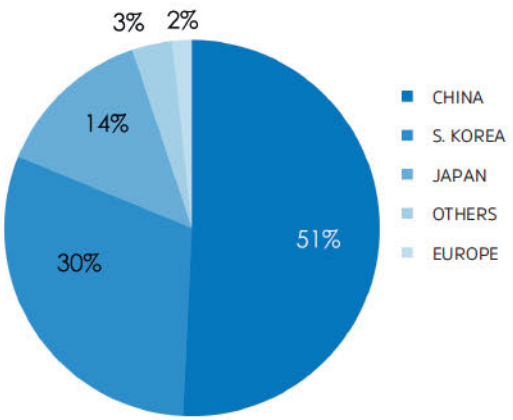


2017	2018		2019		2020		2021		2022		Scheduled Orderbook		
2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd half	1st Half	2nd Half	2023	2024	2025
21	21	18	39	29	22	15	23	12	24	18	24	0	1
22	25	7	23	3	11	19	20	3	28	14	9	6	5
28	26	24	41	12	12	6	28	25	21	17	49	23	15
11	7	6	6	7	6	4	1	1	4	5	3	0	0
25	27	22	50	46	43	29	39	37	35	23	42	20	16
6	10	8	5	10	4	7	7	11	6	7	8	1	0
31	45	41	34	28	32	25	25	23	25	25	46	37	14
37	45	43	27	28	29	27	23	34	31	33	55	19	2
20	30	21	31	49	64	48	52	36	28	22	67	32	15
27	39	25	69	64	96	47	65	37	52	46	133	75	20
1	2	2	1	4	3	0	0	1	8	12	24	9	4
51	57	33	55	77	92	56	60	56	53	67	126	128	30
35	51	45	56	40	45	45	77	56	63	77	129	92	30
0	0	0	1	2	0	2	3	0	0	0	0	0	0
12	32	23	22	20	16	21	35	30	17	16	53	87	91
17	26	9	16	13	19	14	19	14	20	22	89	27	18
36	47	23	27	23	13	22	28	26	22	27	100	121	87
5	7	3	6	1	1	5	5	1	0	13	81	121	37
42	50	39	45	56	43	56	54	48	52	73	202	118	11
23	24	14	10	10	5	5	11	15	21	31	63	17	5
3	8	4	12	10	6	8	8	13	7	13	23	16	14
11	11	18	16	16	11	11	15	16	13	10	32	16	7
54	49	48	58	53	39	65	83	87	81	85	164	131	69
518	**639**	**476**	**651**	**601**	**612**	**537**	**681**	**581**	**611**	**656**	**1,522**	**1,096**	**491**

ORDERBOOK BY SECTOR (NUMBER OF VESSELS)



ORDERBOOK (DWT) BY BUILDER REGION



CHINA

CHINA MOVES FORWARD WITH CRUISE SHIP AMBITIONS

By **Daniel Johnson**

THE NEW 80,000GT CONCEPT WILL JOIN THE ADORA CRUISES BRAND

China's push to expand its presence in the cruise ship construction sector is in the spotlight again, with China State Shipbuilding Corporation (CSSC) releasing further details for its joint venture with US-based Carnival Corporation, and also previewing a new luxury cruise ship design. The Chinese government has long seen large cruise ships as part of "the crown jewels" of shipbuilding and considers the full promotion of their design and construction key for the upgrading of the country's shipbuilding industry.

According to CSSC, China's first domestically developed cruise liner will be delivered to CSSC Carnival Cruise Shipping, the joint venture between CSSC and Carnival, by the end of this year under the new brand Adora Cruises. The newbuild has been under construction at Shanghai Waigaoqiao Shipbuilding (SWS) for a number of years, being held back by the Covid pandemic and several lockdowns in China. Based on Carnival's Vista-class platform, it will be 135,000gt, 323m long, 37m wide, with 2,125 passenger cabins.

The vessel is just the first of several: at least two more new ships are in the pipeline and a number of older vessels, such as the *Costa Atlantica* and *Costa Mediterranea*, will be converted to the same Adora Cruises standards. The new brand plans to begin cruising along the 'Maritime Silk Road' – a trade route that connects the Chinese mainland with Southeast Asia, India, the Arabian Peninsula, Egypt, and the Mediterranean – as part of an offering of both short and long cruises for both domestic and international travel. It will also call at countries important to China's 'Belt and Road' initiative.

SWS has already started design and construction for a second larger 341m-long, 142,000gt cruise vessel which is set to debut in 2025 and in recent weeks the design for a third smaller, more luxurious ship has been given approval in principle (AiP) by China Classification Society (CCS). Developed and designed by CSSC Cruise Technology Development, a subsidiary of CSSC, the 80,000gt vessel is being heralded as an important milestone for CSSC, highlighting its ability to apply key technologies in cruise development.

"The design underlines the R&D work and innovation and green technology advances being made," says CCS's Wang Zhirong.

The ship has a total length of 293.5m and a width of 34m, and its design includes a number of enhanced features. In order to enhance energy efficiency, CSSC says it has optimised the aerodynamic and hydrodynamic performance of the vessel's superstructure and equipped a range of energy-saving devices, helping the ship meet the requirements of the phase three of IMO's Energy Efficiency Design Index (EEDI).

Outlook for Chinese cruise industry

Whether China's nascent cruise ship construction sector can ever compete with the established shipyards in Europe, which have achieved their dominance through years of specialisation and the development of local cruise ship building eco-systems, remains to been seen.

Despite the impact of Covid-19, CSSC is extremely bullish on the outlook for the cruise industry for the mid to long term. However, it notes that the development of a domestic cruise industry cannot be successful without a complete and specialised supply chain. Its partnership with Carnival should help with that.

An example of China's Company Law, which requires foreign businesses to form a joint venture with a local partner in order to expand into the local market, such partnerships typically require the foreign company to transfer propriety methods, designs, and other know-how to the joint venture company. And as local production is often a requirement of these deals, emerging industries, in this case cruise ship construction, receive a major boost in terms of the development of local expertise.

It may take some time, but the Chinese government's serious commitment to master large cruise ship construction and the country's developing access to the latest technical and design knowledge could very well see China position itself to take its European counterparts in the decades ahead. ■

SAFETY

SIRE 2.0 BRINGS ENHANCED ASSURANCE TO THE TANKER INDUSTRY

By **Aaron Cooper**, programmes director, OCIMF

THE WRECK OF THE SS *TORREY CANYON*. THE TANKER RAN AGROUND OFF THE WESTERN COAST OF CORNWALL, RESULTING IN BRITAIN'S LARGEST OIL SPILL TO DATE. SOURCE: CREATIVE COMMONS

It has been 55 years since the *Torrey Canyon* ran aground off the UK's Cornish coast spilling more than 100,000tonnes of crude oil into the waters between England and France, but its legacy lives on. The catastrophic event galvanised industry efforts to raise standards of safety across the board. As such the Oil Companies International Marine Forum (OCIMF) was born, formed by a coalition of oil companies seeking to collaborate on how to mitigate risk in the construction and operation of oil tankers.

Today, as a voluntary association OCIMF has more than 100 members, including oil majors and continues to grow including the majority of NOCs and many independent oil companies. OCIMF provides the technical skills and knowledge to develop and implement practical guidance and best practice for companies and individuals involved in the shipment of crude oil, oil products, petrochemicals and gas.

One of OCIMF's most significant safety initiatives is the Ship Inspection Report Programme (SIRE), launched in 1993 to address concerns about sub-standard tanker shipping. The SIRE Programme is a unique tanker risk assessment tool used to assess a vessel's condition and operational standards. It has proved to be of great use to charterers, ship operators, terminal operators and government bodies concerned with ship safety.

The increasing use of SIRE information over the past two decades has corresponded closely to increasing efforts made by the oil industry to find out whether the vessels they use are well managed and maintained, and the decrease in accidents and incidents. It continues to serve the industry well with more than 180,000 inspection reports having been submitted to SIRE since its inception.

Digitalising the inspection process

Technology, risks, vessel design and operation have, however, moved on considerably since SIRE was first introduced to the industry 30 years ago and while the programme has been continuously reviewed and improved to align with the changing nature of risk, a wholesale change was required to meet the challenges of tomorrow. OCIMF is now introducing a new digitalised programme that can more readily evolve with the industry as vessel operators and managers as well as crew respond to the introduction of new technologies, regulations and operational requirements.

Known as SIRE 2.0, the new regime will be a step-change for the industry and when fully implemented will look and feel quite different to the current SIRE regime. However, all involved in the new reporting process will benefit – from inspectors and ships' crew to the vessel operators and programme recipients that use the reports to vet vessels prior to charter.

As a digitalised programme (but still with physical inspections) SIRE 2.0, will more accurately report on the quality of a vessel and its crew (on an ongoing basis) and indicate future likely performance, using enhanced tools, strengthened governance processes and more in-depth reporting outcomes, following a risk-based approach.

One obvious difference will be inspectors' use of tablet devices to record their findings whilst onboard. Gone will be the notebook and pen synonymous with OCIMF

inspectors, along with the standardised questionnaire, with assessments made based on 'yes' or 'no' answers.

Instead, all inspectors will carry an intrinsically safe tablet device installed with bespoke inspection software.

Specially developed software will generate a unique Compiled Vessel Inspection Questionnaire (CVIQ) using an algorithm to select questions from a question library based on the type of vessel, its outfitting and information supplied by the vessel operator to create a bespoke risk-based inspection questionnaire.

As inspectors will be using tablet devices to report their observations in real time whilst onboard, reports can also be supported with photographic evidence (where permitted) for the first time ever, ensuring greater transparency and objectivity throughout the inspection process. There is also more room for context; questions in the CVIQ require the inspector to provide responses based on hardware, processes and human factors with observations graded from 'not as expected' through to, in the case of human factor responses, 'exceeds expectation'.

Human factors at heart of programme

Crucially, by integrating human factors across the entire inspection process, SIRE 2.0 will significantly aid industry understanding of human factors issues, tangibly improving support for crew and transforming safety in the marine industry. Human factors are the physical, psychological and social characteristics that affect human interaction with equipment, systems, processes, other individuals and work team(s).

In OCIMF's view, taking a human factors approach means recognising that it is the people on the ships and in the operations and support teams who make safety work, but that human error still occurs in interaction with conditions, systems and/or other people. It is by addressing these interactions, that industry can reduce human error and so, reduce incidents and improve reliability and productivity.

OCIMF PROGRAMMES DIRECTOR AARON COOPER

It is important to point out that this does not make these inspections a punitive process; in fact, quite the opposite – under SIRE 2.0 there is an opportunity to demonstrate best practices and have excellence recognised. This much more all-encompassing approach will help industry to better identify and address root causes of risk.

OCIMF realises that the new SIRE 2.0 is a significant change for industry and it is vital that industry is fully prepared before full alignment with the new programme commences. It has been developing the programme alongside the various sectors that will use it and will continue to work with industry in this way during its phased implementation over the coming months.

A phased approach to implementation

Given the significance of the changes to the programme, SIRE 2.0 will be delivered to industry in a 'phased approach' comprising four stages, rather than a single 'go-live' switch between the current SIRE (VIQ7) and new SIRE 2.0. Pursuing a phased approach will provide the opportunity for all industry sectors to become fully familiar with the SIRE 2.0 guidance materials, training materials and inspection process.

Further, to allow for thorough interrogation at each stage, the roll-out strategy is underpinned by a comprehensive plan of phase-specific critical success factors which need

	SIRE VIQ7	SIRE 2.0
What questions are included in the inspection?	The template is fixed to the vessel type and variants selected	A CVIQ is compiled according to the HVPQ and PIQ. Questions are included according to OCIMF risk rating into 'core' (related to significant risk) and 'rotational' questions (not related to significant risk)
How are the questions structured?	A simple Yes/No response, with supplementary options for N/A or Not Seen	Multiple categories of response for Hardware, Process, Human Factors and photograph validation
How does the inspector answer the questions?	Binary: positive or negative	A graded scale of responses 'not as expected' to 'exceeds expectation'
What are the contents of a negative observation?	Free text observation contents	One or more negative observations identifying a codified subject and nature of concern supplemented with free text
What forms of media can be added by the inspector	Not supported	Photographs can be taken to support question responses and negative observations
What data is provided by the vessel operator to support the inspection?	HVPQ, crew matrix, Port State Control (PSC) reports and incident data	A pre-inspection questionnaire, certificates and vessel standard photography, plus HPVQ, crew matrix, PSC and incident data

to be met before moving to the next phase. Users of the programme will be provided with ample warning before each stage is progressed.

Phase 1: SIRE 2.0 internal testing – One-month User Acceptance Testing involving the OCIMF Secretariat and vessel operators that have previously been involved in SIRE 2.0 Trial Inspections. The goal is to rigorously test the full end-to-end reporting process.

Phase 2: Beta test of full end-to-end process – a two-month testing period with optional participation from invited parties, with a goal to test the end-to-end process without assistance from OCIMF.

Phase 3: Unlimited beta test of full end-to-end process – a four-month transition period allowing participation for all programme users. The goal is to allow all submitting companies, vessel operators and programme recipients to use and familiarise with the SIRE 2.0 system prior to full launch.

Phase 4: SIRE VIQ7 withdrawn – SIRE 2.0 launches and replaces the existing SIRE system as the commercial tanker inspection programme.

Delivering a change in culture

Inspectors have been receiving comprehensive and ongoing training and examination over the past 15 months in preparation for their transition to SIRE 2.0 and companies that have integrated SIRE into their in-house IT environments have been working with the project team to integrate the new web API. Programme participants, including submitting companies, have also been engaged in a range of engagement and learning activities.

Training resources, including documentation, factsheets and familiarisation videos developed to meet the needs of each participant group (vessel operators, programme recipients, inspectors and officers/crew) can be downloaded from OCIMF's website and used onboard ships or integrated into in-house training programmes. Submitting companies, programme recipients and operators are strongly encouraged to use these pre-recorded and subtitled presentations as a tool for aiding understanding and expectations of SIRE 2.0 inspections.

The evolution to the programme requires buy-in from all involved in tanker shipping and OCIMF recognises that the move will understandably take some time.

The benefits, however, will be long-lasting and will transform the marine industry's ability to understand and address issues of risk across tanker operations and to become altogether better positioned to respond to evolving risks and changing regulations. ■

RO-ROS & FERRIES

VISENTINI'S NEXT-GENERATION JACK OF ALL TRADES

Italian shipbuilder Visentini, together with the naval architects of NAOS Ship and Boat Design, has developed a new SRtP- and SOLAS 2020-compliant ro-pax ferry platform that addresses all the shortcomings of the highly successful standard Visentini ro-pax built hitherto. Corsica Linea's recently introduced LNG-powered *A Galeotta* is the lead ship of this new design with construction of a near sister ship already well underway. More Visentini Mk II class ro-paxs are set to follow in the years to come

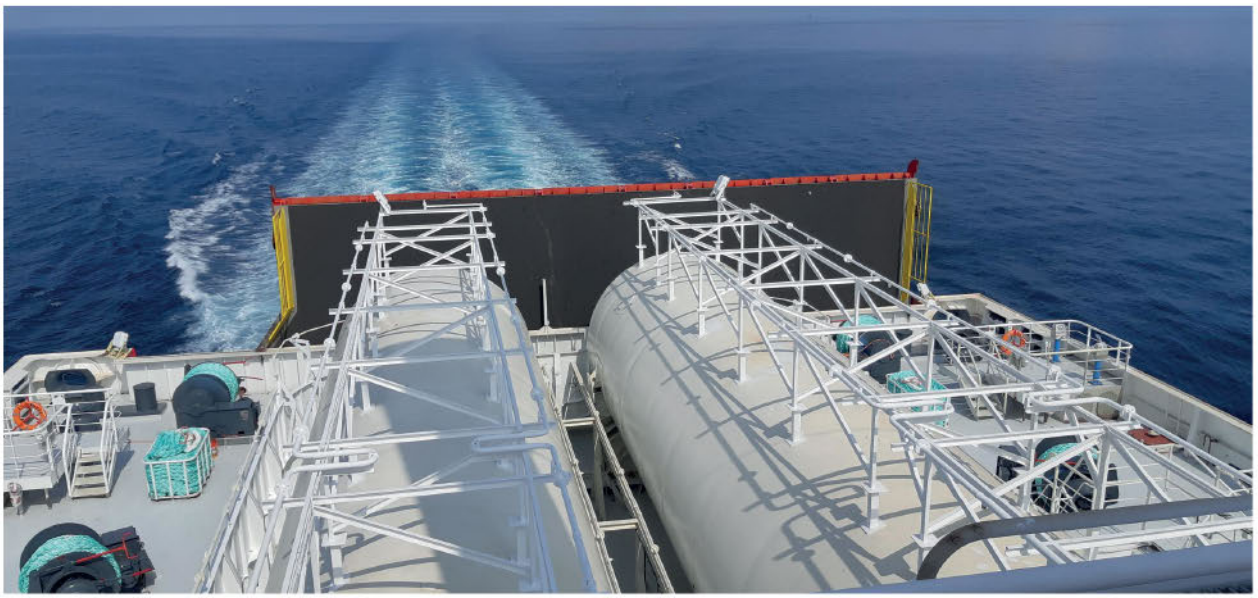
By **Philippe Holthof**, Correspondent

During the past 25 years, Cantiere Navale Visentini has been one of the most successful builders of non-complex, yet very efficient ro-pax tonnage. The family controlled shipyard, located in Porto Viro, delivered its first large ro-pax ferry, the 2,200-lane-metre and 330-passenger capacity *Mersey Viking* (currently *Strait Feronia*), in mid-1997. Trieste-headquartered NAOS Ship and Boat Design has been instrumental in the success of the series, acting as the naval architects on Visentini's behalf.

Arguably the most successful ro-pax class of the past two decades, Visentini's ro-pax ferries have been deployed in all four corners of the world. All major European ferry operators have operated them, a testament to the design, characterised by simplicity and excellent fuel economy. Sweden's Stena RoRo, a leading provider of ro-pax and ro-ro tonnage, has been a keen supporter of the Visentini ro-pax platform. The vessel's uncomplicated design, fuel efficiency with twin engine setup and the use of only the necessary high-quality equipment served as a benchmark for Stena's one-size-fits-all Stena E-Flexer class, of which nine ships have already been built by CMI Jinling Weihai Shipyard with three more to follow.

Built-in flexibility is a Stena hallmark and as this was a shortcoming of the first Visentini generation, lessons have been learned when designing the Mk II class which, not coincidentally, started out as a project for Stena RoRo. Many years back, Stena was already looking at ways to modify the Visentini design to drive-through mode, yet the builder wasn't convinced and stuck to the stern only loading/unloading arrangement. As the Visentini Mk II started out as a Stena RoRo project, the original design called for a drive-through concept. When Stena RoRo withdrew, the bow entrance was jettisoned but a later conversion to drive-through mode has somehow been considered with the main vehicle deck, Deck 3, now devoid of the extreme forward centreline stair casing. Instead of a Visentini Mk II, Stena RoRo walked down the E-Flexer path, but the platform also attracted interest from

A GALEOTTA. SOURCE: CAPTAIN PHILIPPE SILLAN



EACH TYPE C LNG TANK HAS A MAXIMUM CAPACITY OF 250M^3 WITH A 95% FILLING RATE LIMIT. SOURCE: CAPTAIN PHILIPPE SILLAN

Brittany Ferries. The long negotiations between Brittany Ferries and Visentini eventually came to nothing with the French ferry operator choosing for an adapted Stena E-Flexer design to renew its fleet.

New design from scratch

Production of the Visentini Mk I class continued until 2021 with *GNV Bridge*, delivered in May 2021, closing the successful series. As the vessel's keel had been laid before 1 July 2010, *GNV Bridge*, just like her sister ship *Ciudad de Valencia*, and Baleària's LNG-powered *Hypatia de Alejandria* and *Marie Curie* – both from 2019 – wasn't Safe Return to Port (SRtP) compliant. SOLAS 2020 damage stability regulations and SRtP rules made the Mk I design obsolete, so the Mk II represents a totally new platform that complies with these IMO regulations. When Corsica Linea ordered the first Mk II in July 2019, the design was 90% complete so rather than starting from a clean sheet of paper, Corsica Linea opted for an off-the-shelf design adapted to its requirements when it came to LNG propulsion, the number of passengers, passenger cabins and car intake.

Although showing similarities with the original design, especially when it comes to the layout of the passenger decks, the Mk II platform started from scratch with a totally new hull design.

The twin skegs have been retained, but the so-called free flow form with V-brackets has been abandoned in favour of a full twin skeg. NAOS Ship and Boat Design's proprietary Flex Bow, creating a longer waterline and near-vertical stem, has been redesigned. This 'Flex Bow 2.0' comes with an integrated bulb. Thanks to exploiting the full available ship's length, the angle of entrance of the waterlines is lowered, reducing the vessel's pitching movements and guaranteeing a lower bow pressure impact in rough seas. Depending on the Froude number in relation to service speed, the Flex Bow also contributes to a reduction of fuel consumption with a 4% lower power requirement compared to a conventional bow shape.

While the 203.28m-long *Ciudad de Valencia* and *GNV Bridge* represented a lengthened version of the Visentini Mk I design, the standard first-generation Visentini ro-pax had a length of about 186m and 25.6m width. The

TECHNICAL PARTICULARS *A GALEOTTA*	
Length oa	206.6m
Length,bp	200.98m
Breadth, moulded	28.2m
Depth to main deck	9.6m
Draught, full load	6.7m
Gross tonnage	38,282
Net tonnage	14,943
Deadweight	8,190t
Lanemetres	2,559m (+149 cars)
Passengers	1,000 (short international voyages); 400 (international voyages)
Passenger cabins/ berths	220/878
Main engines	2 x Wärtsilä 12V50DF
Output	2 x 11,000kW at 514rpm
Service speed	23knots
LSAs	2 x 150-person Palfinger lifeboats + 2 VIKING MES (+ 8 liferafts)
Class	RINa
Class notation	RO-RO passenger ship, Unrestricted navigation, AUT-UMS, AUT-PORT, Gas fuelled, SRTP, IWS
Flag	France

THE VISENTINI MK II BOASTS A TOTALLY NEW HULL DESIGN WITH FULL TWIN SKEGS. SOURCE: CAPTAIN PHILIPPE SILLAN

dimensions of the Mk II increased to 206.6m and 28.2m, respectively, resulting in a higher block coefficient and displacement. For this reason, one of the main challenges was to achieve the same or even a better fuel efficiency which was achieved thanks to a long CFD optimisation process carried out by NAOS Ship and Boat Design. The ship's dimensions were dictated by the limitations imposed by Visentini's single building dock with *A Galeotta* having a Visentini-max beam. The near sister ship currently under construction for long-term bareboat charter to Polferries will be 10m longer, the shipyard's absolute maximum possible length.

Built-in flexibility – a Visentini first

While the low block coefficient of the first generation was one of the ship's strengths, it was at the same time also one of its weaknesses as it didn't allow for an extension of the accommodation decks on account of stability and displacement limitation issues. This drawback has been addressed in the new design, which allows for an extension of the accommodation decks to the ship's very aft, increasing the maximum passenger capacity to 2,000. This, together with the possibility to convert to double deck drive-through mode is part of the built-in flexibility, something that will be welcomed by shipowners operating outside of the Mediterranean Sea.

The lower decks, including the machinery spaces, have been redesigned to comply with SRtP and SOLAS 2020 damage stability rules. The Mk I design already featured a B/5 double skin for almost the full length of the hull, something which has been repeated on the Mk II class. Once again, simplicity rules in the engine room with twin engines driving two Kongsberg shaft lines via single input, single output clutchless Renk reduction gears. Although not an SRtP requirement, the naval architects opted to separate the main engines from the auxiliaries. A longitudinal centreline bulkhead divides the engine room into two halves with a transversal bulkhead separating the twin main engine rooms from the aft genset rooms, effectively creating four engine compartments. This compartmentation is probably best in class but is a more expensive solution as it requires additional escape routes and ventilation ducts.

The B/5 double skin protects both the main and auxiliary engine rooms from flooding. This compares to the Stena E-Flexer and other recent ro-pax designs which have full-width transversal bulkheads separating the main-cum-auxiliary engine rooms without B/5. Despite being fully SRtP compliant, such a design could potentially flood both engine rooms in the event of a damaged bulkhead following a collision, jeopardising the SRtP principle. On *A Galeotta*, the starboard B/5 double skin holds void spaces and the fixed ramp that connects the main vehicle deck with the lowermost car deck. On the portside, the B/5 compartment contains stores and the purifier room.

Dual fuel engines

Rather than the popular 46-type main engine, Corsica Linea opted for Wärstilä's 50 Series which is now out of production. The 12V50DF engines each have an output of 11,700kW, guaranteeing a 23knot service speed at 85% mcr and 15% sea margin. Anticipating a possible higher hotel load should accommodation be added, the Visentini Mk II comes with an extra auxiliary engine. In the case of *A Galeotta*, each genset compartment holds a

THE FULLY ENCLOSED 983LM UPPER VEHICLE DECK HAS A FIXED CAR DECK ON THE PORTSIDE FORWARD. SOURCE: CAPTAIN PHILIPPE SILLAN

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RINA is committed to ensuring that all individuals, regardless of gender, faith or ethnicity, have equal opportunity of being part of the global maritime community.

To raise awareness on this important topic RINA is launching the 2023 Eily Keary Award.

The award will distinguish an individual, company, or organization who has contributed to increasing **equality, diversity and inclusion** in the maritime industry.

HOW TO PARTICIPATE?

Nominations may be made by any member of the global maritime community. Individuals may not nominate themselves, although employees may nominate their company/ organisation.

Nominations should include a 750 word summary, describing the nominee´s contribution towards the advancement of equality, diversity and inclusion in the maritime industry.

Nominations are open until the 28th February 2023.
Online at: www.rina.org.uk/EilyAward
Or, by email: EilyKearyAward@rina.org.uk

A panel of members of RINA will deliberate and the winner will be announced at RINA's Annual Dinner.

For queries about this Award please contact the Chief Executive at: hq@rina.org.uk

THE ROYAL INSTITUTION
OF NAVAL ARCHITECTS

in association with

QINETIQ

2023
rina.org.uk

MARITIME INNOVATION AWARD

To enable the sustainable growth of maritime industries, innovation is paramount.

RINA in association with QinetiQ are launching the **2023 Maritime Innovation Award.**

The award will distinguish an individual, company, or organisation, whose research has pushed forward the boundaries of design, construction, or operation of vessels, particularly in the areas of:

Hydrodynamics, propulsion, structures, or materials.

HOW TO PARTICIPATE?

Nominations may be made by any member of the global maritime community. Individuals may not nominate themselves, although employees may nominate their company/ organisation.

Nominations should include a 750 word summary, describing the research and its potential contribution to improving the design, construction and operation of maritime vessels and structures.

Nominations are open until the 28th February 2023.
Online at: www.rina.org.uk/maritimeinnovationaward
Or, by email: maritimeinnovationaward@rina.org.uk

A panel of members of RINA and QinetiQ will deliberate and the winner will be announced at RINA´s Annual Dinner.

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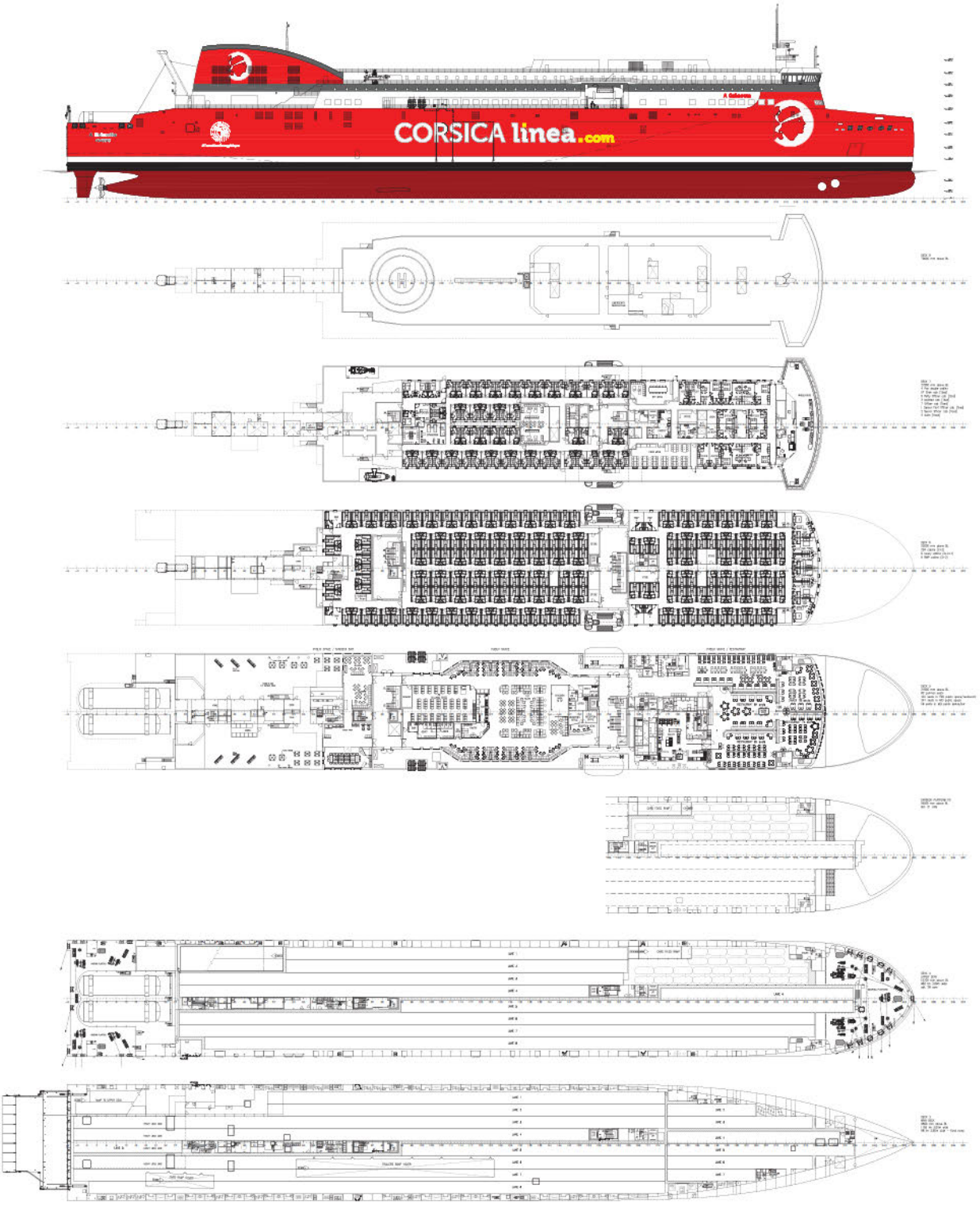
GENERAL ARRANGEMENT PLAN FOR *A GALEOTTA*



THE SINGLE STERN RAMP GIVES DIRECT ACCESS TO THE MAIN DECK WITH STRAIGHT LANES AND FIXED RAMPS LEADING TO THE LOWER FREIGHT DECK AND SEPARATE CAR DECK, RESPECTIVELY. SOURCE: CAPTAIN PHILIPPE SILLAN

combination of a Wärtsilä dual-fuel 9L20DF and an MDO-powered Caterpillar 3516C engine.

A Galeotta is engaged in a public service contract between mainland France and Corsica, serving either Bastia or Ajaccio from Marseille. Bastia is the island's main freight gateway and as *A Galeotta* is too long a ship to turn inside the port's basin, she swings off her berth just outside of the port, helped by a pair of Mariner spade rudders and Kongsberg bow thrusters that have an output of 1,500kW each.

On-deck LNG tanks

Corsica Linea considers *A Galeotta* as a major first step in its energy transition strategy and therefore it was clear from the outset that the new vessel had to be LNG-powered as no other alternative, 'cleaner' fuel was readily available on the market yet. The on-deck positioning of the two Type C LNG tanks, which each have a maximum capacity of 250m³ with a 95% filling rate limit, follows the tank arrangement of *Hypatia de Alejandría* and *Marie Curie*, the first LNG-powered ro-pax ferries built by Visentini. The Italian shipbuilder typically relies on proven technologies and therefore felt more comfortable to have the tanks installed on deck. However, the yet unnamed near sister ship under construction for Polferries will be completed as 'LNG ready' with tanks to be installed below deck, yet occupying the same location as on *A Galeotta*, which means that the fully enclosed Deck 4, the upper vehicle deck, will be extended to the very aft, creating an additional open car deck on Deck 5 level aft accessed via a hoistable car ramp.

According to NAOS Ship and Boat Design, the location of the LNG tanks on *A Galeotta* allowed for an optimisation of the cargo intake on decks 2, 3 and 4. Added benefits of the outdoor location of the LNG tanks are a complete segregation between the LNG spaces and the cargo as well as passenger spaces, not to mention the reduction of extra ventilation that is required when tanks are installed below deck. The tanks and all ancillary equipment were supplied by Wärtsilä with high partitions on either side of the funnel casing separating the tank and vent mast zone with the sundeck on Deck 5 aft. Until the arrival of Titan LNG's dedicated 4,500m³ LNG bunker barge *Krios*, Corsica Linea is relying on truck-to-ship bunkering in Marseille with *A Galeotta* having an autonomy to make three return sailings per week between Marseille and Corsica.

Improved cargo flow

To comply with the SOLAS 2020 damage stability rules, the blueprint of the lower vehicle decks had to be rethought. The standard Mk I Visentini typically boasted a car deck below the main deck with its access ramp continuing to a lower freight deck. As per SOLAS 2020 regulations, this arrangement was no longer possible, but NAOS Ship and Boat Design found a solution to retain both the car and freight deck without affecting the lane-metre intake. The freight deck moved up one deck, to Deck 2 level. Accessed via a single 47.7m-long and 4.05m-wide fixed ramp which has a two-section side-hinged watertight cover, Deck 2 has a 295lm intake. This comes very close to the 301lm capacity on Deck 1 of the 203.28m-long Mk I pair, *Ciudad de Valencia* and *GNV Bridge*. The Deck 1 car deck is totally separated from the lower freight hold, being directly accessed via a 48.7m-long and 3m-wide fixed ramp with a single watertight cover. It has a capacity of about 90 cars, nine cars short of the Deck 2 car deck capacity on the extended Mk I. It is a steep climb from the lowermost car deck to the accommodation decks, but a small stair casing forward also contains a lift that brings passengers directly to decks 5 and 6.

The ramp covers, just like the rest of the hydraulic access equipment, including the single stern ramp, were designed by Seville-based SP Consultores y Servicos. It also supplied the hydraulic and electric systems, but the steel structures were built by the yard. The 16m-long stern ramp, including 3m flaps, gives access to the eight-lane, 1,183lm main deck. The ramp has an 18m driveway that increases to 21.2m at the Deck 3 entrance. A fixed, 52.2m-long and 4.55m-wide portside ramp – which itself has a 98lm capacity – connects the stern with the fully enclosed upper vehicle deck which has a 983lm capacity. On the earlier generation, this fixed ramp was wider,

boasting the engine control room underneath it on Deck 3 level. With the engine control room moved to Deck 2 and the fixed ramp to Deck 4 narrowed from three to two lanes, the cargo flow into the main deck has improved a lot with straight lanes from stern to stem.

A requirement from Corsica Linea was the installation of a fixed car deck in the extreme forward end, on the portside of Deck 4. Up to 59 cars can be parked on two levels, increasing the total car capacity to about 149 without affecting the total 2,559lm trailer intake. Besides simultaneous loading of decks 3 and 4, the separation of the lower deck from the car deck, now makes simultaneous loading of all four vehicle decks possible. Something missing on *A Galeotta* though is the separate stern entrance for foot passengers with escalators connecting Deck 3 with the main accommodation deck.

A purebred Visentini

Never change a winning formula applies to the proven layout of the accommodation decks which span about two thirds of *A Galeotta*'s length. All public spaces are concentrated on Deck 5 with Deck 6 being the main passenger cabin deck. As befits a Visentini class ro-pax, the interior design is functional with long-term partner IGI Allestimenti in charge of the interior outfitting. The interior design was in the hands of Corsica Linea which collaborated closely with Paolo Ancora acting as the interior architect on behalf of IGI Allestimenti. Two stair halls divide Deck 5 into three parts. Forward is the 440-seat restaurant with partitions splitting the vast room into five smaller sections. Passengers can either opt for à la carte dining or light meals which are served from a dedicated snack bar located at the restaurant's portside entrance. With the focus on à la carte dining or snacks, the restaurant lacks the standard self-service counter. Instead, there is a small counter/buffet that is used to serve breakfast. The galley is located to the starboard side of the restaurant's entrance corridor, forward of the stair hall. A 347-seat midships bar lounge connects the aft with the forward stair hall. It comes with a dedicated children's play zone and a separate inboard reclining seat lounge with 82 seats that have plenty of legroom. The reception desk can be found on the starboard side, immediately abaft the forward stair hall.

At the rear of Deck 5 are a multifunctional room and electronic games zone to the starboard side and quiet seating lounge on the portside. On either side, there is access to the sundeck which has fixed deck furniture. On the starboard side of the funnel casing is a kennel with the sundeck bar on the portside of it having an outdoor-indoor function as it also service the quiet lounge. More outer deck space in the form of promenade decks is available midships. This doubles as the evacuation deck with two 150-person Palfinger lifeboats and two Viking MESs connected to eight inflatable liferafts.

216 passenger cabins stretch the full length of Deck 6 – 204 standard four-berth inside and outside cabins, six four-berth cabins for people with reduced mobility and six five-person forward-facing luxury cabins. With four more double-bed cabins on Deck 7, the bridge deck that also accommodates the officers and crew, the total number of passenger cabins stands at 220, equivalent to a maximum capacity of 878 passengers. Visibility from the fully enclosed bridge has improved with full-height windows replacing smaller windows throughout. In compliance with the SRtP rules, a windowless emergency bridge has been integrated into the Deck 8 deckhouses, being located abaft the emergency generator room.

More Visentinis to follow

Once the Mk II for Polferries has been floated out, Cantiere Navale Visentini will start with the construction of a lengthened sister ship of the 2017-built *ML Freyja*. A freight-only vessel, there are no SRtP obligations to be adhered to. This freighter will be followed by yet another Mk II ro-pax which will be built on speculation as Visemar, the builder's shipowning arm, is already in discussion with potential charterers. Interestingly, the lengthened sister ship of *ML Freyja* will be the first ship to have NAOS Ship and Boat Design's in-house Wing Sail Module (WSM) installed. Meant to reduce the ship's mechanical propulsion, the fully automated WSM is made of rotating solid steel and aluminium blades that can fold down. A scale model prototype of the WSM has been in operation onboard *GNV Bridge*. The system has met expectations so far and the design has meanwhile been improved with NAOS Ship and Boat Design likely to join forces with an unspecified equipment manufacturer for the production of its WSM. ■

COMPARED TO THE EARLIER VISENTINI GENERATION, VISIBILITY FROM THE FULLY ENCLOSED BRIDGE HAS IMPROVED THANKS TO FULL-HEIGHT WINDOWS THROUGHOUT. SOURCE: CAPTAIN PHILIPPE SILLAN

ACCOMMODATION & INTERIORS

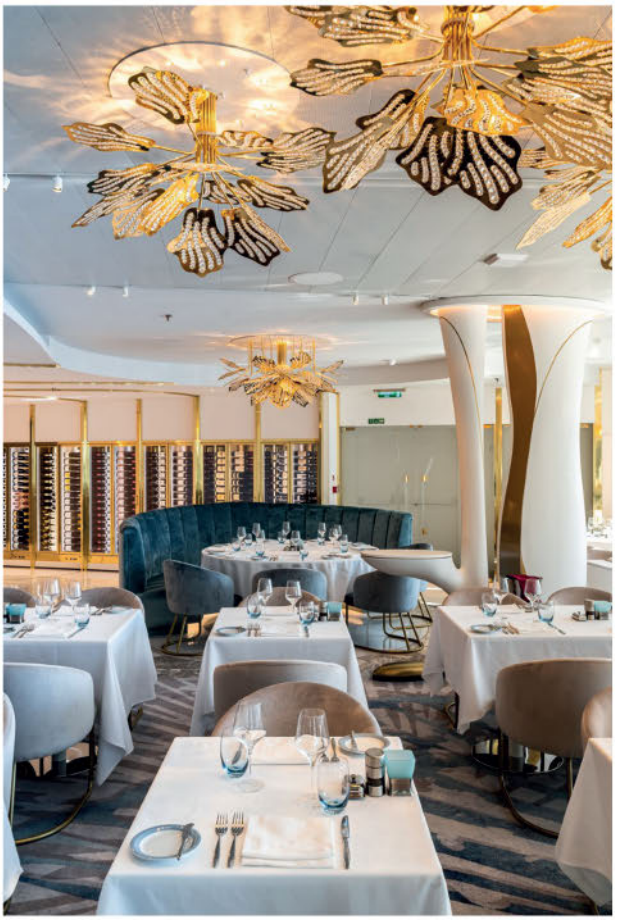
EMERGING DESIGN TRENDS CALL FOR CREATIVE SOLUTIONS

By **Jan Krefting**, chairman, YSA Design

As one of the world's leading design studios for the cruise sector, YSA Design closely follows industry developments to ensure its work meets the ever-evolving expectations of cruise passengers and addresses the challenges facing operators.

In fact, my own appointment as YSA Design chairman in October 2022 was timed to respond to a return to more collaborative working as the company served an upturn in complex cruise industry concept and project work – much of which has centred on two major design trends.

Following the Covid-19 pandemic, there has been an evolution in guest preferences, with tastes moving away from the large spaces which have been a feature of cruise ships over the last two decades, and towards smaller, more private venues that offer a sense of greater intimacy.



PRIMA'S SEVENTH DECK AT HUDSON'S

Reflecting this trend is YSA Design's work onboard *MSC World Europa*. Accommodating over 6,700 passengers, the 333m vessel is the largest cruise ship YSA has ever worked on, and yet by designing multiple outdoor areas to the 'human scale', the company succeeded in offering small, secluded spaces for guests to enjoy alone or in small groups.

Similarly, the YSA-developed Magrodome on deck 19 features partitioned areas including Jacuzzis cocooned in rope netting to offer privacy, while materials and colours throughout the venue evoke a tranquil tropical paradise.

Despite the overall size of the ship, MSC also demanded multifunctionality in other zones onboard *Europa*, in turn demanding that YSA Design reimagined the cruise line's signature Doremiland kids' club. To cater to all age groups from babies to teens, YSA used bold colours, geometric shapes and quirky lighting for the youngest children; a fairy-tale theme for toddlers; and manga-inspired wall art for teens. The company applied the same flexible approach to developing Europa's Sportplex, which hosts team sports, rollerblading and bumper cars and allows quick changes from one function to another.

In another major trend in cruise ship interiors, YSA Design has encountered a growing preference among operators for spaces which call to mind the experience of luxury accommodation ashore. For example, in designing multiple interior spaces onboard Norwegian Cruise Lines' new first-in-class vessel, *Prima*, YSA took the aesthetics of modern, high-end hotel accommodation to create a fresh look and feel for restful days at sea.

The mood continues aft on *Prima*'s seventh deck at Hudson's – a New York-style restaurant offering 280-degree views from the stern. This upmarket venue is decorated in contrasting bright and deep-blue tones, with golden finishes reflecting the natural light that enters through sloping floor-to-ceiling windows. Adding colour and texture are the velvet upholstery and the organic, abstract motif of the carpet, while crystal-embedded gold-leaf chandeliers cast intricate patterns of light on the ceiling.

On Deck 8, aft of the back stairs, is The Local, a more casual venue comprising a starboard bar and a restaurant on the port side. In the bar, cool blue lighting from behind the counter contrasts with the warm, earthy tones of the seating area, and multicoloured mosaic tiling and wood-panel flooring

converge at straight and diagonal angles in the centre. Sharing the warm palette of the bar seating area, the restaurant combines boldly coloured upholstery with subdued wood and brick finishes. The entire venue is unified by a dark, semi-open ceiling partially illuminated by contemporary string lights.

Comprising three lobbies, four lift towers and 14 lifts, the forward and aft public stairs feature a consistent look and feel based on straight lines, marble flooring, stylish stone finishes with metal detailing and deep-blue tones reflected in the mirror elements and chandeliers.

Adjacent to the lobbies are the public toilets, which have themselves been freshly designed in line with post-pandemic hygiene standards, as demonstrated by the touchless taps, soap dispensers and dryers that have been integrated in wash basins throughout. With their sophisticated and clean aesthetic, including wood and stone finishes, even restroom design has been re-envisioned to uphold the modern hotel styling concept throughout. ■

YSA DESIGN CHAIRMAN JAN KREFTING

THE PUBLIC TOILETS ON *PRIMA* HAVE BEEN DESIGNED IN LINE WITH POST-PANDEMIC HYGIENE STANDARDS

OFFSHORE WIND

THE ROLE OF THE NAVAL ARCHITECT IN FLOATING OFFSHORE WIND

By **Jake Anderson**, engineering director, ABL Group

Now is a fantastic time to be a naval architect. The employment market is booming with opportunities across lots of sectors of the marine industry. This article describes one such sector that provides an opportunity for naval architects to solve some of the challenges of the climate crisis.

A ship can be defined as a marine device that carries a payload with a specific hydrostatic and hydrodynamic performance. However, there are other devices that fulfil this definition including floating wind turbine systems.

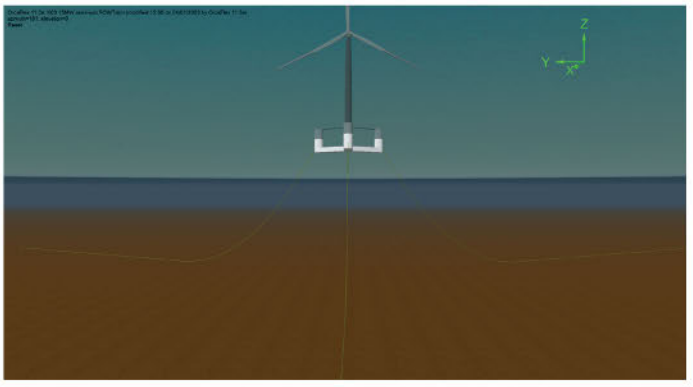
Offshore wind has grown to become one of the cheapest forms of large-scale electricity production in the UK, with the capacity of the recently opened 1.3GW Hornsea Two wind farm being larger than all of the UK's current nuclear power stations ((BEIS), UK Government, 2016), but at a fraction of the cost of the under-construction Hinkley Point C. The vast majority of offshore wind farms are bottom fixed, with a monopile or a jacket foundation, but these are only cost effective for installation in relatively shallow waters of up to around 50m. Northern Europe is surrounded by a continental shelf which is well suited this technology but there are many other parts of the world where the water depth is too deep to allow turbines to be fixed to the seabed. Overcoming this depth restriction is driving a technology race to develop cheap, scalable floating platforms for large wind turbines.

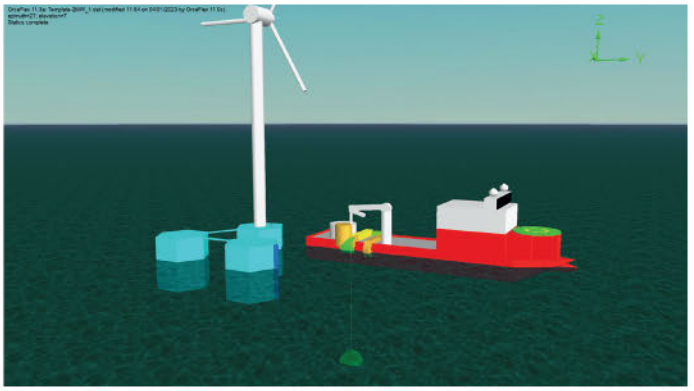
The forecast for the growth in offshore wind is breathtaking. In Q1 2022, the UK's 13GW of installed capacity of offshore wind capacity (UK Department of Business, Energy and Industrial Strategy, 2022) was the second largest type of electricity generation in the UK at 15% of the total, beating nuclear for the first time. However, achieving net zero emissions by 2050 requires the worldwide annual additional installed offshore wind to increase from 5GW per year in 2020 to 80GW per year by 2030 (International Energy Agency, 2021). The number of sites suitable for floating wind will depend upon how the technology matures, but there is no doubt that there will be an order of magnitude more sites that bottom fixed wind. Accordingly, as the costs decrease, it is likely that the demand for floating wind will be unprecedented, and its contribution to addressing the climate crisis will be huge.

A floating wind turbine generator is a complex marine device. Buoyancy carries the payload of the turbine, which can comprise of a 150m-tall tower topped with a 700tonne nacelle driven by 55tonne blades that sweep an area with a 220m diameter. Geographical position is maintained by a mooring system, either catenary bottom fixed, catenary daisy-chained between turbines or taut bottom fixed. The system must also support dynamic electrical cables for the export of the power. There are several different types of buoyant structure that support the wind turbine, all of which will be familiar to naval architects that have experience in the oil and gas industry.

Fluctuating forces

The fluctuating forces from the turbine are dictated by a control system designed to optimise power generation, which along with the flexible nature of the turbine and mooring systems mean there are many different load frequencies to resist. Unlike bottom fixed foundations, floating wind foundations are designed to be buoyant and many proposed designs are stiffened plated structures that will be built by shipyards. Deriving the optimum design for all of these drivers requires engineers with knowledge of wave loadings, hydrostatics, hydrodynamics, mooring systems, marine operations, stiffened plate design, cost and benchmarking of fabrications in shipyards, and





FLOATING WIND SYSTEM. SOURCE: ABL LONGITUDE ENGINEERING

the design process required to solve this conundrum. The one engineering discipline that covers all of these topics is of course the naval architect: the marine system integrator.

Naval architects working in the oil and gas industry have been designing and installing both floating and fixed structures for many years. They provide a fairly minor contribution to a bottom-fixed structure project, focused on the calculation of hydrodynamic loads and the transportation and installation. However, floating production systems required a much greater contribution from naval architects, and there are many parallels of the expansion of the opportunities for naval architects that occurred as the number of oil and gas floating production projects increased as with the transition from fixed to floating offshore wind.

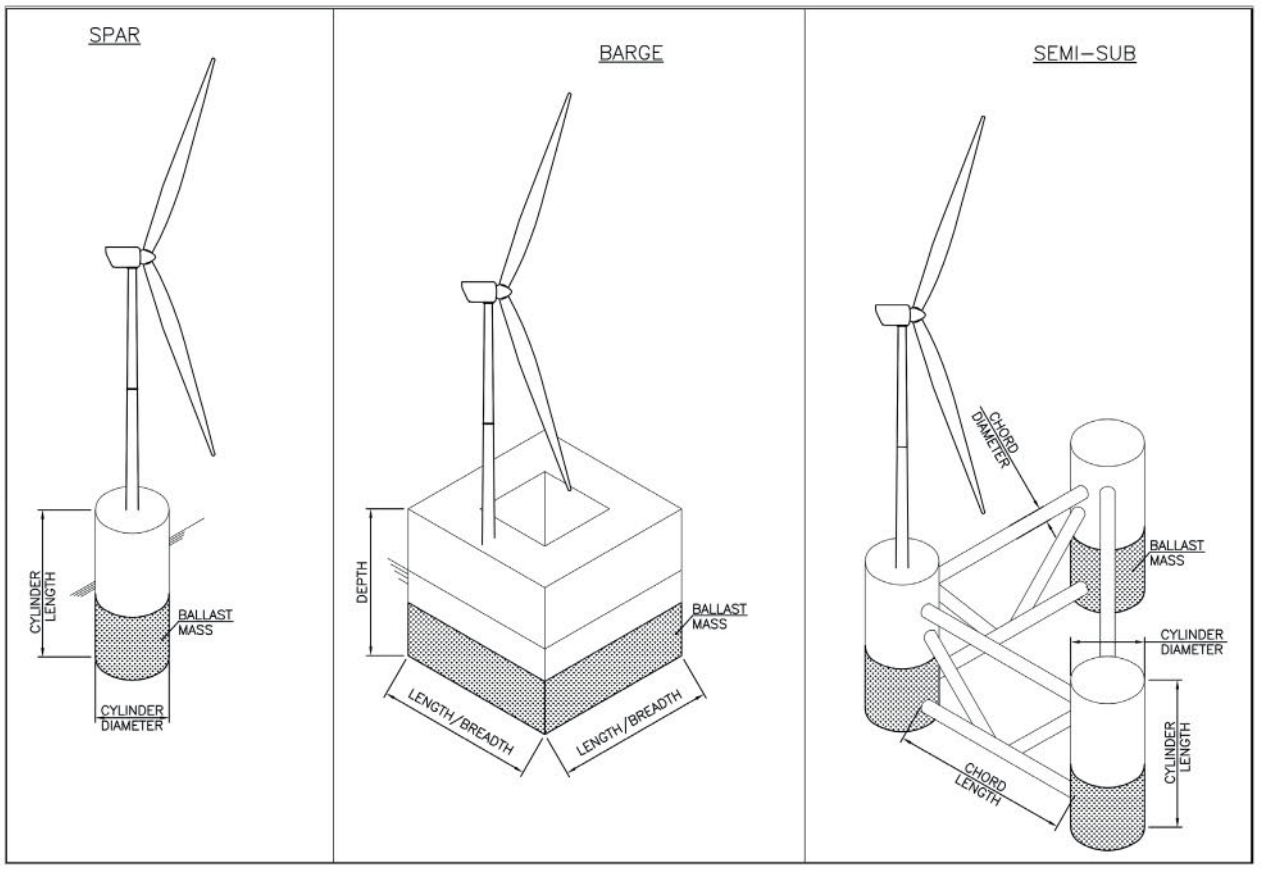
ABL Group is focused on energy transition in the marine environment, and as part of this drive, has become a leading force in offshore wind having worked on over 40 floating wind projects. It has teams dedicated to the development of floating wind technology, to the development of floating wind projects and the engineering and oversight of the installation of the projects. ABL Group company OWC is currently the principal designer and owner's engineer on a UK-based floating wind farm, the first of many floating wind projects in the Celtic Sea currently under development. OWC has worked on the development of several different floating wind technologies and worked alongside other ABL companies which have prepared the installation engineering and installation oversight of projects.

ABL ENGINEERS ON A SHIP VISIT. SOURCE: ABL LONGITUDE ENGINEERING

Evolving ways of working

Naval architects are critical members of the teams within all ABL companies, but the industry is facing unprecedented pressures from simultaneous growth in many directions. The defence industry is booming, with increased expenditure by governments leading to growing numbers of opportunities and expanding design teams. Commercial shipping requires new low- or zero-emission tonnage, and the increase in oil and gas prices is increasing the investment in the extension of existing facilities and in some cases, new projects. Further to concerns regarding where the future engineers will come from, employees are also becoming more demanding:

I. Some people only wish to work in energy transition related projects. Whilst this could be interpreted by



DIFFERENT FLOATING WIND FARM FOUNDATION TYPES. SOURCE: ABL LONGITUDE ENGINEERING

employers as a lack of flexibility, it actually shows drive, dedication and a moral stance which should be applauded.

II. Some people undertake market sector degrees rather than discipline degrees, for instance MScs in Renewable Energy. The content of these degrees are often similar to those in a traditional naval architecture degree but the onus is on the employer to satisfy themselves that the content is relevant.

III. Some people look for flexible working. Covid has taught many employers that rigid work patterns of nine-to-five, five days a week in an office are not necessary to maintain productivity. However, people starting out on their careers require interaction and mentoring with colleagues, and oversight from more senior staff to ensure they develop to their full potential. Striking the balance between flexibility and structure can be hard for employers and this is an important factor in defining the culture in the company, so must be treated with care.

IV. Of course, people want their salaries to follow the market rate. The market rate for people is undoubtedly increasing due to the limited supply of engineers and the demand from industry, and employers must stay in touch with these increases. However, as the pool of people is finite and services different sectors, the influence of one sector will affect others. For instance, the increase in defence spending may increase the margins on these military ship projects providing employers in the sector with more room to increase salaries. This could result in other important sectors being unable to attract the right people and the knowledge and opportunity therefore moving overseas.

To address these concerns, ABL has adapted to the changing ways of working, the training and development of staff and embraces the views of younger employees as they provide an insight into the future direction of the company. ABL is also working with universities and professional institutions to raise the profile of the sector and products such as floating wind devices with naval architects to ensure that career paths are known to people before they enter the jobs market. But, wherever today's students training in naval architecture end up, they will undoubtedly have plenty of opportunity to make their mark on society. ■

JACK-UP GIANT READY TO BUILD NEXT GENERATION OF OFFSHORE WIND FARMS

By **Daniel Johnson**

With the increasing demand for decarbonisation and lower-cost green electricity, offshore wind turbine and foundation components continue to increase in size, to a point where their dimensions have largely outgrown the current market installation capability. The global offshore wind industry is already forecasting installation vessel shortages by the mid-decade.

"The bigger the turbine, the more power you generate," explains Rutger Standaert, manager of vessel construction at Belgium-based offshore engineering company Jan De Nul Group. "This simple rule has been shaping the offshore wind industry since its early days. Consequently, technological limits are constantly being pushed."

To illustrate the point, Standaert notes that today's blades are up to 107m long and will soon reach the 120m mark. "But that's all tech for tech's sake if you can't get those turbines out to sea and installed properly," he adds.

Jan De Nul has been preparing for the arrival of these next-generation offshore wind components and in 2019 announced the order of *Voltaire*, "the world's tallest

JACK-UP INSTALLATION VESSEL *VOLTAIRE* LEAVING COSCO SHIPPING SHIPYARD IN CHINA. SOURCE: JAN DE NUL GROUP

WITH ITS CRANE UPRIGHT AND LEGS AT MAXIMUM DEPTH, *VOLTAIRE* STANDS TALLER THAN THE EIFFEL TOWER. SOURCE: JAN DE NUL GROUP

jack-up installation vessel". The vessel was delivered by COSCO Shipping Shipyard in Nantong, China, at the end of 2022 and is now on its way to Europe to begin wind farm installations.

Taller than the Eiffel Tower

Designed in-house, and pushing engineering boundaries, *Voltaire* is built to transport, lift and install offshore wind turbines, transition pieces and foundations. The vessel has nearly double the deck space of Jan De Nul's previous largest vessel and, with its crane upright and legs at maximum depth, stands taller than Paris's Eiffel Tower. It can handle wind turbines over 270m high and blades 120m long.

Key features include a main crane of over 3,000tonnes, an operating depth of around 80m, a capacity to lift 16,000tonnes of useful cargo out of the water (the equivalent to more than 40 Boeing 747s) and accommodation for 100 persons. The vessel has four 130m legs to raise itself above the sea level for stable working conditions and is equipped with a DP2 diesel-electric propulsion system consisting of eight gensets, four stern thrusters, two bow thrusters and two retractable bow thrusters.

"We have a lot of experience with dredging vessels, but we had never built a jack-up installation vessel ourselves," says Jan Van de Velde, head of fleet construction at Jan De Nul. "The challenge was to integrate the legs into the vessel, taking into account all operational aspects. Fortunately, we have learned a lot from the two jack-ups (the *Vole au vent* and the *Taillevent*) we've already been working with."

Thanks to those legs, the *Voltaire* can install wind turbines further out at sea than any other vessel, unlocking a whole new area for energy purposes. "Off the Scottish coast, for example, expensive floating wind farms are often the only way to tap into offshore wind. The water is too deep for fixed wind farms, but the *Voltaire* can offer new opportunities," notes Standaert.

Green technologies onboard

Voltaire is not only innovative in terms of its capacity but also when it comes to sustainability. The vessel can operate on second-generation biodiesel that will reduce the fuel carbon footprint by up to 90%. It is also equipped with an advanced dual exhaust filter system, removing up to 99% of nanoparticles from emissions using a diesel particulate filter and reducing the NOx emissions and other pollutants by means of a selective catalytic reduction system to levels in accordance with EU Stage V regulation.

"The *Voltaire* is the first certified ultra-low emission vessel (ULEv) of her kind," says Standaert.

For its maiden assignment, *Voltaire* will mobilise to the United Kingdom for the construction of the 3.6GW Dogger Bank offshore wind farm in the North Sea, transporting and installing 277 huge GE Haliade-X turbines, each capable of generating up to 14MW. As such, the *Voltaire* will contribute to the largest offshore wind farm in the world, generating enough energy to power up to six million homes every year – around 5% of the UK's electricity needs.

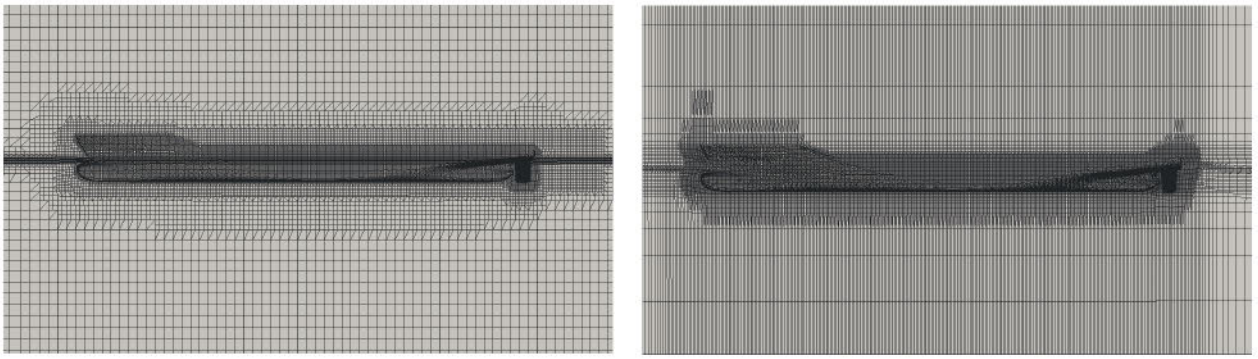
Not only is the vessel ready for the future of offshore renewables, but it is also deployable for the oil and gas industry, and for the decommissioning of offshore structures. ■

TECHNICAL PARTICULARS *VOLTAIRE*	
Length overall	169.3m; 181.78m (incl. helideck)
Moulded breadth	60m
Moulded depth	14.6m
Maximum draught	7.5m
Deadweight, max	21,500t
Max. crane lifting capacity	3,200t
Lifting height above deck	162.5m
Cargo deck	7,000m²
Max. deck load	20t/m²
Max. payload	16,000t
Max. water depth	abt. 80m
Leg length	abt. 130m
Main Gen Sets	Diesel engines: 4 x 3,535kW, 4 x 2,650kW
Service speed	11.5 knots
Class	DNV
Class notation	Self-elevating Wind Turbine Installation, DYNAPOS-AM/AT-R (DP Class 2), Clean Ship ND07, Green Passport EU
Flag	Luxembourg

CFD & HYDRODYNAMICS

COUPLING ADAPTIVE MESH REFINEMENT WITH A 6DOF VOF RIGID BODY MOTION LIBRARY

By **Paolo Geremia**, director, ENGYS Italy, and **Kevin Maki**, University of Michigan, USA



THE STANDARD MESH APPROACH (LEFT) FEATURES 2.2 MILLION CELLS, WHEREAS THE AMR MESH (RIGHT) IS MORE REFINED AND ONLY USES 2 MILLION CELLS

The impressive capabilities of modern simulation tools have allowed computational fluid dynamics (CFD) to be applied to more complex marine vehicle performance evaluations. This has uncovered new modelling challenges, which has stimulated the development of a variety of techniques such as Adaptive Mesh Refinement (AMR). To account for the hydrodynamics of ships, AMR is often used with static meshes, which has become a standard offering in most CFD packages. However, ENGYS have recently developed a new AMR method, which is coupled with a unique 6DoF VOF rigid body motion library, making the HELYX-Marine software suitable for dynamics as well.

CFD simulation challenges

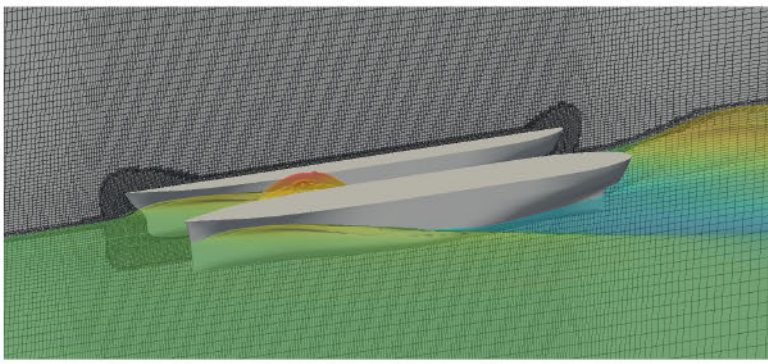
When simulating the resistance and motion of marine vehicles in CFD, one of the main problems is accurately modelling the free surface. The density of water means that when it is displaced, it changes the effective mass of the system. This added mass alters the frequency of the body motions that influence the dynamic response of the free surface continuously over time, and therefore needs to be considered for accurate simulation.

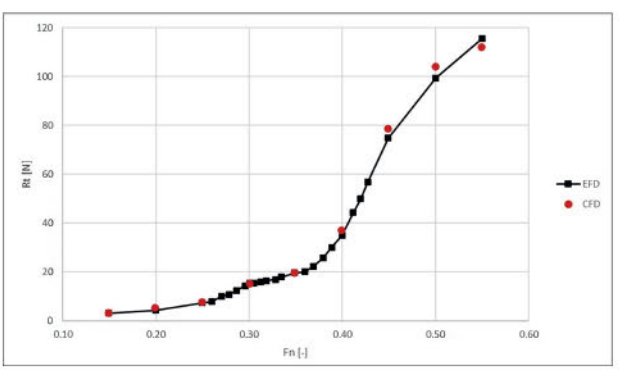
Furthermore, the high Reynolds number of full-scale ships combined with the smooth surface of ship hulls makes it extremely difficult to develop turbulence models and meshes that reliably predict the behaviour of the boundary layer and separation.

Due to the need to pack grid points into the boundary layer, and to use grid points to resolve a moving interface, AMR is a powerful strategy to adapt the mesh dynamically as the ship generates its own wave field and responds to propagating environmental waves.

Coupling AMR with a rigid body motion library

To address these issues, CFD vendors have coupled AMR together with rigid body motion libraries. This enables the automatic generation of a refined mesh whilst also incorporating the Volume of Fluid technique





COMPUTATIONAL GRID AND FREE SURFACE ELEVATION (TOP RIGHT) AND CALM-WATER RESISTANCE OF THE S60 CFD SIMULATIONS COMPARED TO THE EXPERIMENTS (BOTTOM RIGHT)

(VOF) [1]; accurately resolving the free surface and the boundary layer.

"By coupling AMR with a 6DoF VOF rigid body motion library, you can accurately model the hydrodynamics of a ship moving arbitrarily in the sea," highlights Paolo Geremia, director at ENGYS Italy. "The behaviour of dynamically changing free surface patterns and their influence on the ship are accounted for, while the mesh is refined automatically, allowing the user to focus on the solution rather than manually creating an effective mesh."

The HELYX-Marine software from ENGYS features an AMR method specifically developed for free surface flows. It utilises a conservative field mapping and re-computation of wall-distance fields along with an optimised algorithm that prevents successive refinement and unrefinement of the same cells.

This is coupled with a 6DoF VOF rigid body motion library [2] that has been validated with dozens of marine engineering problems over the last 10 years. Unlike other CFD codes, HELYX-Marine features an Earth fixed reference frame, which allows for a much more accurate representation of the relative motions. Another unique feature is HELYX's ability to accurately account for the added masses and inertias within a simulation.

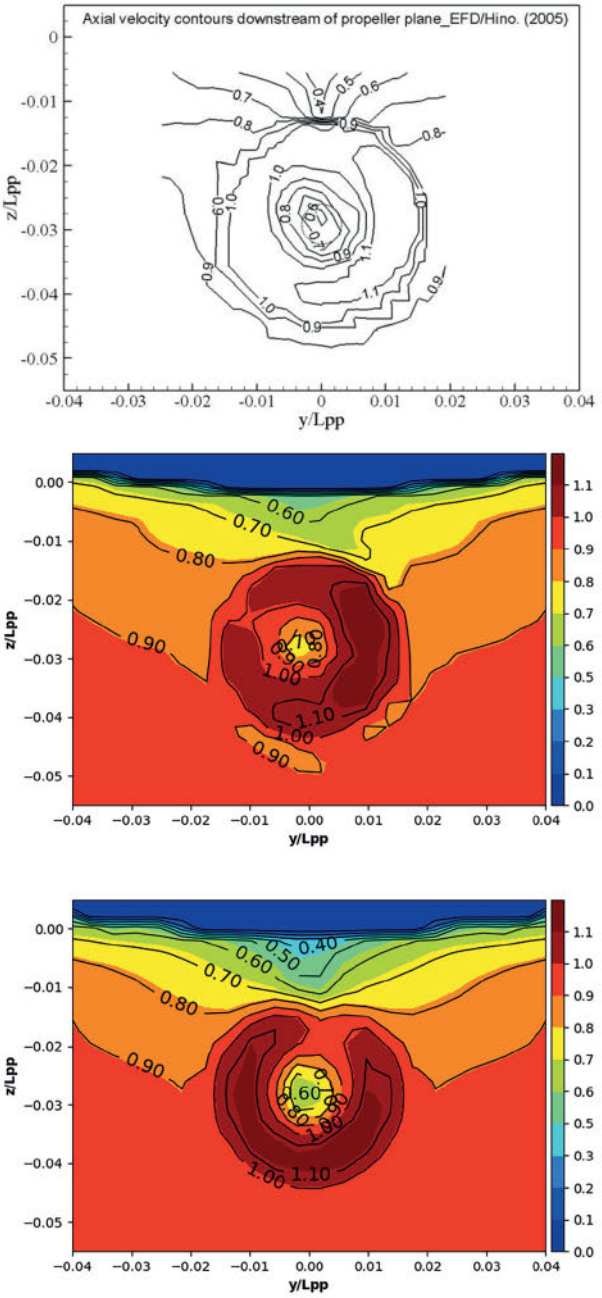
"The rigid body motion library essentially solves the equations of motion," highlights Kevin Maki, professor at the University of Michigan, USA, who partnered with ENGYS to develop HELYX-Marine. "Our algorithm implicitly solves the fluid equations together with the rigid body equations with only a few iterations, even in large-amplitude seaways. To achieve a robust and efficient algorithm that is suitable for a wide range of wave conditions, we use a relaxation technique that considers the added mass of the body to stabilise the time integration. The algorithm allows for general purpose ship hydrodynamics simulations in a wide range of wave and calm-water conditions. Then, the meshing is highly efficient since the adaptive mesh refinement allows you to generate a very basic background mesh, and then the solver will refine the mesh adaptively as the solution develops, and that is very powerful."

Calm water resistance

To validate the accuracy of this approach, simulations were conducted on a variety of case studies including calm water resistance, self-propulsion and seakeeping.

For calm water resistance, the reliability of the AMR was first validated using three sizes of mesh on the Gothenburg 2010 workshop case 2.2a tested at Fr 0.26 speed. The results were correlated with research experiments, and the percentage error was found to decrease from 3.22% for a coarse mesh to 0.51% for a fine mesh. This monotonic convergence proves the algorithm is stable and that the higher the mesh refinement, the higher the accuracy.

Next, the results of an AMR mesh were compared with a manual meshing approach. AMR not only optimised the mesh in complex regions, but was also more



AXIAL VELOCITY CONTOUR DOWNSTREAM OF THE PROPELLER PLANE: EXPERIMENTS (TOP), CFD SIMULATION USING THE DISCRETIZED PROPELLOR (CENTRE) AND THE ACTUATOR DISC (BOTTOM)

efficient, using less cells (2 million) than the standard mesh (2.2 million cells).

"The overhead increase between an unoptimised mesh, without AMR, and a mesh using AMR is only around 10 to 20%," says Geremia. "This leads to a very small increase in computational time, yet the increase in accuracy is extremely high because of the extra refinement."

This was further proved by another study which compared the total resistance of a S60 Catamaran using HELYX-Marine with experiments conducted by the Model Basin Research Group at the University of Madrid. The mesh was refined with AMR, resulting in a mesh of 2.8 million cells using five near-wall layers. The

results show a strong correlation between the CFD and the experiments, particularly from Fr 0.15 to 0.45 testing speeds. The accuracies and run times achievable with modern CFD codes means that CFD is now replacing the majority of calm water resistance testing.

Self-propulsion

Modelling the behaviour of propellors in self-propulsion cases presents further simulation challenges. "When a propellor operates near the hull of a ship, the fluid accelerates along the hull which lowers the pressure slightly and therefore changes the force on the ship," explains Maki. "You also need to consider the effect of the wake, as this influences the propellor performance. Propellors spin fast relative to the time it takes a ship to travel one of its lengths. For every length of the ship travels, it may spin more than 100 times. To capture that in CFD, along with the high velocities at the propellor tips, you need to simulate at much smaller time steps. Typically, time steps can be around 50 times smaller than that of a calm-water resistance test case."

This smaller time step demands a much higher computational time. To minimise this, the common practise is to use a simplified rotating actuator disc that provides the same thrust and torque as a propellor. Using the Gothenburg 2010 workshop case 2.3a, simulations were run using a discretized propellor and a simplified actuator disc. In both cases, the AMR was shown to accurately resolve the flow downstream the propellor plane, which is particularly impressive considering the complex flows resulting from the propellor.

Seakeeping

As mentioned earlier, the continuously changing added mass of non-linear waves is essential to achieving reliable CFD simulations of seakeeping analysis. However, this can be very computationally expensive and so requires running on HPC clusters. This is where the open-source nature of HELYX-Marine brings further benefits, as it gives users the flexibility to distribute the load across numerous processes at no extra cost.

For the final study, the free surface elevation of the waves was modelled using the Tokyo 2015 workshop case 2.10 C2 and the results were compared with experiments. A close correlation was found between the simulation results and experiments for both sinkage and trim ship motion.

PAOLO GEREMIA, ENGYS ITALY

KEVIN MAKI, UNIVERSITY OF MICHIGAN

Benefits of HELYX-Marine

Overall, the coupling of HELYX's AMR together with an earth-fixed 6DoF VOF rigid body motion library has resulted in a CFD software that can accurately model the hydrodynamics of ships in calm water resistance, self-propulsion and seakeeping. The open-source core of HELYX-Marine allows users to exploit computational resources, leading to an accurate yet cost effective CFD solution to solve some of marine's most complex performance evaluation scenarios. ■

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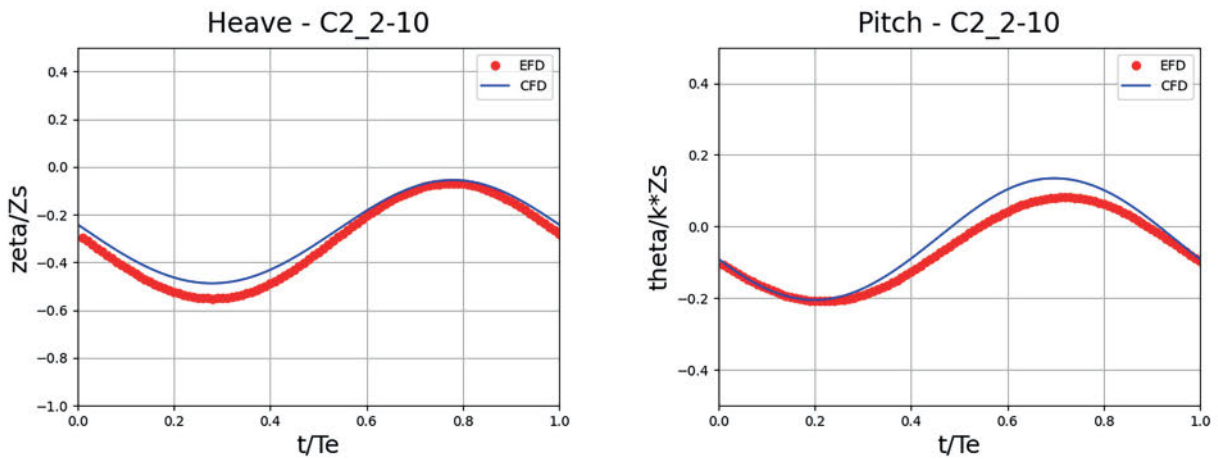

SINKAGE (LEFT) AND TRIM (RIGHT) COMPARISONS BETWEEN CFD AND EXPERIMENT RESULTS FOR SEAKEEPING

COMBINING LOG DATA AND CFD IN TRIM TABLES

By **Falko Fritz**, Albis Marine Performance GmbH, Germany (falko.fritz@albis-mp.com)
Inno Gatin, Cloud Towing Tank, Croatia (innogatin@cloudtowingtank.com)

Decarbonisation is the grand challenge of the 21st century. Rising fuel prices and the IMO's push with regulations like CII have put the topic high on every shipowner's and operator's priority list. One aspect of optimisation is the vessel's trim, commonly represented by trim tables that identify the favourable trims in various draft conditions. These tables are usually based on performance data logs recorded on the vessel over years (see Figure 1) or on computerised fluid dynamics (CFD) simulations. This article assesses the benefits and limitations of both methods.

Log data quality requirements for trim tables

A ship's efficiency is generally defined by the speed it reaches at a given propulsion power, taking other influences like draft, weather conditions, etc. into account. The standard ISO 19030, measurement of changes in hull and propeller performance [1], defines the parameters and measurement accuracy required for a reliable monitoring of hull condition. But while the effects of hull fouling or laden vs. ballast draft can easily change a vessel's power demand by 20% or 30% to reach the same speed [2], the differences expected from trim changes are much smaller. Consequently, the requirements to measure all relevant factors precisely are even stricter.

The propulsion power of an M/E drive train is relatively easy to measure and mass fuel meters logging the M/E inlet and M/E outlet fuel flow may even be more reliable in practice to gauge the ship's energy consumption precisely. The more difficult parameter to measure is the speed through water (STW). The exact speed over ground (SOG) is very easy to determine by GPS, but STW takes sea currents and tidal flows into account. Two different methods are widely used to log STW:

- Recording SOG and correcting it for surface currents using weather service data. However, weather data has a limited resolution in time and space and only shows currents at the very surface. But most of a ship's hydrodynamic resistance is created many meters below the surface, where currents may have a different speed and direction than directly at the surface.
- Recording STW directly with the ship speed log installed at the bottom, where the more relevant currents are. However, speed logs are often affected by fouling even if the hull itself isn't, since the sensor itself creates an irregularity in the surface, which helps organisms to attach. This causes changes in the fluid flow directly at the log and affects the reading.

Accurate STW data are crucial. Due to the cubic dependency of propulsion power and ship speed a ship only speeds up by approximately 1.5% if the power is increased by 5%. This means, if the STW measurement can't reliably detect speed changes of 1-2%, it is impossible to attribute e.g. a power reduction of 5% to improved trim with certainty.

Consequently, high-quality sensors and proven evaluation methods are a necessity to generate meaningful trim tables. Only ships travelling short distances between the same destinations repeatedly may generate analysable data on a per-voyage basis. Extensive practical experience with ship data shows that the great majority of cargo vessels will require high frequency data logs to generate accurate trim tables. Trim changes happen on a comparatively short time scale and noon reports cannot capture the various changing influences occurring over 24hr. Only sensor data logs as described in ISO 19030 with an additional Inertial measurement unit (IMU) to record trim changes automatically can realistically reach the accuracy required for the task.

Systematic benefits and limitations of log data based trim tables

The main benefit of log data is that they show the ship in its actual state. Only recordings on the vessels itself

Measured Fuel Consumption Rates in Percent of Average

Center Draft [m] \ Trim [m]	Trim by Head -1.50	-1.25	-1.00	-0.75	-0.50	-0.25	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	Trim by Stern 3.25	3.50
8.0					63%									72%	72%	67%	71%		81%	83%	
8.5										82%	82%	80%	81%	84%	85%	84%	84%	83%	82%	84%	84%
9.0					85%	84%	83%	83%	80%	83%	83%	81%	81%	83%	84%	83%	83%	82%	84%	83%	80%
9.5				89%	84%	84%	85%	86%	88%	85%	86%	85%	81%	83%	83%	84%	85%	87%	87%	84%	77%
10.0			78%	86%	90%	97%	91%	86%	86%	86%	87%	88%	88%	88%	88%	89%	90%	88%	88%	91%	85%
10.5				89%	89%	91%	87%	85%	88%	88%	87%	89%	90%	91%	91%	87%	87%	87%	86%	87%	89%
11.0			102%	92%	96%	96%	91%	88%	93%	93%	79%	78%	76%	80%	90%	88%	87%	87%			
11.5		90%	91%	92%	92%	95%	93%	91%	94%	95%	95%	93%	89%	93%	95%						
12.0	93%	93%	92%	95%	103%	98%	90%	92%	90%	90%	93%	93%	92%	92%							
12.5	99%	96%	97%	98%	100%	101%	98%	99%	96%	97%	101%	96%	104%	102%	101%	100%					
13.0	98%	97%	98%	98%	98%	96%	99%	100%	102%	101%	100%	100%	100%	107%	101%	96%	82%	82%	75%		
13.5	103%	100%	98%	95%	99%	100%	99%	101%	101%	98%	101%	103%	103%	99%	87%	89%	90%	96%	107%		
14.0	101%	100%	101%	101%	100%	101%	101%	100%	101%	106%	105%	105%	109%	114%	108%						
14.5	107%	105%	105%	104%	105%	106%	106%	105%	106%	108%	109%	109%	108%	117%							
15.0	103%	99%	98%	103%	105%	110%	111%	110%	109%		102%	111%	116%								
Scale	63%	66%	69%	71%	74%	77%	79%	82%	85%	87%	90%	93%	95%	98%	101%	103%	106%	109%	111%	114%	117%
FCR [t/d] at 0-4 Bft and 15kn	21.9	22.9	23.8	24.7	25.6	26.5	27.5	28.4	29.3	30.2	31.2	32.1	33.0	33.9	34.8	35.8	36.7	37.6	38.5	39.5	40.4

FIGURE 1: EXEMPLARY TRIM TABLE BASED ON SENSOR DATA

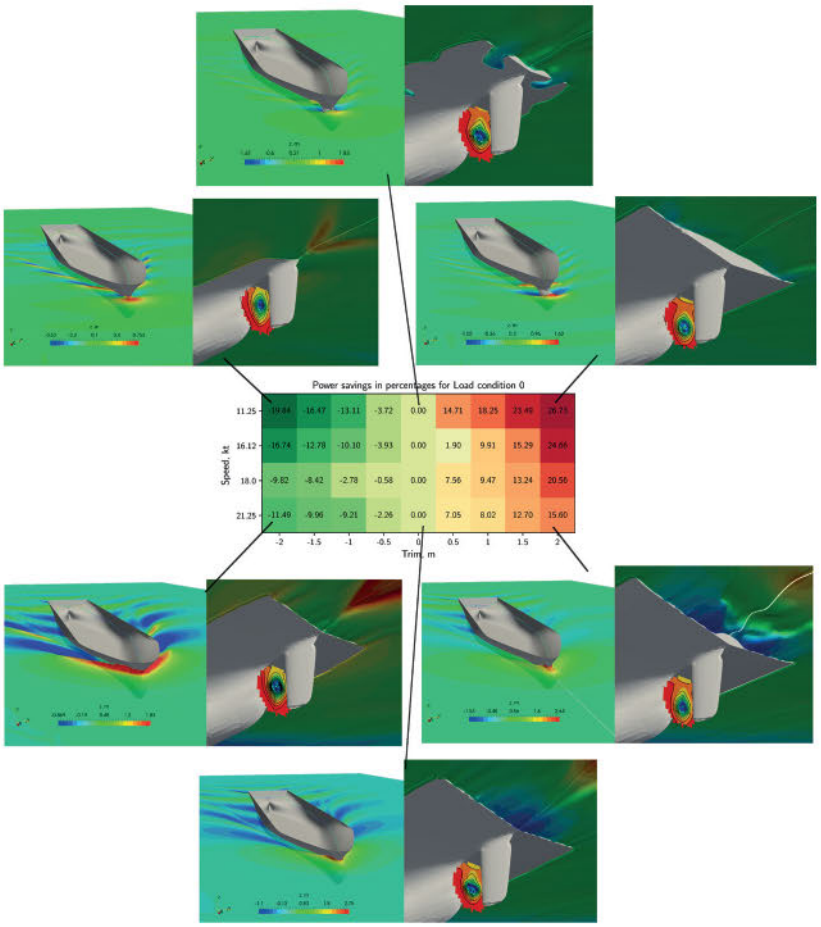

FIGURE 2: EXAMPLE OF AN CFD-BASED TRIM OPTIMISATION TABLE

can represent the hull in its actual condition during normal operation. The hull roughness changes over its lifetime due to fouling, and roll, pitch and yaw motions may also influence the hydrodynamic efficiency. So, there are very good reasons why more and more shipowners and operators look at high quality sensor data from their vessels to evaluate their hull condition, optimal trims, charter party compliance, etc.

However, with regards to the trim tables specifically, the use of recorded data from the ships in regular service comes with a systematic drawback on top of the data uncertainty. The vessels are operated by trained seafarers that don't trim them randomly. Speed and consumption measurements are only gathered for trim and draft combinations actively chosen by the crew, based on experience and/or routine. These data never show the full scope of possibilities in various conditions. Many draft and trim states that are not used regularly might find their way into the tables eventually, but that takes time, and it may be that these unusual trims were chosen for specific reasons under exceptional circumstances that don't represent the normal vessel operation.

CFD-based trim tables

Beside obtaining trim tables from log data, there are alternatives that offer data points outside of typical operational conditions. By using model tests or CFD simulations, trim data can be collected for a pre-defined matrix of speed/draft/trim combinations, offering a wider scope of data compared to the log-based approach. Due to lower costs and quicker turnaround, CFD has been preferred over model tests in the past one or two decades.

Numerical simulations using CFD offer a perfectly levelled ground for comparing different trim conditions in terms of propulsion power. If the CFD study is conducted consistently and correctly, only parameters influencing propulsion power between different simulations are speed, draft and trim. Environmental uncertainties are eliminated, where there is no influence of wind, waves, currents, as well as SOW uncertainties. Even though numerical uncertainties exist as well, they are maintained at low levels if the simulations are carried out carefully and skillfully; generally being an order of magnitude smaller than environmental uncertainties.

Another obvious benefit of using CFD to produce trim tables is time, and in this case, time literally means money. From commission to delivery, it takes a couple of weeks, at which point the crew can start applying the data and saving precious fuel.

On the other hand, CFD does not take into account the actual state of the hull and propeller, and in general does not take into account waves and swell, which might influence the position of the optimum trim. Covering all possible scenarios of wave conditions using CFD, on top of all trim/draft/speed combinations, is not feasible. It is for this reason that the two methods described above come hand in hand to deliver the best out of the two worlds: CFD complemented log based trim tables.

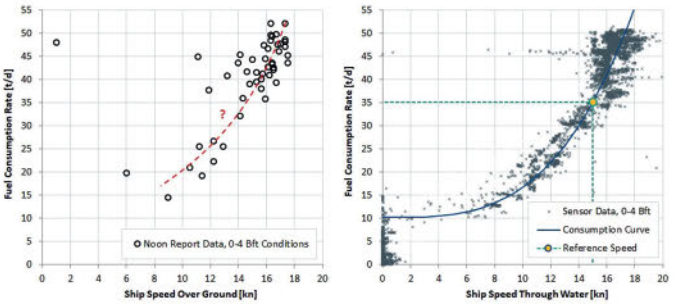

FIGURE 3: COMPARISON OF NOON REPORT AND HIGH FREQUENCY SENSOR DATA, THREE MONTHS PERIOD OF THE SAME VESSEL

Complementing log data with CFD

Log-based trim tables take time to take shape, as a large number of voyages are needed to gather a significant amount of data needed to draw conclusions. In the meantime, CFD-based tables provide the missing information and enable the crew to start saving fuel. As more and more logged data comes in, a more detailed understanding of trim-power relationship in realistic operational conditions is obtained.

By correlating log data to weather conditions, it is possible to derive conclusions regarding possible shifts of trim optimum due to wind waves or swell. Trim that is optimal in calm seas, which are simulated in CFD, might not necessarily be optimal in head swell, for example. Using this approach over time and over multiple vessels, we hope to be able to draw more general conclusions regarding the relationship of trim and wave conditions, spanning across different ship or bulbous bow types.

Sister ships

Regardless of where trim table data comes from, especially well positioned to benefit from them are fleets of sister vessels. Both log-based and CFD produced trim-power data can be used interchangeably between hydrodynamically identical hulls. For log-based trim tables this means that data collected across all sister vessels can be pooled together, and then used across all vessels. On average this means that the quantity of gathered data increases by a factor of N, where N is the number of sister vessels. Similarly, any investment made to conduct the CFD study, is returned N times quicker.

Improving CII

Trim optimisation is one of the methods that can be used to improve CII. It is a purely operational measure with low cost intensity that can bring a notable reduction in fuel consumption and CII. There are other ways in which both high frequency ship performance monitoring and CFD are used to save fuel.

What is measured can be improved

Improving a ship's efficiency is difficult if it cannot be measured. As stated previously, ship speed and propulsion power or fuel consumption rate are the primary parameters to record. Secondary parameters are added to put the primary readings into perspective. Ships operate at different speeds and drafts in various weather conditions, and they all have an influence. For example, for comparing the efficiency of a vessel traveling at 17knots with her performance some months earlier when she was doing 14knots, a well-founded mathematical model for the consumption curve is essential.

Figure 3 shows an exemplary comparison of noon report data and high frequency sensor log data for the purpose of deriving the present consumption curve of a vessel. It is evident that the sensor log data contain a lot more information and allow for a much more accurate definition of the curve. The position of the curve and its consumption rate at reference speed (15knots in this example) can then be tracked over time to monitor the vessel's efficiency continuously, even when the ship speed changes due to variable trades or fluctuating charter rates. Regardless of the type of mathematical evaluation that is used to assess the various effects on the vessel (traditional statistical methods or AI), the quality of their output is always dependent on the quality of the input data.

Energy saving devices and bulbous bow retrofits: using CFD to test and optimise

There are various devices available with the aim at reducing the propulsive power, mostly by increasing the propulsive efficiency of the hull-propeller system. These come in several most common forms:

- Ducts positioned upstream of the propeller, generating thrust and a more uniform inflow to the propeller,
- Fins positioned upstream of the propeller, designed to create counter-rotation of the flow relative to propeller rotation, and to increase the angle of attach

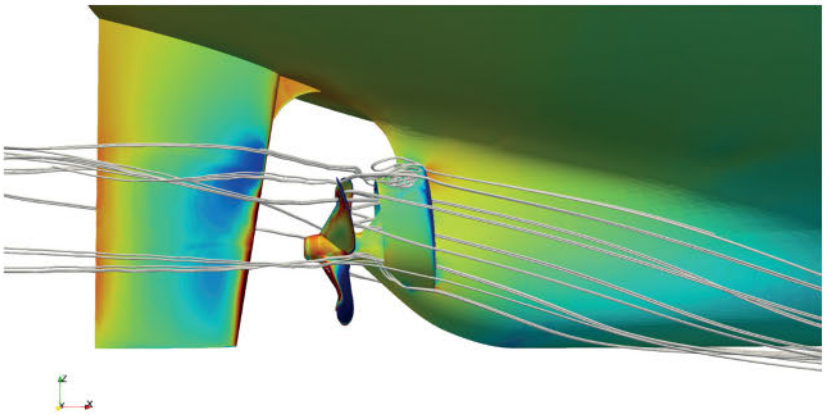

FIGURE 4: SIMULATION OF AN ESD USING CFD

of propeller blades; thus increasing the efficiency of the propeller,
- Fins mounted at the hub of the propeller, a.k.a. Propeller Boss Cap Fin (PBCF), design to reduce vortical losses at the hub,
- Fins mounted at the rudder, recuperating some of the rotational energy induced by the propeller.

CFD can be used to quickly explore different options and find the device that works best for the specific ship at hand, or to help decide whether or not to remove an existing device. Simulations where the rotating propeller is modelled capture the necessary hull-device-propeller interaction and enable accurate assessment of the effectiveness of a device in full scale of the ship. This can be especially important, as it is well known that scaling the effects of ESDs is often difficult, and model test results are not always representing the full scale savings very well.

In addition to ESDs, retrofitting the bulbous bow of a vessel can also be an attractive option, especially for vessels that are often operating in off-design conditions. CFD is used here to find a better bulbous bow design for relevant operating conditions, that can in certain cases reduce power consumption up to 15%. In other cases it can show that the existing bow is the best option, which can be equally as valuable piece of information.

Summary

Improving the energy efficiency of a ship can be achieved through measuring her performance accurately and then using that knowledge to make informed decisions. Trim optimisation is one of the ways in which measure data can be used; in this article we explore the possibility of complementing the measured data with CFD-based trim optimisation data maps to get the best out of the two approaches. Apart from trim optimisation, hull performance monitoring and CFD can be used in their own separate ways to improve energy efficiency. High frequency and high accuracy ship performance monitoring enables deriving accurate mathematical models of ship performance related to speed, draft, weather, and fouling; this is essential for making informed decision regarding maintenance and retrofits. CFD can help select and optimise an energy saving device, as well as a bulbous bow retrofit. ■

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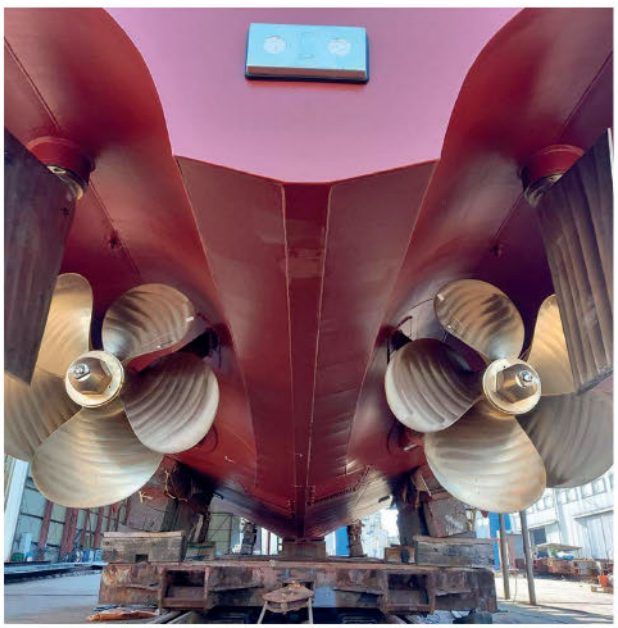
USING CFD TO ENABLE BETTER DECISIONS EARLY IN THE DESIGN PROCESS LEADS TO LOWER LIFECYCLE COSTS

Teignbridge uses Simcenter STAR-CCM+ and HEEDS to optimise design and performance of propulsion systems

Founded in 1974, Teignbridge Propellers International is a world-leading designer and manufacturer of marine propulsion and stern gear products. With more than 65,000 square feet of floor space and over 100 employees at its headquarters in Southwest England, it is the largest producer of its kind in Europe. Renowned for continually optimising the performance of ships of all sizes, from yachts and patrol boats to tankers and military vessels, Teignbridge manages everything from the engine and gearbox to the back of the vessel. This includes the coupling, shaft, bearings, seals, stern tube, brackets, propellers, and rudders.

Regardless of the size of a propeller, which could be up to 8m in diameter, changing the design by just 1mm can noticeably impact both efficiency and performance. Therefore, Teignbridge uses computational fluid dynamics (CFD) simulations to not only develop the best possible designs but also ensure the highest level of manufacturing precision.

"With the latest significant investment in enhancing production precision, we're able to build the propeller to within the accuracy of a hair," says Mark Phare, group managing director at Teignbridge. "Now whatever the engineers design, we can replicate it perfectly in the finished product. Ensuring design and production accuracy is paramount for our business as we are acting on a global scale and we can't fly out or keep shipping parts to fix possible issues. We need to get it right the first time, every time."



TEIGNBRIDGE USES CFD SIMULATIONS TO DEVELOP THE BEST POSSIBLE PROPELLER DESIGNS AND ENSURE THE HIGHEST LEVEL OF MANUFACTURING PRECISION

Stricter maritime regulations

The International Maritime Organization (IMO) and the Marine Environment Protection Committee (MEPC) set the regulations for the industry. In the past, their requirements have been guidelines but now they are becoming much more strictly enforced. IMO has put in place a strict emissions mandate to reduce CO_2 output by 50% by 2050 and introduced an energy efficiency index for new designs and existing ships. It will be impossible to make this kind of significant reduction without innovations. It is vital that Teignbridge makes full use of the latest technology to stay ahead of the competition, meet all the industry regulations and build leading components that deliver optimum performance.

As Saeed Javdani, innovation and technology manager at Teignbridge, explains: "It is important for us to be on top of the game and design products with the required index, improving the product efficiency and reducing emissions."

Harnessing the power of CFD simulations

To meet these challenges and optimise designs, Teignbridge uses Simcenter STAR-CCM+ software, with support from Maya HTT, to run fast and accurate CFD simulations that evaluate a variety of complex phenomena so the designers can understand the interaction between propulsion systems and the high-velocity water flowing across their surfaces.

Understanding cavitation – where vapour bubbles in a fluid grow and collapse due to local pressure fluctuations – allows engineers to predict the impact on propulsion performance, durability and noise. The simulations help them predict the location, extent and type of cavitation and modify designs to minimise it.

Engineers also use Simcenter STAR-CCM+ to optimise components for the entire propulsion system to ensure their influence on the water flow complements the propeller's design. In one instance, they identified areas of low pressure on the leading edge of a rudder that could cause cavitation and noise. By redesigning the rudder and carefully aligning its leading edge to the downstream rotational flow from the propeller blades, they also managed to increase the vessels' top speed by around 2knots.

By using computer-aided engineering (CAE) and Simcenter simulation tools, all these performance insights and improvements are made before any of the components even get wet. This allows for crucial decisions to be taken much earlier in the design process, leading to increased efficiency, reduced costs and improved products.

According to Phare, the shipbuilding industry is embracing innovation in design and manufacturing. "We see the designs are becoming much more accurate as we're taking into account a lot more factors. With CFD simulation we're able to predict the wake field coming into the propeller, and then how that flow can be affected by the bracket in front and the rudder behind. So we're looking at the whole thing as a system rather than as individual items."

Javdani says Simcenter STAR-CCM+ is vital to his team's development processes: "You need sophisticated tools that can predict your hydrodynamic loads and how your propulsion system will behave in different operating conditions. We used to just consider one or two design points, but with Simcenter STAR-CCM+ we can predict how the vessel will perform at different speeds and in different sea conditions. Simulation makes it possible to explore many more iterations in less time so we can come up with the optimal design."

Crucially, this technology allows engineers to consider the entire ship as a system rather than just a collection of individual components. They can place their propulsion systems inside vessels in a virtual environment to understand how they will interact. "Now we can go back to the ship designers and give them suggestions for improvements," says Javdani. "We can explain how they can make changes to improve the flow into the propulsion system during the design stage before anything has been built. So with Simcenter STAR-CCM+ we are not only optimising the design of our components, but we're also helping shipbuilders to achieve the maximum propulsion performance for their vessels."

Reducing noise pollution

Protecting the environment involves more than just designing propulsion systems that use less or cleaner fuel. Noise pollution can have a damaging effect on marine life and biology. "If you want to save the planet, save the oceans," remarks Javdani. He says the capabilities of Simcenter STAR-CCM+ are critical to analysing noise generation and adapting designs to reduce it. "We can predict lower frequency ranges relatively easily but the higher frequency range, typically caused by the turbulence in the flow and the collapse of cavity bubbles within the downstream of the propeller, is much more complicated. With CFD simulation we can predict more accurately and optimise our designs. Every vessel has a unique acoustic signature in the form of the underwater radiated noise it generates, so the simulations help us reduce the amplitude and mask the signature as much as possible."

Javdani explains why Teignbridge selected Simcenter solution as the best tool to use in these analyses: "We don't have to combine Simcenter STAR-CCM+ with another software package because everything is in one place. The procedures, tools and techniques are all intuitive and well documented, so it makes life much easier for us. With the built-in linear finite element analysis it's very simple to set up a fluid structure interaction to analyse the propeller within the whole flow."

Optimising performance

When designing new components, it is critical for Teignbridge to provide its customers with an accurate indication of the efficiency and performance improvements they will deliver. Using Simcenter STAR-CCM+ numerical simulations and CFD analysis, allow engineers to predict what effect design changes will have, leading to the development of velocity aligned rudders and brackets.

For example, a customer had a boat with a target speed of 34knots, but she was only achieving 31.8knots. By adding a velocity aligned rudder, she was able to achieve the required speed. In another case where a customer needed to reduce the radiated noise level by 10 decibels below 1kHz, using CFD, Teignbridge achieved approximately 15-decibel reduction.

Using HEEDS software enables the firm to explore as many design iterations as possible – up to 500 iterations in 48 hours – to find the most optimum design. Simcenter STAR-CCM+ and HEEDS are part of the Siemens Xcelerator portfolio, the comprehensive and integrated portfolio of software, hardware and services.

"Running so many iterations is simply not possible without HEEDS," says Javdani. "Trying that many designs manually would take far too long and wouldn't be cost-effective.

"We're also working on the design of new devices that reduce the energy efficiency index of the propulsion system. These devices such as propeller boss cap fins (PBCFs) can be built into the design at the start or they can be retrofitted to an existing propeller. Essentially, it's a smaller propeller attached to the main propeller that recovers energy from the rotating flow of the blades."

CFD as a common language

Teignbridge also needs to prove to the classification societies that new components will meet their safety requirements. "Simcenter STAR-CCM+ enables us to show the relevant authorities that new designs will meet their standards before they are even built," says Javdani. "Fatigue analysis is important to them. Without CFD we wouldn't be able to give them the level of detail they need."

Using CFD as a common language makes it much easier for designers to show classification societies that all their requirements are being met early in the development process. "For instance, we can show that new components will still perform within the safety factor required under dynamic loading," says Javdani.

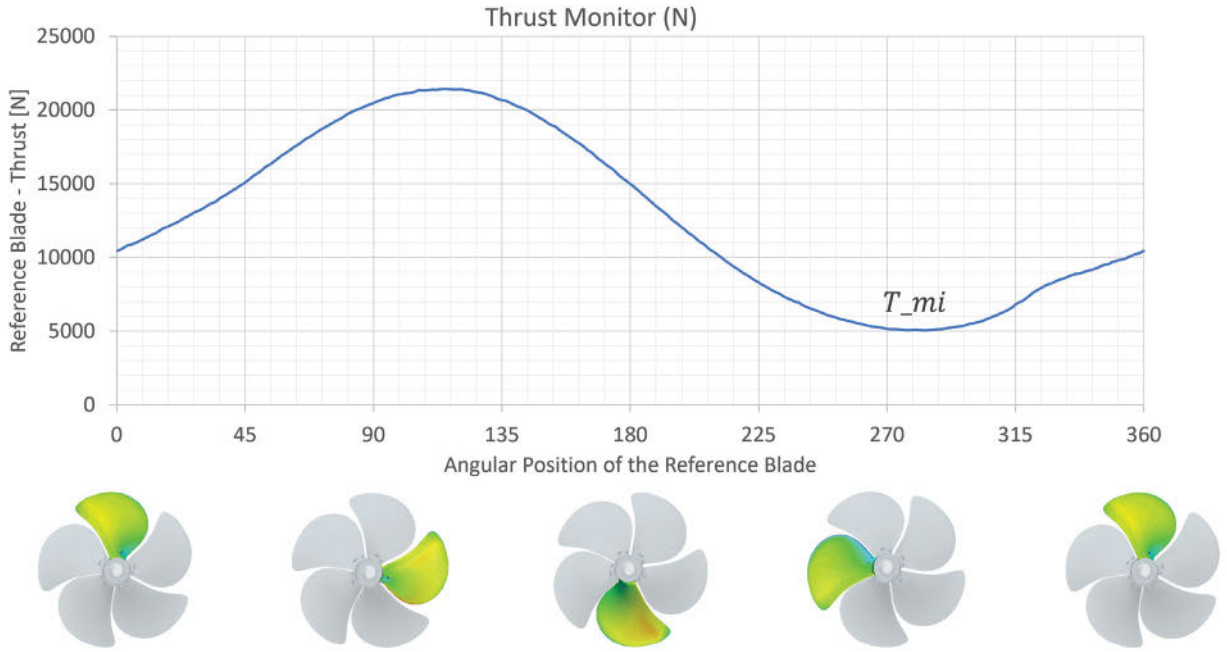
Teignbridge's decision to adopt CFD is appreciated by classification societies and customers, according to Phare. "Although we have nearly 50 years of experience in designing propellers and shaft lines, the addition of CFD analysis provides extra reassurance to our customers,"

he says. "Incorporating CFD into our design toolbox has been essential to the progression of our designs in recent years. Many of our customers use Simcenter STAR-CCM+, which enables us to easily share data and talk the same language when evaluating new projects. Most naval architects and designers expect propulsion designers to have CFD capability and to offer an analysis of the underwater equipment at the design stage."

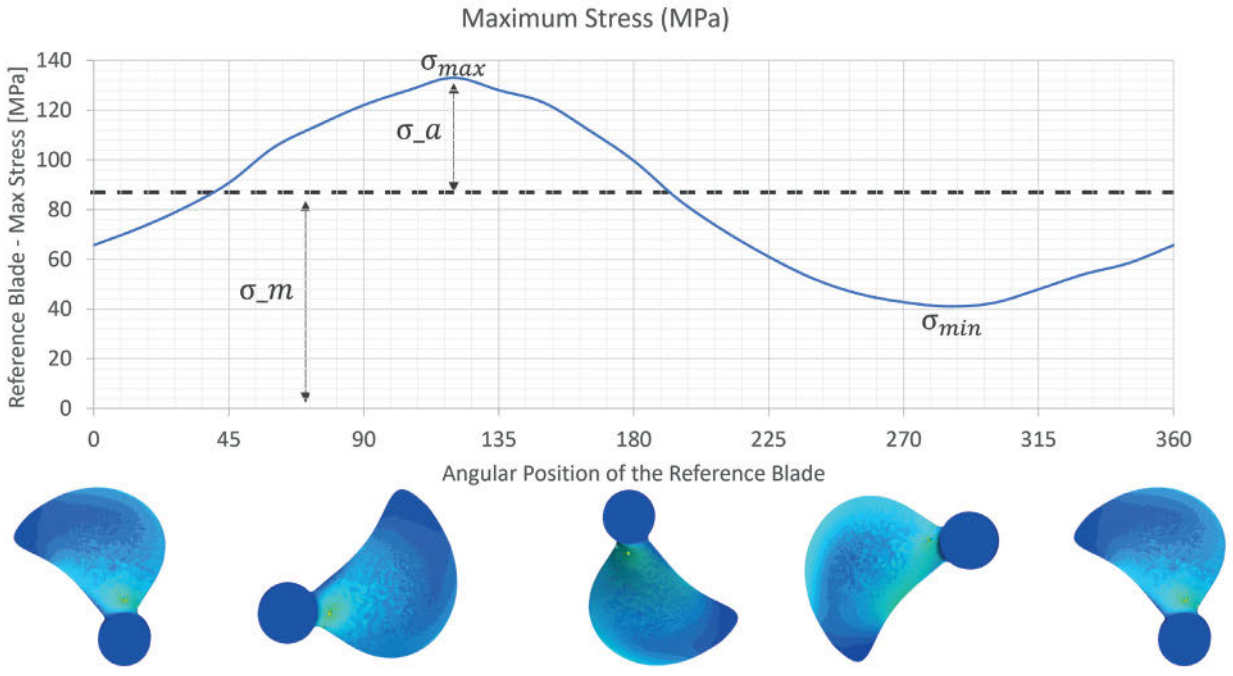
Seeking to be the best

Phare is clear on his vision for the future: "We want to be the world-leading designer and manufacturer of propulsion equipment. To do that we need to produce the best components and deliver the best customer service."

Javdani adds: "Simcenter Star-CCM+ has enriched the scope of work and sparked a great deal of innovation at Teignbridge. It helps us to better understand exactly what customers need, and also helps us solve problems they didn't even know they have. We can now design and supply products that we weren't able to previously, opening up new markets and establishing ourselves as the go-to company within the industry." ■



CFD RESULTS: GRAPH SHOWS THE DYNAMIC THRUST LOADING DURING ONE REVOLUTION AND THE MAPPED PRESSURE DISTRIBUTION ON THE SURFACE OF THE REFERENCE BLADE



FEA RESULTS: GRAPH SHOWS THE DYNAMIC STRESS DURING ONE REVOLUTION AND THE MAPPED STRESS DISTRIBUTION ON THE SURFACE OF THE REFERENCE BLADE

TWO SIDES OF THE CFD COIN: DO THE RIGHT CALCULATION AND DO THE CALCULATION RIGHT

By **Norbert Bulten** PhD, senior product performance manager, Wärtsilä Propulsion

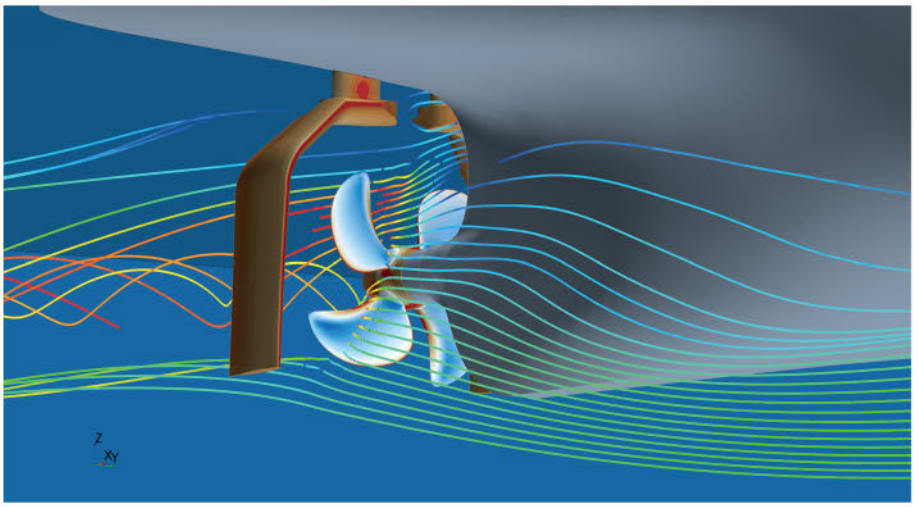


FIGURE 1: GATE-RUDDER CFD SIMULATIONS INCLUDING DETAILED PROPELLER AND HULL GEOMETRY

The continuous development of computational power has brought CFD from a tool for basic, simplified problems at the beginning of the century to a mature tool to determine the overall vessel performance. In the last decade, the scope of the simulations in both the academic world and the marine industry has evolved significantly, though it is still strongly related to the approaches used in model basin test institutes. The virtual towing tank has been based on the methods from the well-known towing tanks. First focus was thus on straight-sailing vessel operation in calm water. Bare-hull resistance calculations in CFD have been automated to such an extent that you can now get a hull resistance curve of a set of vessel speeds within a working day (assuming that there is access to sufficient computing power). The ability to do more complex and fast computation is a good reason to review whether we are doing the right calculations and doing the calculation right.

Side 1: Doing the right calculation

Limit the discussions – In the early days of CFD there was a healthy suspicion of the colourful pictures from the computers. The model basins organised their own quality assessments within the International Towing Tank Conference (ITTC) for the model-scale measurements and the method to predict the actual full-scale performance. Since such a platform was lacking in the CFD community, the level of validation was left to the CFD users. To limit the discussions to an acceptable level, many CFD users chose to replicate the model-test experiments as much as possible. This meant propeller open-water simulations, bare-hull resistance calculations in calm water and, later on, self-propulsion simulations. Unfortunately, this also brought complex modelling issues, like unexpected laminar flow regimes and laminar-turbulent transition challenges in the simulations. The CFD community has actually been slowed down in its progress due to these aspects, which are insignificant in real marine CFD applications.

Make the step to the actual full scale – The switch to full-scale simulations is being made more and more, which is revealing interesting knowledge about the correctness of some of the extrapolation procedures as used in industry. A typical example was found for vessels with ducted propellers, where the existing ITTC'78 extrapolation method failed to predict the speed-power performance by about 10%.

Now that CFD is becoming a mature alternative for model-scale measurements, one can ask the question: what does the right CFD calculation require? For example, the impact of free surface and even dynamic sinkage and trim are often applied, but it comes with a virtual disk for the propeller to limit the number of cells in the computation. This approach can be valid for the initial powering estimate and propeller-hull interaction determination. However, when the detailed performance and interaction of propeller, aft-ship and rudders is to be analysed, the method is inappropriate. On the other hand, the impact of the free surface and the vessel motions might be neglected when the detailed flow phenomena near the propeller and rudders are studied.

Development of a new concept: Gate-Rudder – For the development of a new Gate-Rudder concept, a lot of CFD simulations are executed to learn about the actual working principles and the occurring flow behaviour. Since the concept has proven itself already at full scale [1], the challenge is to find approaches to quantify the performance with CFD as well, to further drive the

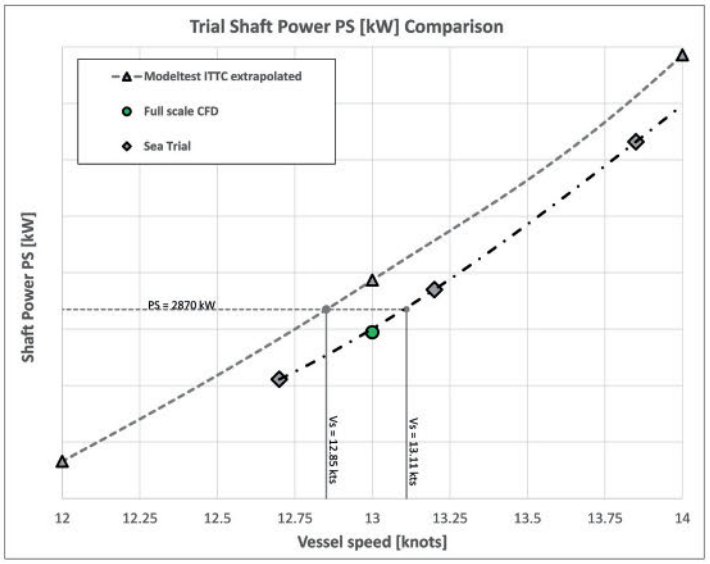


FIGURE 2: SPEED-POWER PREDICTION FROM FULL-SCALE CFD AND MODEL TESTS COMPARED WITH SEA TRIALS

design and optimisation process. Feedback from full-scale simulations has shown that a vessel equipped with Gate-Rudder behaves quite differently compared to a sister-vessel with a conventional flap rudder. Both vessel yaw and roll motions are significantly lower, which is expected to have a positive contribution to the overall performance. Both yaw and roll motions are typical aspects which are excluded from towing tank bare-hull resistance and self-propulsion measurements and therefore overlooked by many CFD experts.

The Gate-Rudder clearly interacts with the propeller and for a proper performance mapping, the matrix of simulation conditions quickly grows with parameters like vessel speed, propeller RPM and rudder steering angle. In the established approach, the propeller open-water performance is decoupled from the hull flow and at a later stage brought together with the well-known wake-fraction and relative-rotative efficiency. In this approach the effects of rudder steering angle and vessel leeway (yaw motion) are discarded. Based on CFD simulations of the complete vessel with propeller and Gate-Rudder, interesting interaction effects have been found when the vessel leeway was considered.

Side 2: Do the calculations right

Validation is a key ingredient of successful CFD simulations – Many people believe that you can only prove that the calculation is right in cases where you have detailed measurement data to compare the numerical results with. This approach is reasonable and it should be appreciated that experts take pride in their work and want to make sure that the results are valid. Nevertheless, there are many cases where it is (almost) impossible to obtain measurement data for your desired simulation. As discussed before, there can be strong arguments to make a CFD simulation in a certain way, including or even excluding some effects. In such a case, it requires the expertise of the CFD user to ensure that all steps in the execution of the CFD simulation are done in the best way.

Full-scale feedback and utilisation of monitoring data – The step towards full-scale CFD simulations and the lack of accurate validation material might be challenging, although it can be rewarding as well. With the proper approach the results of full-scale cases can be compared to the corresponding, validated model-scale cases. Differences in results should be explained with known fluid-dynamic principles to build the credibility of the full-scale solution.

Figure 2 has been presented before in *The Naval Architect* (July/August 2019). It shows good agreement of the full-scale CFD simulations with sea trials on the one hand, and the significant gap with the model-scale prediction on the other hand. Since it publication, similar full-scale results have been found for other vessels, indicating the consistence of the full-scale CFD simulations.

Some more attention to the turbulent viscosity solution – When talking about high-quality CFD simulations the first focus is often on the quality of the meshing of the numerical domain and the way boundary layer flows are solved. Mesh studies have established their position in the workflows of most CFD experts. Also, a lot is being said about the used turbulence model and whether k-e or k-w-SST should be used in marine simulations.

Strangely enough, some aspects like hull roughness and turbulence quantities in the far field hardly get any attention when discussing the results of the numerical simulations. The actual solution of turbulent viscosity, which is the linking pin between any two-equation turbulence model and the momentum-equations, is seldomly mentioned.

The detailed review of the actual calculated turbulent viscosity ratio should be put in the spotlight as well to get more understanding of the underlying numerical aspects. Some simple tests have been made based on the Siemens Star-CCM+ Virtual-Towing Tank (VTT) template for bare-hull resistance simulations. The results of the turbulent viscosity ratio are shown in Figure 3. The VTT-settings show a clear decay of turbulent viscosity in the first part of the domain, and near the vessel a clear increase. This decay in turbulence viscosity can be limited in case the ambient turbulence option is activated, as shown in the second image. Reduction of the turbulence intensity and/or the prescribed turbulent viscosity ratio gives the results as shown in the third image. Even though the calculated bare-hull resistance showed only marginal differences, some parts of the CFD solution are clearly different. This aspect might need some more attention to get further alignment in the future.

Conclusions

The journey towards maturity of CFD in the marine business has been exciting so far. The guidance from the model-scale testing experience has been useful, although at a certain point in time the CFD community will need to define its own direction for further evolution. The practical methods and limitations of model-scale testing will remain, although they might

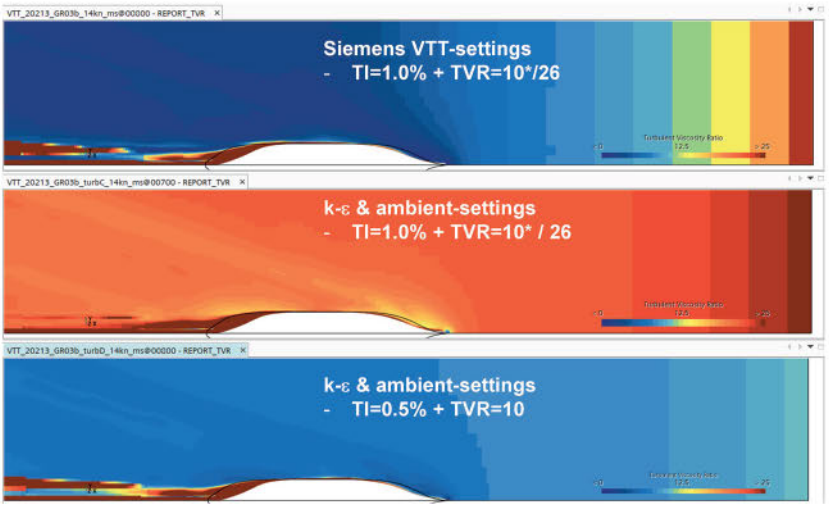


FIGURE 3: CFD RESULTS OF TEST CASE FOCUSSING ON TURBULENT VISCOSITY RATIO WITH VARYING TURBULENCE SETTINGS

not always limit the numerical simulation world. At the end of the day, the purpose of executing the CFD simulations is not to create fantastic colourful pictures. It should further improve the understanding of the occurring flow phenomena to support the decarbonisation of shipping industry. To make this happen, both sides of the CFD coin should be discussed to continuously improve the value of the outcome of the numerical simulation work. ■

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