January 2021

MARITIME REPORTER AND ENGINEERING NEWS

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RESEARCH VESSEL ROGER REVELLE

INSIDE THE $60M MID-LIFE REFIT

SHIP REPAIR & CONVERSION
SCRAP OR REFIT?
FUTURE FUELS DRIVES TODAY'S DECISIONS

INTERVIEW
ROBERT ALLAN
DESIGNING BOATS FOR 90+ YEARS

OFFSHORE WIND
THE FUTURE IS FLOATING
MAKING THE PUSH TO UTILITY SCALE

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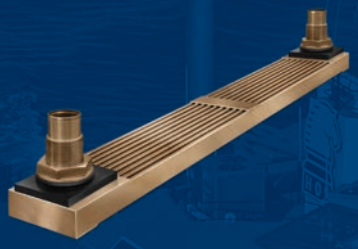

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RV Roger Revelle
The $60m refit of RV Roger Revelle was carried out at Vigor last year.

This photo & Cover Photo Courtesy Glosten

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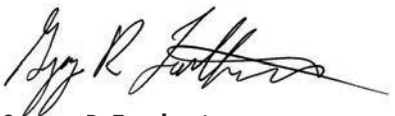
We conduct hundreds if not thousands of interviews annually across our four print titles, 10 websites and dozen eNews services, a family of publications that covers the maritime, offshore energy, subsea, port and logistics spaces. No matter the interviewee, we always like to inject some form of the question: "What's the reality on the streets," lest we get caught up in our own media bubble. This month's edition, our January 2021 *"Ship Repair & Conversion"* edition, gave us the opportunity to dig in for some insightful views on tough decisions being made everyday in vessel owner/operator offices globally.

Starting on page 24 **Barry Parker** provides his signature look inside shipping companies through a financial lens with insights on how stricter emission mandates and a growing array of 'future fuel' choices are impacting ship owner decisions on whether to build new or refit. We have written about the advent and advance of 'future fuel' often, and while there is movement to new fuels, there are still many questions on the pace and direction. **Svein Moxnes Harfjeldm** co-CEO of Double Hull Tankers, perhaps best summed it up on a recent call with investors: "Propulsion is certainly a very important component when we make these considerations. But we think that the conventional technology is able to … meet the targets that we set out for 2030. But there could still be improvements to be made on not just main engines, but also auxillaries and other sort of aspects of being more energy efficient on more of the ships. We do not think that dual fuel is the way to go. We think it might be sort of a short-term fix. It's a basic technology."

The cover feature this month is a walk inside the $60 million refit of the Research Vessel Roger Revelle, a top-to-bottom, stem-to-stern overhaul carried out and completed last summer at Vigor. Roger Revelle obviously differs mightily from a commercial ship in its mission, but it too is a vessel serving around the world in the harshest environments on the planet, and it shares many of the same issues with any other ship at sea: propulsion efficiency, stability, crew comfort, noise and vibration mitigation … the list is long. My thanks to **Bruce Appelgate**, Associate Director and Head of Ship Operations, Scripps Institution of Oceanography, **Paul Mauricio**, Port Engineer, **Tim Leach**, Principal, Naval Architect (Glosten) and **Benton Strong**, Vigor, for making the time to share some candid and lengthy insights on the decision process behind many of the decisions made when executing the plan for this extensive mid-life refit.

Finally, we ended the year with an interview with **Robert Allan** and **Mike Fitzpatrick** of Robert Allan Ltd., a naval architecture firm that has been designing boats for more than 90 years. This was one of those great interviews where we can both dig into the industry's past, but look also to the future. This duo has some interesting insights on the pressing matters of maritime today … decarbonization, digitalization and autonomy … and you can read the story starting on page 14, or you can read the full interview, see all of the amazing historical photos, and watch the MR TV video interview here **bit.ly/2MpJDP6**.



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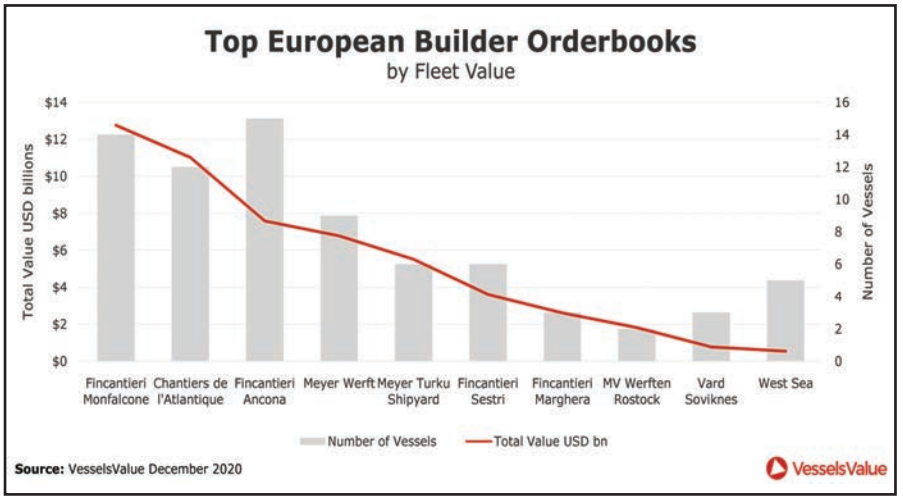
European Maritime Market

As we approach our first ever "virtual" SMM in early February 2021, we take a look inside the European maritime industry with our friends at VesselValue.

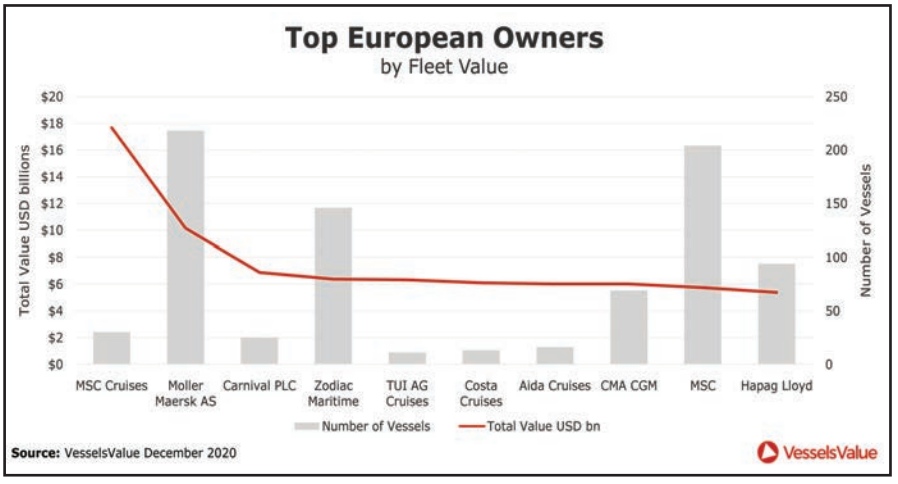
Top European Builder Orderbooks

Owner	# of Vessels	$bn
Fincantieri Monfalcone	14	$12.75
Chantiers de l'Atlantique	12	$11.02
Fincantieri Ancona	15	$7.59
Meyer Werft	9	$6.78
Meyer Turku Shipyard	6	$5.51
Fincantieri Sestri	6	$3.61
Fincantieri Marghera	3	$2.62
MV Werften Rostock	2	$1.82
Vard Soviknes	3	$0.78
West Sea	5	$0.55



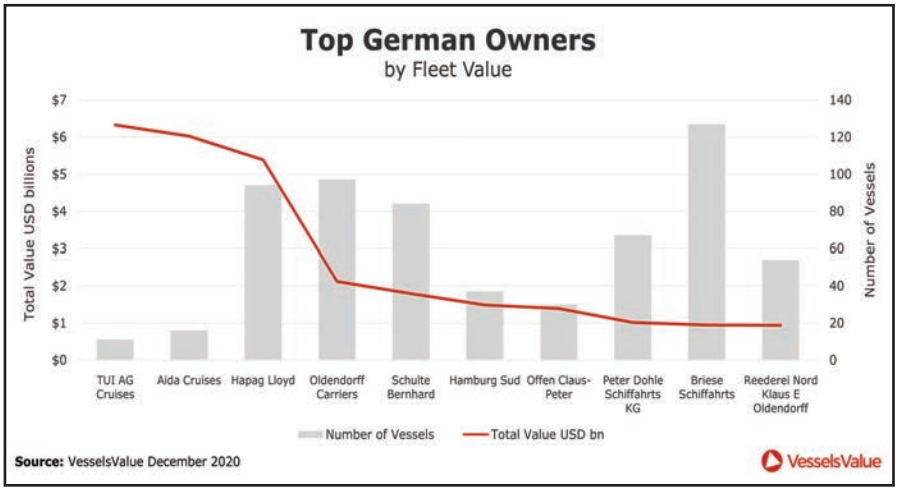
Top European Owners by Fleet Value

Owner	# of Vessels	$bn
MSC Cruises	30	$17.68
Moller Maersk AS	218	$10.17
Carnival PLC	25	$6.89
Zodiac Maritime	146	$6.38
TUI AG Cruises	11	$6.33
Costa Cruises	13	$6.10
Aida Cruises	16	$6.02
CMA CGM	69	$6.02
MSC	204	$5.74
Hapag Lloyd	94	$5.39



Top German Owners by Fleet Value

Owner	# of Vessels	$bn
TUI AG Cruises	11	$6.33
Aida Cruises	16	$6.02
Hapag Lloyd	94	$5.39
Oldendorff Carriers	97	$2.12
Schulte Bernhard	84	$1.80
Hamburg Sud	37	$1.48
Offen Claus-Peter	30	$1.39
Peter Dohle Schiffahrts	67	$1.02
Briese Schiffahrts	127	$0.95
Reederei Nord Klaus E Oldendorff	54	$0.94



"I think it's a valuable exercise to look at a ship holistically in that there's an instrument on the ship, let's say a multibeam, that's only as good as everything that it's attached to. Just like vibration, if you're transmitting a bunch of mechanical sound into your sonars, you're going to get junk. The ship is the instrument."

Bruce Appelgate,
Associate Director and Head of Ship Operations, Scripps Institution of Oceanography

"There certainly has been a lot of media attention to autonomous vessels in the past decade, more media attention than perhaps attention from owners. We have actively been working on autonomous vessels, and we have some projects that have progressed, but it is going to be a slow adoption process."

Mike Fitzpatrick
President & CEO, Robert Allan Ltd.

"By the end of 2022 installations of turbines of up to 14WM will be underway. These turbines require heavier lifts of more than 1,500 tons to higher heights from 125-150m. We expect 160 to 180m lift heights for the next generation 20MW+ turbines before the end of the decade."

Philip Lewis,
Director of Research, World Energy Reports

Floating Wind ... Opportunities, Challenges

By Bartolomej Tomic, Managing Editor, Offshore Engineer

The floating offshore wind industry, still considered nascent – and minuscule compared to the installed capacity of its "older brother," – that is the conventional, fixed bottom offshore wind industry (29GW at 2019 end) – is showing promise and is expected to take off big time by the end of the decade.

While the current installed capacity – less than 100MW – is small and focused on pilot and demonstration projects, the potential is there for the floating wind farms to reach and, theoretically, even surpass the installed capacity of the traditional offshore wind turbines, and not by a little, given that there are no water depth limitations for installation.

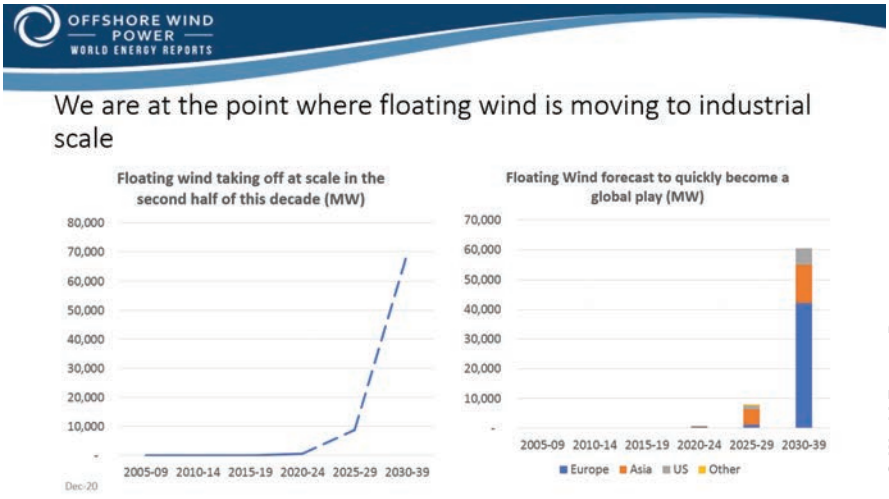
OE TV interviewed Philip Lewis, Director of Research, World Energy Reports, and author of *OUTLOOK FOR OFFSHORE WIND POWER, THE FRONTIER OF FUTURE ENERGY*, to learn more about the opportunities and challenges in the industry that could rise to prominence sooner that one might think.

Lewis first provided some context on the traditional offshore wind industry, which uses fixed-bottom turbines, installed at water depths of up to 60 meters.

"…bottom-fixed offshore wind farms have been in operation since 1991, and so this is not a new industry. We saw the true industrialization of the sector over the last decade and the adoption by more and more European and East Asian countries of this increasingly cost-competitive technology," he said.

80% in Deeper Waters

However, Lewis says the reason World Energy Reports is so interested in floating offshore wind is the sheer amount of resource available beyond the 60-meter water depth, the general threshold considered for floating solutions.



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"Some 80% of the world's wind resource is found in deeper waters suited to floating wind foundations. These resources are generally able to access higher quality wind resource. Further, floating structures can deploy larger turbines which support higher capacity factors, which means they produce more electricity," Lewis says.

So, where are we now? We are passing from the prototype and demonstration project phase towards industrial-scale floating wind farms, Lewis says.

According to World Energy Reports, the floating wind installed capacity will reach between 8 to 10 GW by the end of this decade, and next decade WER expects to see more than 60GW of floating wind farms commissioned.

Worth reminding, DNV GL recently said that floating wind could grow 2000-fold, by 2050 (DNV-GL), from 100 MW today to 250 GW in 2050.

Opportunity for Supply Chain Firms

Lewis says that the expected growth in the floating wind industry also represents a significant opportunity to those in the supply chain, and the companies that have traditionally served the offshore oil and gas industry. Concrete contractors will benefit, as well.

According to WER's offshore wind report, floating offshore projects differ from bottom fixed in that offshore construction and installation calls on methods very familiar to oil & gas offshore yards and offshore support vessel (OSV) owners and operators.

"At World Energy Reports, we see the opportunities for traditional offshore and marine companies that support the oil and gas sector like offshore yards, mooring system chain and anchor manufacturing and OSV operators. We also see exciting opportunities for those not traditionally involved in the offshore oil and gas market, such a pre-cast concrete and in-situ concrete contractors and manufacturers of synthetic ropes," Lewis says, however warning that WER does not feel that the supply chain has fully embraced the scope and scale of the opportunities that exist in this sector.

60 Concepts

World Energy Reports is tracking

some 60 floating wind substructure concepts. Of these 60, 38 have been tank tested and 20 scale tested in the field and 3 concepts have been demonstrated at full scale.

"Only 2 concepts have reached the stage of pilot array to date, although several more concepts will reach this stage over the next couple of years. We expect to see the first pre-commercial arrays - that's under 100MW by 2022 - and the first commercial arrays over 100MW by the middle of the decade," Lewis says.

Challenges

With any opportunities, invariably, there are challenges. What has been touted as a benefit earlier in the article – bigger size – can also pose a challenge.

"Firstly, I think most people would struggle to picture how big these units can be. If we take an industrial-scale floating wind farm, you could easily expect to see 50 to 100 steel or concrete or substructures to meet a 200-300 day installation weather window.

Taking the example of a steel floater, Lewis explains, that could be 150,000 to 350,000 tonnes of steel to be produced in two to three years, with each 2500-3500 tonnes structure requiring some 6,000+sqm of area.

"The structures are physically large and will be required in large quantities," Lewis says.

Furthermore, in addition to waterside laydown areas, there will be a need for assembly berths and wet storage, where turbine diameters exceed 200 meters.

Lewis' World Energy Reports also sees a major opportunity, as well as a constraint, in the quantity and capacity of anchor handlers and construction vessels to tow wind turbines, pre-lay moorings, and hook-up systems.

"There is a specific challenge to adapt offshore oil & gas mooring solutions to floating wind – addressing weight, quantity, and footprint of the anchors and mooring lines," Lewis explains.

Dynamic array and high voltage export cable manufacturing and installation capacity is another challenge to address, especially the manufacture of above 66kV dynamic export cables, he says. And finally, Lewis says, the inspection of large numbers of in-water components and where the question of in-situ (floating-to-floating) versus tow-to-port repair and maintenance programs is to be addressed.

Tip #20

Training in the Age of Data

If we understand it, we can lay the groundwork to take advantage of it.

As we greet 2021, it seems fitting to address a "big" topic – a topic that is ultimately going to change everything, including (and perhaps especially) training. The topic is "big data." The goal of this month's *Training Tips for Ships* is to get us thinking about big data in training. If we understand it, we can lay the groundwork to take advantage of it.

We are in the data age – and this is especially important for training. Everything we do can be done more efficiently and more effectively by understanding it more deeply. In the case of training, how do we understand what training works and what does not work? How do we understand the most reliable and efficient paths to closing knowledge gaps and increasing retention? How do we best understand how to translate knowledge to practice? Which employees are likely to be our safest? How do we identify those we wish to develop as leaders? Until now, intuition, anecdotal information and experience have been our best available guides. But now we have something far more powerful to answer all of these questions and many many others. Big data. Big data is already proven in so many domains. It is used to make firefighting safer and more effective. It is used to identify fraudulent financial transactions. And big data is being used in many ways and to remarkable effect to save us from this pandemic. Similarly, the opportunity for big data in training is enormous.

Big data is really about two things. First, it is about the data itself and the granularity, volume and veracity of this data. And second, it is about mining our data ro reveal patterns that are not otherwise visible. We can then use knowledge of those patterns to make better, more deeply informed decisions.

What data should we be gathering now to help support future training optimization? The potential sources are bountiful. There are millions of trainees and experienced mariners around the world using a wide variety of technology every day in their training and work. Each of these technologies can be a source of rich data. We can collect information from simulation training and assessment systems, online learning systems, competency management systems and recordings from vessel

operations. We could collect "macro" data such as assignment, exam and course grades, and even information from incident reports.

We could collect "micro" data such as how long trainees spend on learning materials, how long they spend answering each test question, and how they navigate through the learning content. We could collect the stream of real-time navigational decisions and actions, equipment control input, and current conditions. Each of these has the opportunity to reveal how seafarers learn and operate. In a short time we could have a very deep and very wide pool of data to mine for insights.

So how, specifically, do we collect this data to establish a base upon which we can ultimately gain insights? The most direct path is to consider big data in every technology procurement choice we make.

We must consider this every time we procure electronic training, administration and operational systems such as simulators, learning management systems, skill assessment systems, bridge navigation systems, HR and crewing systems, and so on.

Ask the vendors what data the system is able to record and expose in the effort to build a robust and granular dataset for future data mining. It takes years to build these datasets, so the time to begin is now.

Once we have a sufficient initial data set, how do we mine it for insights? The most powerful technique is a form of artificial intelligence called machine learning. This may sound difficult or complex, and in some sense it is. But never fear. There are tools available that make it relatively easy to derive insights from big data. We do not need to be experts. The next edition of Training Tips for Ships will look at some of the insights we can hope to gain by using tools to collect and examine our organization's big data.

Until then, keep healthy and sail safely.

The Author

Goldberg

Murray Goldberg is CEO of Marine Learning Systems which provides software and services to optimize knowledge, skills and behavior in maritime operators. Murray@MarineLS.com

Cosmic Rays: The Unseen Menace

Most people are aware of risks inherent in our increasingly electronic maritime industry. There is malware, ransomware, and spear phishing to name a few. But a new one has been recently identified – cosmic rays.

Cosmic rays are high-energy protons and atomic nuclei which move through space at nearly the speed of light. They originate from the sun, from stars outside of the solar system, and from distant galaxies. They are capable of penetrating and passing through almost any material. The vast majority of the time encounters with cosmic rays do little or no harm.

But cosmic rays have sufficient energy to alter the states of circuit components in electronic integrated circuits, causing transient errors to occur (such as corrupted data in electronic memory devices or incorrect performance of CPUs) often referred to as "soft errors". This has been a problem in electronics at extremely high-altitude, such as in satellites, but with transistors becoming smaller and smaller, this is becoming an increasing concern in ground-level electronics as well. Studies by IBM in the 1990s suggest that computers typically experience about one cosmic-ray-induced error per 256 megabytes of RAM per month. To alleviate this problem, the Intel Corporation has proposed a cosmic ray detector that could be integrated into future high-density microprocessors, allowing the processor to repeat the last command following a cosmic-ray event. ECC memory is used to protect data against data corruption caused by cosmic rays.

Effectively cosmic radiation can flip a "1" in a computer program's binary code to a "0" or vice versa. That may not seem like much, but computers rely on an accurate set of binary instructions, which are made up of millions of ones and zeros. To a computer, 1 is a different instruction from zero. It could be the electronic equivalent of ordering right full rudder when you meant left full rudder. In the open ocean with plenty of sea room, that might not be a problem, but when approaching a narrow passage, it could be a disaster.

Galactic cosmic rays are one of the most important barriers standing in the way of plans for interplanetary travel by crewed spacecraft. Cosmic rays also pose a threat to electronics placed aboard outgoing probes. In 2010, a malfunction aboard the Voyager 2 space probe was credited to a single flipped bit. Fortunately, the satellite had plenty of room in which to maneuver. Strategies such as physical or magnetic shielding for spacecraft have been considered in order to minimize the damage to electronics and human beings caused by cosmic rays. Flying 12 kilometers (39,000 ft) high, passengers and crews of jet airliners are exposed to at least 10 times the cosmic ray dose that people at sea level receive. Aircraft flying polar routes near the geomagnetic poles are at particular risk. In the district of Schaerbeek in Brussels, one polling station during the 2003 election registered more than 4,000 votes in favor of the Communist Party. The problem was that those 4,000 extra votes didn't match up with the area's population. The Communist Party received "more votes than there were voters" at that polling station. Clearly, this posed a problem. The nation's political identity was at stake. A detailed recount resolved the cosmic-ray induced error.

In 2008, data corruption in a flight control system caused an Airbus A330 airliner from Australia to twice plunge hundreds of feet, resulting in injuries to multiple passengers and crew members. Cosmic rays were investigated among other possible causes of the data corruption. The other possible causes were ultimately ruled out as being extremely unlikely, leaving only cosmic rays.

It happened again in 2009. That year, Toyota issued a recall on more than 9 million vehicles worldwide because of sudden and unintended acceleration, with people unable to use their brakes because the controls were all computerized (Toyota was ahead of the game at the time when it came to vehicle technology). It was a pretty dramatic — and tragic — episode. People were killed. Someone was even released from prison because the person had been wrongfully charged with running people over in a Toyota that accelerated uncontrollably. When experts dug into the problems with Toyota cars

at the time, it was found that many of the issues were caused by a bit flip.

In August 2020 scientists reported that that ionizing radiation from environmental radioactive materials and cosmic rays may substantially limit the coherence times of qubits if they aren't shielded adequately, which may be critical for realizing fault-tolerant superconducting quantum computers in the future.

These days, cosmic rays might be a concern, but there are workarounds. Companies in aerospace, defense, aviation, and consumer electronics as well as chip manufacturers, the automotive industry, the communications industry, the IT infrastructure, and more are aware of the effects of cosmic rays and have worked with researchers to implement safety and mitigation measures.

Cosmic rays seem like one of those things that have been largely taken care of behind the scenes. It's also a "wrong place at the wrong time" kind of thing, in which the chances of cosmic rays flipping the bits in our electronics is sparse and random. And so far, few major catastrophes can be attributed to cosmic rays, or at least as far as we know. Even in cases in which it's suspected, there's never a guarantee cosmic rays were actually the cause of a given malfunction. It's just a plausible explanation.

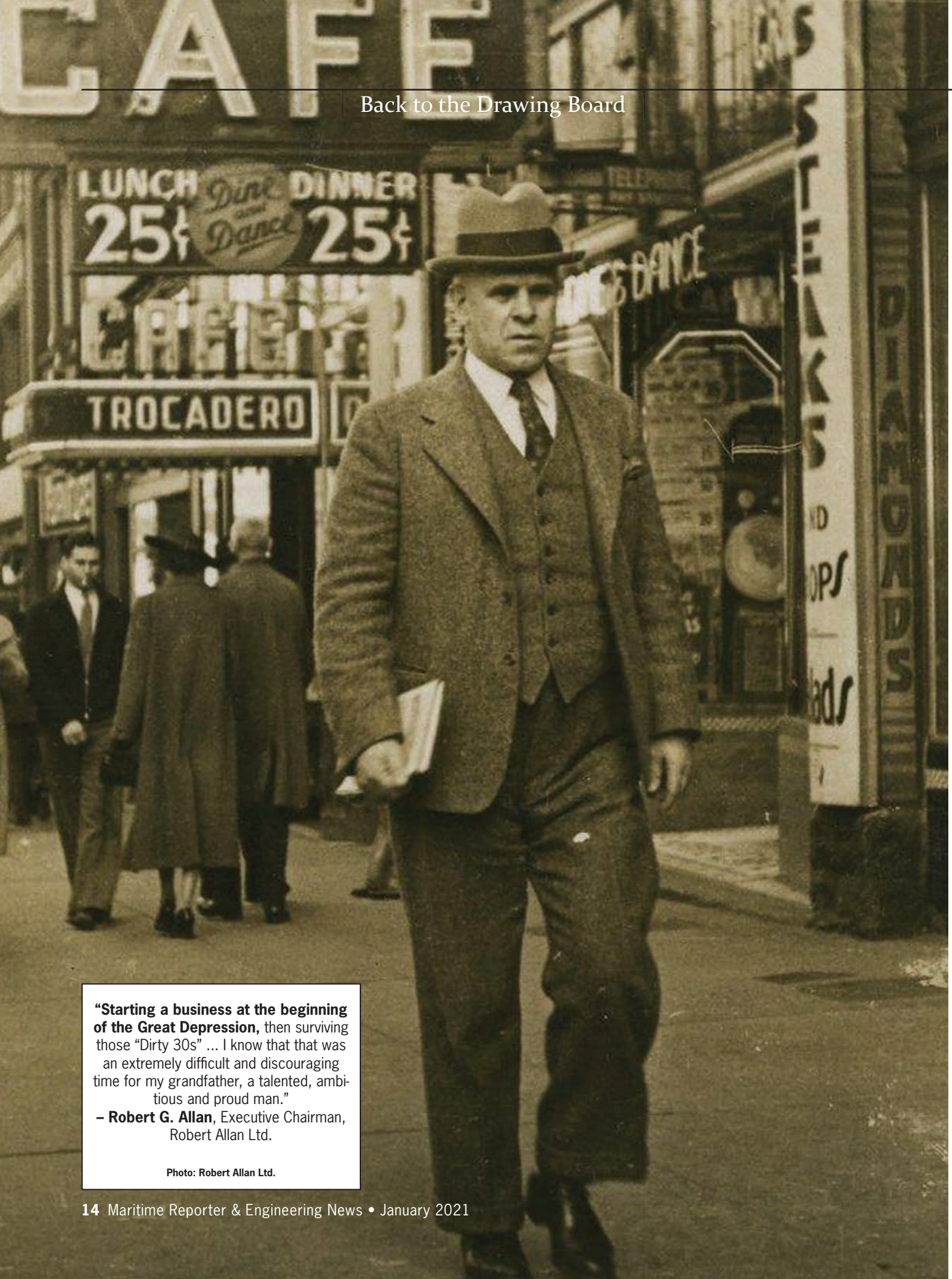
On important satellites, three duplicate computers are sometimes installed. If the output of one of the three computers doesn't match the output of the others, it is ignored, since the likelihood of two of the computers being struck by cosmic rays and suffering the same bit flip is astronomical.

Ships are not considered as important as these satellites. Yet, they are being crammed with more and more computer chips. As ships move increasingly toward autonomous operation, there will be no one onboard to override bit flip errors. Remember the HAL computer in 2001: A Space Odyssey. But for the lone surviving astronaut, the movie would have had a much different ending.

The Author

Bryant

Dennis L. Bryant is with Bryant's Maritime Consulting, a regular contributor to *Maritime Reporter & Engineering News.*



"Starting a business at the beginning of the Great Depression, then surviving those "Dirty 30s" ... I know that that was an extremely difficult and discouraging time for my grandfather, a talented, ambitious and proud man."
– Robert G. Allan, Executive Chairman, Robert Allan Ltd.

Photo: Robert Allan Ltd.

Robert Allan & Mike Fitzpatrick Reflect on

Designing Boats: 90 Years & Counting

By Greg Trauthwein

Robert Allan founded Robert Allan Ltd. in 1930 when he commenced private practice as a consulting Naval Architect after serving as Technical Manager of a local major shipyard. In the 90 years that have passed, the organization has evolved from a one-man shop to a global powerhouse in the business of naval architecture and marine design. Following the founder into the business were his namesake son and grandson, with the company in recent years passing to an employee-owned model led by Mike Fitzpatrick. Robert G. Allan, Executive Chairman, and Mike Fitzpatrick, President & CEO recently interviewed with *Maritime Reporter TV* to discuss not only the company's rich past, but also the drivers for what is shaping to be a promising future.

Did you always know that yours would be a career in maritime?

Robert G. Allan I'm not sure that I always knew that Greg, but I really didn't have much of a genetic chance. You know, my father and grandfather were both naval architects. My other grandfather was a steam engineer and I kind of just grew up with salt water in my veins. The only time I ever kind of wavered from that, in grade school, a teacher would ask you, "Are you going to be a fireman, a policeman or a doctor?" And I'd put up my hand and say, "I'm going to be a naval architect." And of course, no grade school teacher ever knew what a naval architect was. But yeah, I think I always did it. In my teen years, I was quite keen on architecture.

So there was a chance you could have been designing buildings instead of boats?

RA I recall saying to my father "Maybe I'll just become an architect instead of a naval architect." And my father, who was a very wise man, said, "You could do that and become one of tens of thousands of starving architects. Or you could stick with the marine side and get to be a big fish in a little pond." And that turned out to be pretty prophetic.

When you look at how the company from where it started to today, how has it evolved?

RA Well, let's start with the differences because there are a lot easier to identify. We started out as a one-man operation working out of a basement office; today we've evolved to a company of about 90 people with a global outreach.

The way we do business is totally different, evolving from all manual drafting and manual calculations to a completely computerized, high-tech kind of operating environment. Probably one of the most invisible, but most important changes, is how we work. Our work now is much more structured and detailed, working to ISO standards in how we document design work and design decisions. That makes record keeping for the future generations infinitely easier.

What's the same? Our subject matter has never really changed: a focus on purpose designed work boats. My grandfather, and I think particularly my father, set a tone for the way in which we do business; working honestly, with integrity, with strong relationships. That's something that I hope will never change.

With decarbonization, digitalization and autonomy, I would contend that the maritime industry is in a transcendent period. What's your opinion?

Mike Fitzpatrick Decarbonization is certainly at the forefront of many projects, and it presents probably the biggest challenge to the industry today, mainly because it's difficult to make the economics of decarbonization work, particularly in small workboats. The capital cost difference of a low carbon tug boat for instance, is typically on the order of 30% more expensive than a typical diesel mechanical tug. We've done numerous LNG fueled tugs dual fuel tugs, hybrid tugs, and they've pretty much all been done when there is some outside source providing (a financial) incentive to have it done.

Digitalization is certainly the one that's made the biggest difference in how we do things. Look in the shipyards, where in the past a typical shipyard might have spent 5,000 hours working on the production level design, and then spent 100,000 hours building a tugboat. The more advanced and most efficient shipyards today spend 15,000 hours on a really detailed production model, with 60,000 to 70,000 hours spent on the construction of the tug.

(In regards to autonomy), there certainly has been a lot of media attention to autonomous vessels in the past decade, more media attention than perhaps attention (or interest) from owners. (That said), we have actively been working on autonomous vessels, and we have some projects that have progressed, but it is going to be a slow adoption process. We see it (evolving) as first remotely operated vessels, then semi-autonomous vessels. We're focused primarily on areas and operations where autonomous vessel offers an obvious advantage, such as firefighting, or on the other side, monotonous, uncomfortable jobs crews. I don't see autonomous vessels replacing tugboats for typical operations anytime soon. But what I would hope to see is, like we see in the automotive industry, integration of technologies that are being developed to allow autonomous operation into manned vessels, to improve the safety and ability of crews to be a little more comfortable.

One non-technical challenge we regularly discuss is grooming the 'next generation.' How do you see it?

RA There are so many interesting technical challenges today that it's an exciting time to be in (this business), and I see that continuing for at least the next generation. We've got 20 or 25 years before we're all supposed to be carbon neutral, and as Mike outlined, there are huge technical challenges to overcome (particularly in this smaller vessel category).

MF When I was going to university in Australia, the naval architecture program was co-operated with the aeronautical engineering program. At the time there were about 60 students in the aeronautical program and six in the naval architecture one. On the job boards there were three jobs for aeronautical engineers and seven for naval architects. I figured those were pretty good odds, and I think the same is probably still true today.

Nine decades is quite an achievement for any business today. When you look back, what do you consider your company's greatest achievement?

RA How much time did you say we have, Greg?! I've been immersed in the corporate history for the last year or so, particularly in these COVID-isolated times. I think first and foremost, surviving for 90 years as a continuous business is a pretty significant achievement. And particularly when one looks at starting a business at the beginning of the Great Depression, then surviving those "Dirty 30s" as a one-man enterprise. I know that that was an extremely difficult and discouraging time for my grandfather, a talented, ambitious and proud man. There was a couple of years in the early 30s there where I think his total earnings were in the low hun-

dreds of dollars.

But, he didn't have enough money to go back to his home in Scotland; otherwise I think he may have, and I probably wouldn't be here. Just surviving in business through those early years is a notable achievement. The 1960s were really formative period in the history of our company, and my father was really running the business by the early 60s. It was a transformative time here in British Columbia, where, with the benefit of a fairly significant national shipbuilding subsidy, owners were replacing their old wooden tug fleets with more modern diesel powered steel tugs and building new and innovative types of barges. Our entire coastal economy is run on tug and barge, most of that was developed in the 60s, and my father designed 80-85% of it. There were self-loading, self-dumping log barges developed in this office; and the first widespread use of Kort nozzles in North America were developed here. We did the first icebreaking supply vessels for work in the Beaufort Sea … the list goes on and on. That laid the foundation for the kind of business we are.

When I took over the business from my father in the 1990s, I had (mostly) ruled out Europe and Asia because there was a lot of competition in our field, and we didn't really have the means to penetrate that market.

Then, out of the blue, we made a connection with owners and ship yards in Turkey, a relationship that was good for them, and it was good for us and our business just mushroomed as a consequence. This gave us a foothold with user clients in Europe and with these amazing shipyards in Turkey and that has transformed our business a hundred fold over what it was before.

But ultimately, at the end of the day, the thing I think of which I am most proud is how we made the transition from this being a single family owned company to an employee owned company under first Ken Hartford's direction, and now under Mike's direction. To be able to move the company over to the ownership of the people with whom I have worked is absolutely fantastic. And it worked out immensely well for me personally, for our whole family, and I think I'm sure Mike would echo this, that it's worked out extremely well for all the new shareholders in the company. So that's been the icing on the cake for me.

Read the full interview with additional historical images at: bit.ly/2MpJDP6

Watch the full interview with additional historical images and footage on Maritime Reporter TV at: bit.ly/2XfEprf

Decarbonization via the

Digitalization Path

*When talk turns to decarbonization, it often starts with new builds, new fuels or main engine refits. **Madeleine Engelhardt**, s-Suite Product Management, StormGeo, contends that data-driven fleet performance services – deserves to be in the conversation.*

By Greg Trauthwein

The marine industry is being driven by regulators and social pressure to reduce emissions, and more than two years ago the Initial IMO Strategy on reduction of greenhouse gas (GHG) emissions from ships was released, calling on the industry to reduce its average carbon intensity by up to 40 percent by 2030 and by 70 percent in 2050 (compared to 2008 statistics). But as anyone in the industry knows, the path to 2050 is neither straight nor clear, and most industry insiders and analysts agree that meeting these targets will require a mix of technology and technique, from alternative fuels to innovative ship design and outfitting. The bigger, immediate question hovers around the 50,000+ fleet of existing ships that must make step changes to cleaner operations while remaining economically viable.

As owners evaluate scrapping old ships and building new, or investing in high CapEx main propulsion refits, Madeleine Engelhardt and her StormGeo s-Insight team reckon that true end-to-end digital solutions with voyage planning and weather routing at the heart are a viable means to reduce fuel consumption, cut fuel costs and reduce emissions at the same time as software tools combined with advances in data analytics and improved ship-to-shore communications have created genuine opportunities for owners and operators seeking to improve voyage efficiency and fleet performance.

In one case, StormGeo reports that it pilot-tested weather routing system with Odfjell Tankers over a period of 10 years. Since then, Odfjell Tankers saved an estimated 48,602 metric tons of fuel, which is equivalent to nearly $18m in fuel cost savings.

"You could consider a fleet decision support monitor for shipowners, but also operators, where we integrate different data sources within the applications of our s-Suite," said Engelhardt. "So this could be, for example, intended tracks, manual event data reporting, sensor data, vessel schedules, bunker data, which is, at the end, super-imposed with mid-ocean data. And special areas such as war risk areas, or ecozones, or areas with recent pirate attacks, as well as ENC overlay. So basically, s-Insight provides tools for assessing commercial, technical, and operational performance to real field potential saving, and of course to steer improvement."

The same information is necessary, too, if ultimately the decision is made to invest in new tonnage or a machinery upgrade to existing ships, as it's important to have precise data on where you are at, and where you want to be. "If you have an older vessel, and you're considering design retrofits, before you (start the design), you have to determine a new operational profile," said Engelhardt. "You need data. And after the retrofit, you of course want to assess the effectiveness of the measure, and you want to verify the fuel savings, and to know when the return-on-investment point is achieved. For that you need data, and that is what s-Insight serves."

What is s-Insight?

StormGeo provides weather intelligence and decision support services, and cumulatively it manages approximately 5,500 routings per month globally. Recently, the company launched s-Suite, designed as a complete, one stop solution for shipping customers that includes Voyage Planning, Onboard Route Optimization, Route Advisory Services and Fleet Performance Management, which can be used together or as individual modules.

"s-Insight provides the framework to set the scope to identify and establish best practices, related to efficient ship operation and maintenance," said Engelhardt. "But also, it helps you to understand the impact of measures (taken onboard ships to enhance efficiencies). Igt helps owners to manage ship performance, environmental compliance, and to drive continuous improvement. By using s-Insight, you can integrate it into existing energy management system, or we can also help you to set up an energy management system, to help procedures to achieve targeted energy objectives."

The package transcends the simpler definition of 'software solution', rather s-Insight is designed as a wholistic data management and decision support system. That said, the system is only as good as the people on ships and on shore that use it. "Purchasing voyage optimization and fleet decision sup-

> "If you have an older vessel, and you're considering design retrofits, before you (start the design), you have to determine a new operational profile. You need data. And after the retrofit, you of course want to assess the effectiveness of the measure, and you want to verify the fuel savings, and to know when the return-on-investment point is achieved. For that you need data, and that is what s-Insight serves."
>
> **Madeleine Engelhardt,**
> s-Suite Product Management, StormGeo

Photo: StormGeo

port software for onboard and onshore usage may not yield a quick return on investment if owners neglect to provide adequate training for crews, especially senior officers," Engelhardt said. This is a topic she knows well, having served for many years as a seafarer, primarily onboard containerships, and she is quick to admit that the technology is one part of the equation, while the maritime culture and the sharing of shipboard decisions with shore-based crew is still a work in progress. "At the same time, shore-based personnel must learn to work in close cooperation with crew members to build trust and achieve a shared purpose: improving fuel performance while ensuring safety."

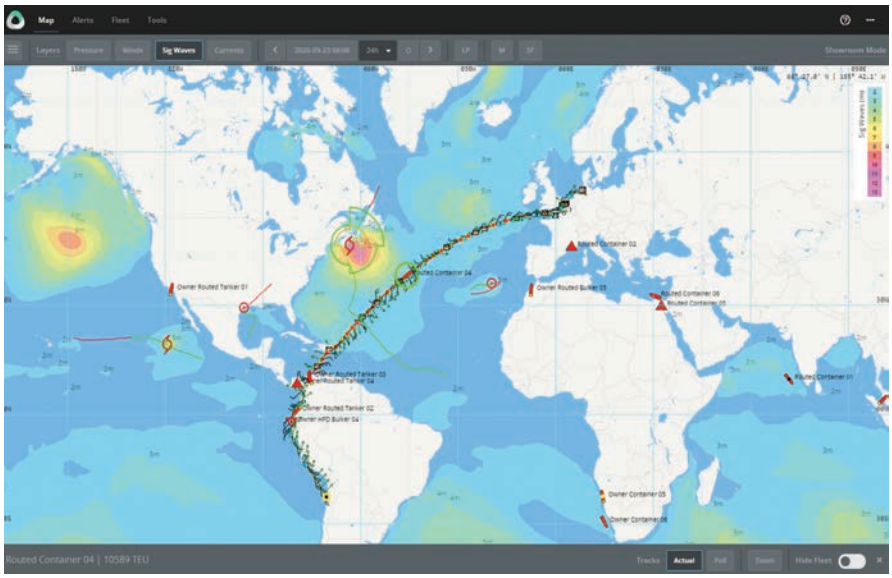


Photo: StormGeo

"From my experience as an energy manager and also internal auditor for a shipping company I used to work for, I know that only qualified and well-trained people are able to respond to the full scope of technical and analytical problems, and are able to explain their decisions to their charterer," said Engelhardt. You have to establish a common understanding about the targets and achievements," meaning that direction and goals must be shared. "Then you have to provide open and constructive feedback. You have to provide regular follow ups, especially also where the crews are constantly changing."

StormGeo's vision is keeping vessels compliant with EU MRV, IMO DCS regulations and actively support initiatives such as Sea Cargo Charter, ESI, CSI and CCWG working towards the greater goals to align maritime activities to be environmentally responsible.

"s-Insight is a powerful application to improve fuel performance. And if you improve fuel performance, you automatically reduce greenhouse gas emissions," concludes Engelhardt.

Images: NCE Maritime CleanTech

A Piece of the Zero Emissions Puzzle

Ammonia Fuel Cells for Deep-Sea Shipping

Interest in ammonia-powered fuel cells for the maritime sector is growing, but stakeholders have been hesitant to commit to investments in large-scale systems. Now the ShipFC project is aiming to secure a place for ammonia in the future of deep-sea shipping. The project will equip the offshore supply vessel Viking Energy, owned and operated by Eidesvik and on contract to energy major Equinor, with a 2MW ammonia fuel cell, allowing it to operate for at least 3000 hours annually on clean fuel. Following the completion of that phase, the project will ramp up to qualifying 20MW fuel cell solutions for oceangoing vessels. "The ultimate goal of the project is to demonstrate the feasibility of ammonia fuel cells for ocean going vessels and long sea voyages," says Dr Michail Cheliotis, Research Associate at the University of Strathclyde, lead partner in the project. "Once the first phase of the project is completed, that's when the fun starts."

Apples and Oranges

"The huge difference in scope makes ShipFC much more interesting than just a replication of Viking Energy," says Cheliotis. "The similarities basically end with ammonia, because a 20MW power plant requires significantly different treatment." That said, he assures that scaling up the project is seen to be well within reach, given the prior knowledge of both fuel cells and ammonia as an energy carrier.

The project will consider three replicator vessel types, including a bulk vessel, an offshore construction vessel, and a container ship. Cheliotis tells that the work will involve close cooperation with replicator vessel owners and a thorough examination of vessel requirements.

A Known Commodity

Technical and economic knowledge developed in the Viking Energy pilot will be incorporated in a broader analysis of ammonia in the maritime sector and comparison with other alternative fuels. "Ammonia presents certain technical challenges, but even though it is corrosive, the safety trade-off between ammonia and hydrogen favors ammonia," says Cheliotis. "It is less explosive, requires less complex storage and transport solutions, and it is a well-known commodity from industry. Based on this experience, the necessary safeguards can be built in." Experience with gas fuels will be a significant building block, he adds: "We have seen that liquid ammonia is similar to liquefied gas in the handling process. Industry has a high level of maturity and an excellent track record in handling LNG and LPG, and this experience is proof that it can be done safely."

Considering all the Steps

ShipFC will closely examine the ammonia supply chain, Cheliotis reports. "We will be looking at the entire life cycle of ammonia, from production to transport and bunkering. One of the ShipFC partners is a major supplier of ammonia, and we will be working together with them to address these issues." Ammonia for fuel cells can be produced with a green profile, Cheliotis explains, giving ammonia a positive overall environmental footprint: "Ammonia can easily be made from renewable resources, making it one of the fuels that will likely meet part of shipping's future green energy demand."

Strathclyde will also provide maritime safety analysis for onboard solutions. "Part of our work will be to propose new

safeguards and accommodations for marine installations of this size," Cheliotis tells.

Ammonia + Fuel Cells = Efficiency

The efficiency of ammonia in fuel cells is good, Cheliotis says. "Successful cases have taken advantage of the most efficient fuel cells. We believe that we can hit the sweet spot of fuel cell technology with ammonia."

Fuel cells have favorable characteristics in the configuration of vessels as well, he says. "As they do not require the same dedicated space as large two- or four-stroke engines, fuel cells can be distributed in modules, saving space and exploiting otherwise unavailable options."

"People are ready to listen to arguments for fuel cells. The technology is becoming more common, and stories of success from other projects in road and rail are getting media attention," Cheliotis observes. "Now we want to take advantage of fuel cell momentum and examine the use of ammonia in addition to hydrogen."

Cheliotis sees the relationship between hydrogen and ammonia in fuel cells as more complimentary than competitive: "This is simply because different solutions will be required to meet different challenges. The choice of solution will depend on a case-by-case evaluation," he believes.

Solving the ammonia–fuel cell equation for deep-sea shipping is a step in the right direction for ensuring progress in the decarbonization process, Chiliotis concludes. "We will need many solutions to meet diverse needs in the maritime industry, and fuel cells powered by ammonia can be among them."

ShipFC project partners:

The University of Strathclyde (UK) and National Center for Scientific Research Demokritis (GR) will assess safety criteria. Norwegian members of the European consortium include NCE Maritime Cleantech, Eidesvik Shipping, Equinor, Prototech, Yara, and Wärtsilä Norway, responsible for fuel systems, ship's design and stability, and vessel energy management. Fraunhofer IMM (GE) will assist Prototech in the development and construction of the ammonia fuel cell system. Persee (FR) will provide expertise on energy management controls and data. Replicator vessel owners are StarBulk Management (bulk vessel), North Sea Shipping (offshore construction vessel) and Capital Ship Management Corp (container vessel).

Images: ShipMoney

ShipMoney &

Seafarer Wages "101"

Stuart Ostrow developed ShipMoney as a means to make the process of paying crew more efficient and cost-effective. Little did he realize then that his company could be instrumental in helping seafarers during their greatest time of crisis.

By Greg Trauthwein

How did you come create ShipMoney?

I'm the definition of an accidental salesman. By professional training, I'm a Big Six CPA. Many years ago, I read a business plan that talked about prepaid. It was a poorly written but an interesting idea that piqued my interest. I began to research and realized that there was an emerging third Visa/MasterCard scheme called prepaid. This was right at the very beginning of prepaid. So I wrote a business plan, raised some friends and family funds, found a bank in Chicago that was very early in prepaid; they loved my business plan and said, "Let's do business together."

Was it focused on maritime from the start?

My first program was not maritime; the first program was for specialized insurance payments for senior citizens. Then a friend introduced me to a company called MTN, Maritime Telecommunications Network, which was a South Florida based satcom company. MTN managed Internet Café's on about 90 (cruise ships) and was having a tough time paying their onboard managers, who were all foreign nationals. Post 9/11, the banks made it very difficult for foreigners to open accounts in the U.S. MTN successfully used our payroll card program to administer pay for their onboard crew solving a fundamental problem (for the cruise companies).

Accidental is how some of the best ideas are formed!

This giant light bulb went off in my head that said, "you have this vertical market that represents more than 250,000 crew members working on cruise ships; they all come from foreign countries and they're all paid in cash." It was the perfect opportunity to introduce a payroll card program.

As I began to research the industry, I realized the opportunity. Once a month a Brink's truck with a million+ dollars would back up to a port. Two guys would bring the cash onboard and the crew purser and a couple other people would spend the entire night breaking it up into envelopes to pay their crew. The next day there'd be a line of individuals. They hand them their pay and away you go. That's how the industry worldwide paid its crew members. Mind boggling if you think about it. I asked the question, *'what do those crew members do with their cash?'* Well, a lot of them send money home. And how do they do that? Well, if they're lucky enough to be able to get off of a ship in port, they would go out to a bodega or a remittance place, take out the cash that they just received, and send money home. So I made contact with Travelex, and I figured out that if I could take that wire service and connect it to a to a payroll card and enable crew members to get paid and send money home when they were on board, we would have a real solution.

Travelex bought into the idea and we were the first company in the world to take a wire service and integrate it directly into a payroll card. Today payroll card programs are universally utilized across the cruise industry worldwide. That simple idea that I had – connect a wire service to a payroll card for crew members, fundamentally changed the entire industry in terms of how crew member are paid.

It is somewhat risky and costly to funnel all of that cash?

Indeed it is. The commercial industry is a bit different in terms of how crew are paid compared to the cruise line industry. The commercial industry pays crew members via a combination of both cash onboard and a wire sent home. We did a presentation once a couple of years back in Manila at Crew Connect. And I did a back of the envelope calculation. If you look at the BIMCO estimate in terms of number of ships out there, call it 50,000 commercial vessels, and you take an estimate in terms of how much cash typically is on board at any one point in time, and how often cash is delivered, we calculated that somewhere in the order of $4 to $6 billion in cash being distributed in the commercial industry worldwide annually. And if you factor in the cost of delivering CTM (cash to master) at say at 3%, it's a big number. Not only is there the cost to deliver the cash, but there's also the capital cost of maintaining that cash on board. And the delivery of cash for crew payroll advances only represents one cost associated with paying commercial seafarers. It does not factor in fees and administrative burden associated with sending wire payments.

Do you see any positives coming out of this mammoth COVID-19 negative?

We are fortunate to have a growing portfolio of commercial clients and have signed a number of significant clients over the last nine months including Maersk and V.Ships. We think that this pandemic has finally shaken the industry to ask itself: 'why do we need cash on board?' (Plus), if you have 1,000, 2,000 or 5,000 crew members, you're potentially doing 1,000 to 5,000 wires a month, which are expensive, difficult and inefficient to administer. ShipMoney solves both sides of the equation: it's a more cost-effective way in terms of providing advances as opposed to cash. And it's a much easier to administer and manage.

So relieving stress for shipowners is one thing, relieving stress for seafarers quite another, particularly today.

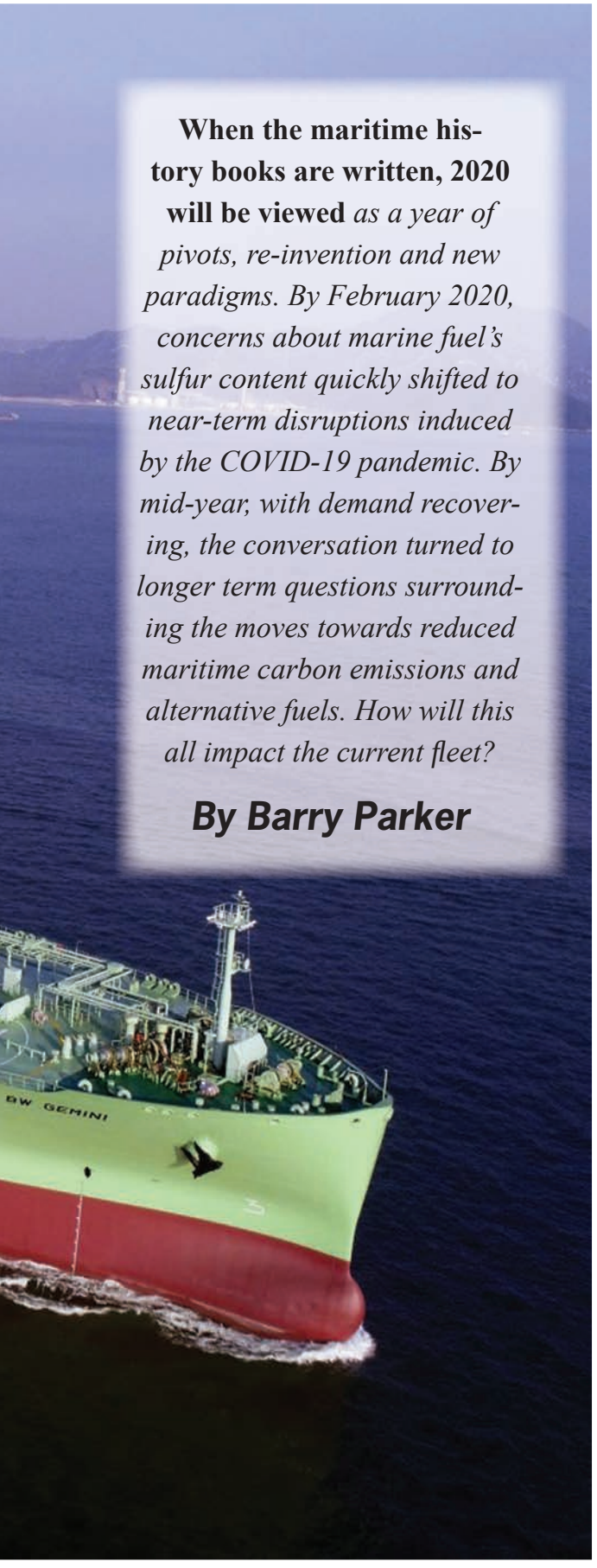
I think that one of the impacts of this pandemic has been a new appreciation for seafarers. The industry has realized how important seafarers are and is making concerted efforts in terms of taking care of them. We've always believed that ShipMoney is a crew welfare benefit.

Fuel, emissions & making the decision to

Scrap or Refit

BW LPG – the world's leading owner and operator of LPG vessels – will retrofit another three MAN B&W 6G60ME-C9.2 type engines to MAN B&W 6G60ME-C9.5-LGIP dual-fuel types, capable of operating on fuel oil and LPG.

Photo: MAN ES



When the maritime history books are written, 2020 will be viewed *as a year of pivots, re-invention and new paradigms. By February 2020, concerns about marine fuel's sulfur content quickly shifted to near-term disruptions induced by the COVID-19 pandemic. By mid-year, with demand recovering, the conversation turned to longer term questions surrounding the moves towards reduced maritime carbon emissions and alternative fuels. How will this all impact the current fleet?*

By Barry Parker

Perhaps the most extreme reaction to the shifting landscape is the ongoing "pivot" of Scorpio Bulk (NYSE: SALT), an operator of mainly owned drybulk carriers, which has the intention to sell its entire fleet of Ultramax and Kamsarmax bulkers, and invest the proceeds in Wind Turbine Installation Vessels (WTIVs). While the bulk carrier market chugs along, with occasional short-lived upward spurts, forecasts point sky high for offshore wind demand in the 2020s. As of mid-December, 2020, SALT had sold nearly two dozen vessels (for prices between $16 - $20 million each), which would leave a fleet of 32 ships either owned, or on long-term leases, and five ships operated under time-charters. The vessel sales, to be completed by end 2021, will result in a staggering write-down on vessel disposals approaching $500 million; as its mid-2020 fleet of 55 vessels had aggregated 3.2 million dwt. Scorpio Bulk had announced, in late September, its intention to finalize an order for one WTIV from South Korea's Daewoo (DSME) to be delivered in 2023, with a price tag estimated at $265 million to $290 million, and options in place for an additional three vessels. From an investment standpoint, betting the whole ranch on renewables may be a savvy move, writedowns notwithstanding.

"Offshore wind capacity is growing rapidly in existing and new markets, supporting increased wind turbine installation vessel demand. As demand grows, the average project size is increasing, from around 100MW average farm size 5 to 6 years ago to around 600MW by 2025," according to Philip Lewis, Director of Research, World Energy Reports (WER). "This growth is more easily achieved with larger turbines, increasing from 4MW turbines on the largest utility scale wind farms in 2014 to 9.5MW in 2019. By the end of 2022 installations of turbines of up to 14WM will be underway. These turbines require heavier lifts of more than 1,500 tons to higher heights from 125-150m. Further, we expect 160 to 180m lift heights for the next generation 20MW+ turbines before the end of the decade." According to Lewis, much of the current Wind Turbine Installation Vessel (WTIV) fleet was not built with these new-generation turbine in mind. Outside of China, WER see 9 WTIV capable of lifting the 10MW and up wind turbines and of these only two are currently capable of lifting 14MW turbines, but these will be joined by a further five vessels currently being built or modified by 2023 and a further four by the middle of the decade.

"Growing overall demand and growing local content market demand will provide potential supply side opportunity for new building, conversions and upgrades, but we also caution against speculative new builds that are not aimed at specific markets, projects or turbines," Lewis said.

The Fuel Conundrum

Paradoxically, confusion about fuels may have salutary impacts on shipping markets in the coming years. Those analysts that were putting positive outlooks on dry bulk (with coal volumes shrinking) and tankers (with oil flows severely battered by 2020's demand destruction) have cited a possibly lower supply of vessels, with scrapping of older ships and, importantly – a reduction in new vessel orders – because of uncertainties about future regulations surrounding fuels. Uncertainty

"Much of the current Wind Turbine Installation Vessel (WTIV) fleet was not built with the new-generation turbine in mind. Outside of China, World Energy Reports sees 9 WTIV capable of lifting the 10MW and up wind turbines and of these, only two are currently capable of lifting 14MW turbines. These will be joined by a further five vessels currently being built or modified by 2023 and a further four by the middle of the decade."

Philip Lewis, Director of Research, World Energy Reports

abounds, leaving some owners watching from the sidelines. For example, in an investor call detailing Q3 2020, in response to a question about ordering newbuild ships, Trygve Munthe, co-CEO of Double Hull Tankers (NYSE: DHT, an owner of 27 VLCC's, many on charter to oil majors), told investors: "…we're not there to do anything at the moment in terms of renewing or expanding the fleet… we're on the fence for now. Propulsion is certainly one issue." His co-CEO, Svein Moxnes Harfjeld, in response to another analyst question on fuel choices, offered a detailed shipowner view: "Propulsion is certainly a very important component when we make these considerations. But we think that the conventional technology is able to …meet the targets that we set out for 2030. But there could still be improvements to be made on not just main engines, but also auxillaries and other sort of aspects of being more energy efficient on more of the ships. We do not think that dual fuel is the way to go. We think it might be sort of a short-term fix. It's a basic technology."

Harfjeld, who has worked at shipping companies including Klaveness and Mitsui OSK, brought up the issue of obsolescence, which looms large in any owner considerations, saying: "But the …proposition in – the way the market works is that the ship owner will take the residual value on that technology maybe already being outdated after five, six, seven, eight years. So, to make such a big CapEx commitment up front without having anybody to sort of support it with income, we don't think that's a good investment decision practice. So, from that regard, we'll wait." In discussing future fuels like ammonia, he said: "…there's still a …lack of clarity, if you like, and not really something available for these type of big ships just yet. So, that we think is something to come maybe way down the line."

Fit for Refit?

Energy efficiency on existing ships can be achieved through retrofitting, which can offer efficiencies that go way beyond "slow steaming," usually in response to weak hire markets (but with environmental benefits). In a recent webinar, consultants Marsoft Inc. suggested that 18,000 bulkers, tankers and containerships (typically 5 to 15 years of age) could be the subject of retrofits, a market that could be worth $12 to $16 billion. Using hypothetical economics for a 2004 built Supramax bulk carrier, the consultants economic model suggested that a package of hull, propeller and engine retrofits could eliminate nearly all of the fuel consumption inefficiencies compared to a 2017 vintage vessel. On the same webinar, Wärtsilä provided detailed economics on carbon reduction actions (including digital upgrades, flow devices, and improvements for existing two-stroke engines), using the case study of a 2011 built MR tanker, in the context of the Average Efficiency Ratio (AER), a carbon intensity measurement integrated into European Union annual reporting requirements. Importantly, financial institutions, notably those members of the Poseidon Principles consortium, look closely at this measure when gauging compliance with decarbonization targets over time. Another measure, Energy Efficiency Operational Indicator (EEOI), which differs slightly, will be the numeraire for another important program: Sea Cargo Charter, where top bulk cargo providers will seek vessels with better carbon intensity ratings. In its MR tanker example, Wärtsilä estimated that a $970,000 retrofit package would improve daily earnings capability by nearly $1,000/day, raise the net asset value

by $2.1 million, and extend compliance with Poseidon Principles metrics by 6.7 years, enabling more attractive financial pricing than if the vessel did not meet the requisite AER targets.

In conversations about fuels, Liquified Natural Gas (LNG) now has a place on the map as a solution for reducing carbon emissions in the broader maritime fleet (beyond specialized LNG carriers- which can consume boil off gas, from their cargo, as a fuel) well out into the future, at least part of the way to 2050. As the fueling infrastructure has grown, LNG fueling is now being taken up more broadly. In the container sector, where voyages follow standard routes, LNG took hold. In the U.S., Crowley and Tote's Florida/ Puerto Rico trades are both served, with each company having a pair of gas fueled vessels, from an LNG fuel hub in Jacksonville. CMA CGM is building nine LNG fueled 23,000 TEU containerships in Chinese yards (in addition to chartering in several smaller gas-fueled vessels from tonnage providers), and has fine-tuned its fueling infrastructure in concert with the oil major Total, a leader in the LNG sector. As 2020 was drawing to a close, Hapag Lloyd announced that it would spend $1 billion on six dual fueled (LNG and conventional marine fuels) containerships of 23,500 TEU to be built at Daewoo, with 2023 deliveries. Fueling of vessels has also led to growth in the fleet of barges or small tankers to deliver LNG to vessels; oil giant Total, for example, has been supplying fuel to CMA CGM vessels in Rotterdam using the world's largest LNG bunkering vessel, the 18,600 cu. m. capacity Gas Agility.

In the tramp trades, a number of LNG-ready vessels had been built to handle LNG as a fuel; NASSCO, for example, delivered eight 330,000 bbl. tankers (with a Daewoo design) to American Petroleum Tankers (part of Kinder Morgan NYSE: KMI) and a Seacor (NYSE: CKH) joint venture, capable of retrofits at a later date. But with more confidence in fuel availability, the tide is turning, even for ships on irregular routes. In 2019, the Greek owner Capital Shipping and Trad-

"Marsoft Inc. suggested that 18,000 bulkers, tankers and containerships (typically 5 to 15 years of age) could be the subject of retrofits, a market that could be worth $12 - $16B."

ing (Marinakis) was hinting at an order for multiple LNG fueled VLCCs at the Hyundai yard, though it was not clear if this came to fruition.

The Sea-LNG consortium, a group promoting LNG fuels for ships, and a member roster including TOTE, Total and two dozen others, pegged the gas fueled late 2020 fleet at 175 ships on the water, with 232 on order. The LNG-ready fleet totaled 232. In a November, 2020 webinar, Sea-LNG's General Manager, Steve Esau, made the case that investment modeling showed that fitting vessels for LNG fueling provided "…the best return on investment (ROI), on a net present value (NPV) basis, over a 10-year time horizon…" with "relatively fast" payback periods. In a December webinar concerning the Poseidon Principles first year results, Société Générale shipping banker Paul Taylor, the Poseidon consortium's Vice Chair, stressed the importance of retrofitting vessels, saying: "It's not all about investment in new tonnage ... there are plenty of things that one can do with an existing portfolio."

The business case for growing with refitting existing ships (rather than building new vessels with reduced emissions) is a very real concept. In mid-December, the Oslo-listed BW LPG (controlling 46 gas carriers, and part of the much larger BW Group, which has a large stake in DHT) announced that it would be refitting three vessels with MAN two-stroke engines with a "dual fuel" capability to burn LPG. All told, BW LPG would be retrofitting 15 vessels with MAN LG-IP engines. According to MAN Energy Solutions: "The vast majority of current orders for LPG carriers over 30,000 cu. m. are with ME-LGIP technology, enabling these vessels to use their own cargo as fuel in the future."

For the BW LPG 15 vessel retrofitting program, Wärtsilä has been designated as the system integrator, which involves not only installation of its LPG Fuel Supply System (LFSS) system, but also the required ship design modifications. According to Wärtsilä's description of the LFSS: " The LPG fuel tank(s) is loaded through dedicated bunkering lines, or in case of a LPG carrier reloaded from the cargo tanks. From the fuel tank(s), the LPG is conditioned and prepared as fuel. A system consisting of pumps and heat exchanger is used to supply the engine with a stable and reliable fuel flow, at the correct pressure and temperature."

Vessel modifications need to be financed. In mid-December, BW LPG announced its intention to acquire 39% of the equity in Navigator Gas, another listed owner of LPG vessels, from investment funds tied to WL Ross & Company. At the same time, Epic Gas, a company in the BW orbit, announced that it would be joining forces with Lauritzen Kosan, adding

MOL's Gas Agility is the world largest LNG bunkering vessel with 18,600 cu. m. tanks. Capable bunkering vessels lie at the heart of LNG expanding its presence as a marine fuel globally.

Photo: MOL

34 pressurized LPG carriers, in a $900 million deal anticipated to close in early 2021. Regulatory filings showed BW LPG also taking a stake in Avance Gas, another owner in the sector. Transactions of this type are a prelude to further consolidation in the sector, and among shipping companies generally, which, in turn, will enhance owners' ability to raise capital to fund refits, initially, and new construction later as new fueling alternatives are proven out.

Battery power has also emerged as a real solution to carbon reduction, usually as part of "hybrid" solutions in conjunction with main engines powered by fossil fuels. Because of their recharging profile, batteries are suitable for short sea transits, or coastwise or intra harbor segments of longer voyages. They are also used in the OSV sector to supplement main engines running at high loads, and also to power vessels holding in place with dynamic positioning. "Hybrid" solutions continue to make inroads into OSV's. In the North Sea; Eidesvik Offshore has retrofitted multiple diesel electric vessels for battery power beginning in 2015. Another environmentally-minded OSV owner, Seacor Marine Holdings, had retrofitted a diesel electric "SEACOR Maya", working for Pemex in the Gulf of Campeche, with a battery solution, at Bollinger's Morgan City yard in Spring, 2018.

In November, 2020 the Brazilian operator Companhia Brasileira de Offshore (CBO, a listed company with a stated intention to reduce its emissions) has announced plans to fit its PSV CBO Flamengo, an Ulstein design built 2012 working for Petrobras, with a battery pack as part of the installation of the "Wärtsilä Hybrid Solution." The install, set for the first half of 2021, will gain a DNV "Battery Power" notation. Now, the U.S. OSV operator Harvey Gulf Marine, owner of five DP- equipped dual fueled PSVs (low sulfur diesel and LNG), is moving to "tri-fuel", supplementing the fossil fuels with a Wärtsilä Energy Storage System (ESS), which includes a 1,450-kW lithium ion battery. One vessel, Harvey Energy, working for Shell in the Gulf of Mexico, has already been fitted with ESS; four sister vessels are to be fitted during 2021 and into early 2022. According to Wärtsilä, "When stationary in the field or in port, the boats will be able to operate on battery power only, greatly reducing both fuel consumption and exhaust emissions."

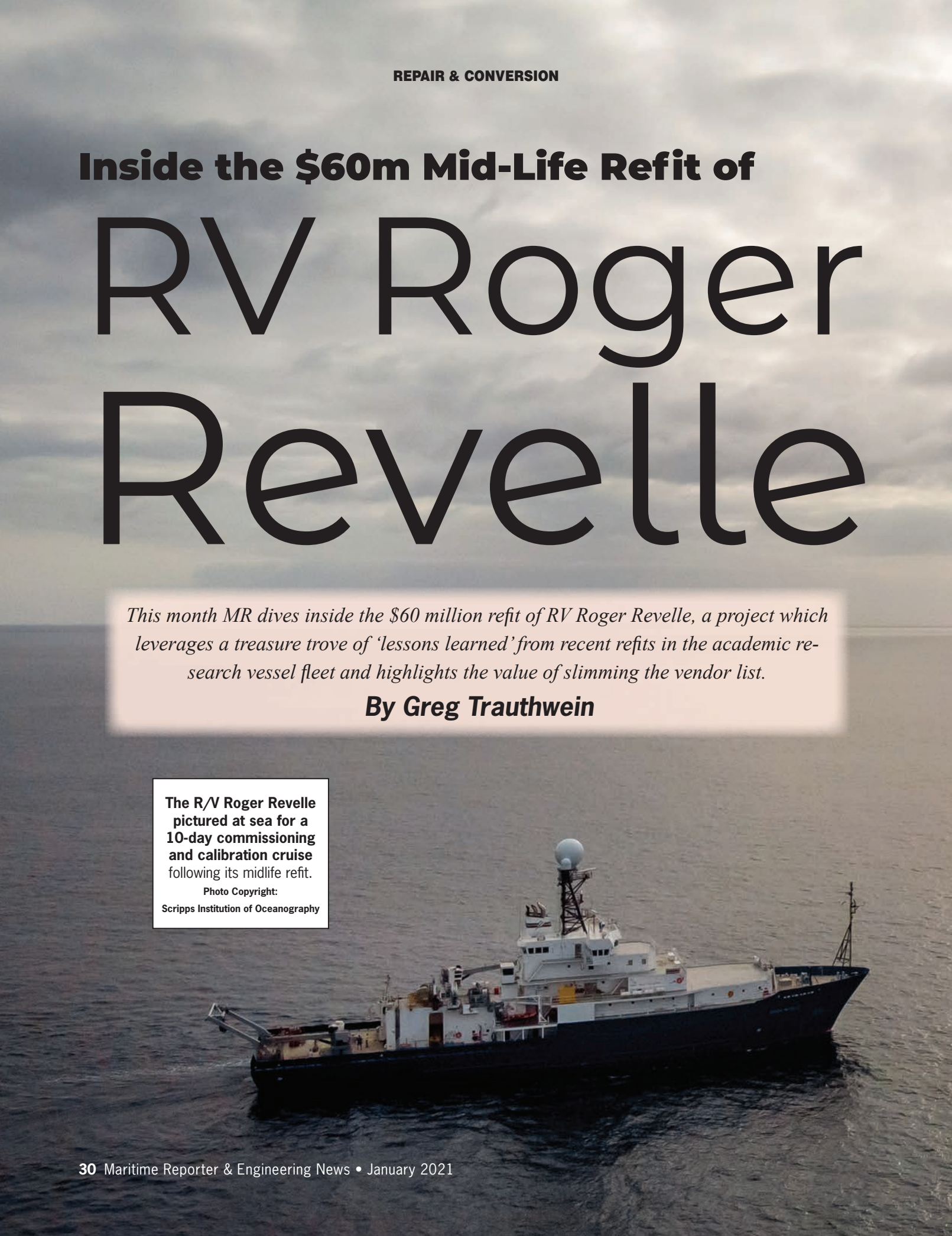
ABS, which has now introduced its "ESS-LiBATTERY" notation, describes tri-fueled vessels as "…shaping the future of sustainability." Paradigm watchers may well agree.

Inside the $60m Mid-Life Refit of

RV Roger Revelle

This month MR dives inside the $60 million refit of RV Roger Revelle, a project which leverages a treasure trove of 'lessons learned' from recent refits in the academic research vessel fleet and highlights the value of slimming the vendor list.

By Greg Trauthwein



The R/V Roger Revelle pictured at sea for a 10-day commissioning and calibration cruise following its midlife refit.
Photo Copyright: Scripps Institution of Oceanography

Research Vessel (R/V) Roger Revelle is back at work after a midlife refit involving upgrades from top to bottom, bow to stern. The ship is owned by the Office of Naval Research and has been operated by Scripps Institution of Oceanography at the University of California San Diego since 1996. It is one of the largest ships in the U.S. Academic Research Fleet, an important asset to U.S. oceanographic research due to its range, payload, duration, and ability to safely conduct scientific operations in remote areas around the globe.

"Roger Revelle isn't just revitalized, it is better than new," said Bruce Appelgate, associate director and head of ship operations at Scripps Oceanography. "The midlife refit was an opportunity to apply everything we've learned about the ship since 1996, in order to make a great research vessel even more effective."

The $60 million refit was supported by the Office of Naval Research (ONR), National Science Foundation (NSF), and UC San Diego, and highlights included:

- **Repower:** The repowering involved replacing the six existing air-cooled generators and split electrical bus configuration (auxiliary and propulsion separate) with four new water-cooled generators and an integrated bus (auxiliary and propulsion together). This included replacing major switchboards and transformers, as well as the propulsion motors and drives.
- **BWMS:** An Optimarin ballast water management system to help stop the spread of invasive species.
- **Bow thuster:** The installation of a new retractable ZF bow thruster to improve performance, vibration and noise.
- **Cranes:** An overhaul and replacement of overboard handling systems, with new cranes, a refurbished A-frame and hydrographic boom.
- **Scientific Gear:** The addition of a scientific instrumentation gondola.

Lessons Learned

Ship design, construction and operation technology has changed mightily since RV Roger Revelle was delivered nearly a quarter of a century ago, and the team tasked to design, outfit and update the ship sought to use 'lessons learned,' both from the operation of the ship itself as well as experience from recent refits of other research vessels in the U.S. Academic Research fleet. A big factor in many of the refit decisions, in fact, were the shared experiences from the refit of the Thomas G. Thompson, operated by the University of Washington. "One of the great advantages that we've got at Scripps is being part of the community of ship operators in academic research fleet," said Appelgate. "They shared everything with us, (including) their lessons learned."

One specific area was taking the decision to replace a noisy, inefficient bow thruster with a new retractable unit from ZF, a change which drops the bow thruster – and the related noise and vibration related to its operation – several feet beneath the hull, making living conditions on the ship more palatable and enhancing the collection of scientific data.

While Paul Mauricio, Port Engineer, and his team did extensive work to improve the efficiency and noise signature of the original bow thruster, including pulling, machining and fine-tuning the impeller on the water pumper, "It would max out at about 270 rpm, it would start to cavitate and it would shake the entire boat." As Appelgate and his scientific colleagues will attest, external noise and vibration at sea is not a friend of good science, particularly as research ships like the RV Roger Revelle use the bow thruster for many hours and days at a stretch to stay on station while equipment is in the water.

With the new retractable bow thruster from ZF, "once it's deployed, the noise is below the ship, not transmitted through the hull" said Mauricio. While the performance of the unit was critical, so too was being able to efficiently fit it into the ship, minimizing the level of modification work needed to get the new unit installed. "One of the driving factors to (which unit we picked) was the fact that it would fit in a retrofit without drastically modifying the entire bow," said Mauricio.

While noise and vibration is bad for science, it's equally bad for quality of life on any ship. "On Roger Revelle, up in the bow is where a bunch of our berthing quarters are located," said Appelgate. "Typically that's where the graduate students get put, so I was stuck up there (a few times). The reason you get 'stuck up there' is because it was noisy as heck because you were next to that (old) bow thruster. Even without cavitation, it was super loud. By installing the extendable bow thruster, it moves the source of noise farther away."

Better Science Minus the Bubbles

"I'm a geologist," said Appelgate. "Back when I was doing research, my interest was in sea floor mapping," and I sailed on the Roger Revelle as a scientist before I worked at Scripps. According to Appelgate, the configuration the ship's mapping sonars when built in 1996 was "the worst place you could possibly pick on the ship for

"We made the mistake in the past by having different vendors supply equipment. The integration is always difficult, and on a retrofit like this, it's one of the biggest deals. It's inevitable that if you have multiple vendors with multiple equipment there is always a problem, but it's always 'his problem, not mine.'"

Paul Mauricio,
Port Engineer

your mapping sonars."

"Ships like Roger Revelle are very broad and not super long; so it pitches a lot," said Appelgate. "As it goes through the water pitching, it makes lots of bubbles and the bubbles sweep down along the hull. Bubble masking is something that we understand very well now, but not so much back in 1996. The place where all the transducers were (originally placed) were right in the place where bubbles would wash down and, basically, wipe out your sonar signals."

"In the period since then, there's been a lot of work done on how to mitigate that on a vessel without rebuilding the ship."

The answer was a gondola that puts the transducers a few feet below the hull "on a big metal structure that looks like a hammer head shark. (see page 37). It allows the bubbles to stay up next to the hull while the transducers are below them." While the gondola was a boon for the science, it was one of the major design and construction challenges in the project. "Building that and then reconfiguring all the cable runs and moving the sonars down onto that thing was a big deal," said Appelgate.

"You know, the ship is the science," said Appelgate. "I cut my teeth on making and operating sonars that were towed behind a ship. As we got better with sonars and motion sensors, those evolved into multi beams. Then we put them onto the ship. Now, all of a sudden, the ship is your sensor. I think it's a valuable exercise to look at a ship holistically in that there's an instrument on the ship, let's say a multibeam, that's only as good as everything that it's attached to. Just like vibration, if you're transmitting a bunch of mechanical sound into your sonars, you're going to get junk. The ship is the instrument."

Cleaner Power

The original ship contract value was for $35 million to take care of specific ship systems – propulsion, controls, HVAC, piping, ballast water management – and steelwork to extend the life of the ship another 15 years or more, said Appelgate.

But "we knew that other issues on the ship needed to be addressed, or the primary users of the vessel just wouldn't be satisfied." That's where the upgrades to science systems came in, adding another $25 million to the project.

"The repower itself was intense," said Mauricio. "We gutted the entire engine room and we pulled about six miles of cable, and we replaced about six miles of cable. There was not a square foot of that ship that wasn't disturbed." *(For full technical details on the ship refit design, see interview with **Tim Leach**, Principal, Naval Architect (Glosten), on page 36)*

"We ended up going with Caterpillars for our main engines, two 3516's and two C32's, running them at 1800 rpm," said Mauricio. "We put 2100 KW generators on the 3516's and 940 KW generators on the C32's." He said while the addition of the scientific gondola increased fuel consumption by about 4%, the efficiency of the new machinery made it break even.

"The biggest challenge with this project is the integration of all new and existing systems," said Benton Strong, Vigor, the shipyard. "Nearly every major system was either replaced entirely or upgraded significantly, merging elements of new construction and ship repair into one cohesive project." To streamline the flow of information among multiple parties,

Vigor commissioned a custom document control system that allowed key partners to upload, review, comment and approve documents on a shared web based platform."

"We made the mistake in the past by having different vendors supply equipment," said Mauricio. "The integration is always difficult, and on a retrofit like this, it's one of the biggest deals. It's inevitable that if you have multiple vendors with multiple equipment there is always a problem, but it's always 'his problem, not mine.'"

RV Roger Revelle Refit
'By the Numbers'

- **Value:** $60m
- **Shipyard contract value:** $43.8m
- **Workers:** 1,000 – including subcontractors and vendors.
- **Duration:** 14 months (April 15, 2019 – July 3, 2020).
- **Cable:** more than 21.75 miles of cable installed.
- **Pipe:** More than 3 miles of pipe installed.

To that end, according to Mauricio, minimizing the number of vendors and use COTS equipment was critical, as when the ship was built it included a broad diversity of equipment and manufacturers, which ultimately made the ship more difficult (and costly) to service. "Our goal here was to simplify everything in common off-the-shelf equipment," and it was able to use experience building the RV Sally Ride five years ago to help in the process. "A lot of our choices were driven by that familiarity with vendors, our crew's familiarity with equipment," said Mauricio. "We felt that if the crew is more interchangeable and you're familiar with equipment, we can keep our boats in better condition."

A point of focus too, for all machinery was to mitigate noise and vibration. "We have learned a lot about power management and efficiency," said Mauricio. "We incorporated all of that when we did the designs for the new propulsion systems. (Critical was keeping the vessel quiet as) Bruce's sonars, their data, relies on the vessel being extremely quiet as far as noise transmitted through the hulls."

To that end much time and effort was expended in the engineering phase to evaluate noise sources and devise means to mitigate. "Nothing makes direct contact with the hull; to

make it acoustically quiet, so we don't interfere with the data sonars," said Mauricio. In addition, Vigor partnered with Bruce S. Rosenblatt & Associates (BSR) to provide detailed engineering support of structural, mechanical and electrical systems. BSR used 3D modeling to develop detailed production level drawings suitable for material procurement and shop prefabrication. The 3D modeling process also helped identify design issues such as equipment and piping system clashes early in the design phase.

Autonomy versus Crewed Ships

While there is a decided move towards increased use of autonomous systems in the ocean study space, Appelgate contends that there are still many jobs – particularly those that are far from shore and power intensive – that still demand a combination of crewed ships and autonomous systems.

"The utility of unmanned systems is that you can achieve a persistence at sea that's not possible with presence," said Bruce Appelgate. "Unmanned systems that we're deploying extend the ability of us to do our sensing at sea. It makes ships more useful."

"Maybe in 50 years it will be different, but things like going to the southern ocean and doing CTE profiles, and the kind of hydrography that the big ships do routinely, you just can't do it (with fully autonomous systems alone); you need too much power. Autonomy extends the utility of the service vessels. It makes us more efficient and gives us persistence.

The Network

Upgraded network capabilities support the significant amount of data collected from these instruments. A new virtual desktop infrastructure (VDI) includes display consoles for all systems throughout the ship, reducing the workload for scientists and crew members alike who use these during their operations. New cyberinfrastructure and centralized computer management helps the ship's technicians maintain security and reliability of onboard computing and networking. "Something that has totally been fast tracked in the last nine months is our ability to use SATCOMs; we have realized the potential of SATCOMs in the academic research fleet in a way that we knew was possible, but there really hadn't been the pressure to do it. In the midlife refit of Roger Revelle, Appelgate said "we completely rethought how we were going to do our cyber infrastructure on the ship."

"What we did with Roger Revelle is we reimagined and reengineered how that infrastructure could be configured in order that we could make the most advantage of existing SATCOMs, and anticipating things like these low earth orbit systems that would be coming out soon that will allow even higher bandwidth at lower cost in a broader geographic area."

"We did a demonstration with Roger Revelle on sea trials, a test shot with a SATCOMs provider (where we) bumped up the internet connection on the ship to be equivalent to about what I experience at home. All of the sudden we went from a situation where you could barely get an email out to streaming video and real-time sending undecimated data sets, big data sets back to shore to be analyzed in near real time and returned to the ship. We've demonstrated that it can work, and it really is going to be a game changer for how U.S. scientific community does work at sea in the short term."

The Ship RV Roger Revelle

R/V Roger Revelle was put into service in 1996. It honors former Scripps Oceanography Director Roger Revelle who is widely regarded for not only establishing the institution as an internationally prominent science center, but for solidifying the decades-long relationship between Scripps Oceanography and the U.S. Navy.

"Roger Revelle was a visionary who – back in 1946 – envisioned the Office of Naval Research as a world leader in sponsoring oceanographic basic research, and later foresaw the need for a new University of California in La Jolla that eventually grew around Scripps," said Tom Drake, director of the Ocean Battlespace and Expeditionary Access department at the Office of Naval Research. "He also suggested the likely trajectory of the Earth's climate, which we are now observing."

Revelle served as an oceanographer for the U.S. Navy during World War II and was instrumental in the founding of the Office of Naval Research. Roger Revelle worked at Scripps Oceanography before and after the war and served as its director from 1950 to 1964. He was among the first to consider the implications of the accumulation of carbon dioxide in the atmosphere and absorption rates of the greenhouse gas by the ocean. A continuous profiling system under the ship will also measure carbon dioxide in seawater, an essential component of ocean acidification research.

The first research expedition on the all-new R/V Roger Revelle got underway in early November, an essential research mission led by UC Santa Barbara to retrieve ocean bottom seismometers measuring seismic activity and to collect rocks from seamounts and underwater volcanoes.

"The ship went down to about the Cook Islands where we recovered ocean bottom seismometers," said Appelgate. "We retrieved 30 out of 30 of these ocean bottom seismometers, which is terrific as these things are worth half a million dollars each; the data on them are priceless. They had been up for a year and they were running out of batteries, so we had to go get them. It was a high priority cruise."

The second research cruise began on Christmas day 2020.

RV Roger Revelle &

Efficient Refit by Design

From 3D laser scanning to Computational Fluid Dynamics, an efficient and successful major mid-life refit such as the one completed on the RV Roger Revelle requires intricate advance design planning, an updated technical toolbelt, as well as the personal touch. **Tim Leach**, *Principal, Naval Architect (Glosten), walks us through the process.*

By Greg Trauthwein

What work was completed by Glosten on the RV Roger Revelle midlife refit.

Glosten has a long history of working with Scripps (SIO) and the Revelle. Building on that knowledge of the Revelle and the experience Glosten gained during the midlife refit of the RV Thomas G. Thompson, we worked closely with SIO to develop 39 work packages for the midlife refit of the Revelle. These work packages ranged from small maintenance items to the complete repowering of the vessel. In addition to the repowering, other major items included replacement of the bow thruster, Ballast Water Treatment System installation, HVAC (Heating, Ventilation, and Air Conditioning) upgrades, noise mitigation of Engine Room fans, pipe replacement, and a new gondola for the scientific transducers.

The repowering involved replacing the six existing air-cooled generators and split electrical bus configuration (auxiliary and propulsion separate) with four new water-cooled generators and an integrated bus (auxiliary and propulsion together). This included replacing major switchboards and transformers, as well as the propulsion motors and drives. Glosten developed a detailed design of the installation of the generators, combustion exhaust, and auxiliary systems, including detailed routing of piping as well as electrical cable pull sheets. The bow thruster replacement involved integration with the powering system changes and major structural changes.

Tim Leach, Principal, Naval Architect, Glosten

Glosten also worked with SIO do develop HVAC modifications to improve function and reduce noise. This included:

1. Upgrading HVAC controls
2. Computer lab server space HVAC
3. Bow thruster room change from ventilation cooling to (AC) air conditioning
4. Modification of port and starboard Generator Room supply fan intakes to decrease noise and improve supply air quality

Other mechanical systems that are reaching the end of life were also replaced. Glosten developed requirements and design for:

1. Chiller replacement
2. New refrigeration units for science and provisions
3. Uncontaminated seawater (for science)
4. PA replacement
5. Dial telephones
6. New cranes

Through a parallel effort, Glosten developed a gondola to house the scientific transducers, with the intent of improving performance. This was incorporated into the midlife. The steel design was developed to a detail level including nest plates.

What was the most challenging portion of the project?

Major modifications are inherently complicated as the new equipment needs to fit in existing spaces and integrate with the existing equipment. During the midlife of the Thompson, lessons were learned that brought about a desire for more control of the design process including more detailed design to ensure fit and performance.

To accomplish this level of design, Glosten started by performing 3D laser scans of the engine room, motor room, and other affected areas. In the development of the modifications, the team modeled the mechanical spaces in 3D in Cadmatic. We brought the scan data into Cadmatic to enable us to place equipment and route pipe while being mindful of existing equipment, pipes, electrical cables, and structure. This provided a high level of confidence that the design would be executed as planned. This also provided a better

starting point for the shipyard when it was time for them to take over the design.

To complete this level of design, it was required to work closely with the vendors of the major equipment. SIO committed to Caterpillar and Siemens as primary suppliers at the beginning of the project. Glosten and SIO worked closely with suppliers throughout the development of the design to address as many issues as possible before construction of the equipment started. SIO also chose ZF to supply the bow thruster and therefore the design was done around their specific product.

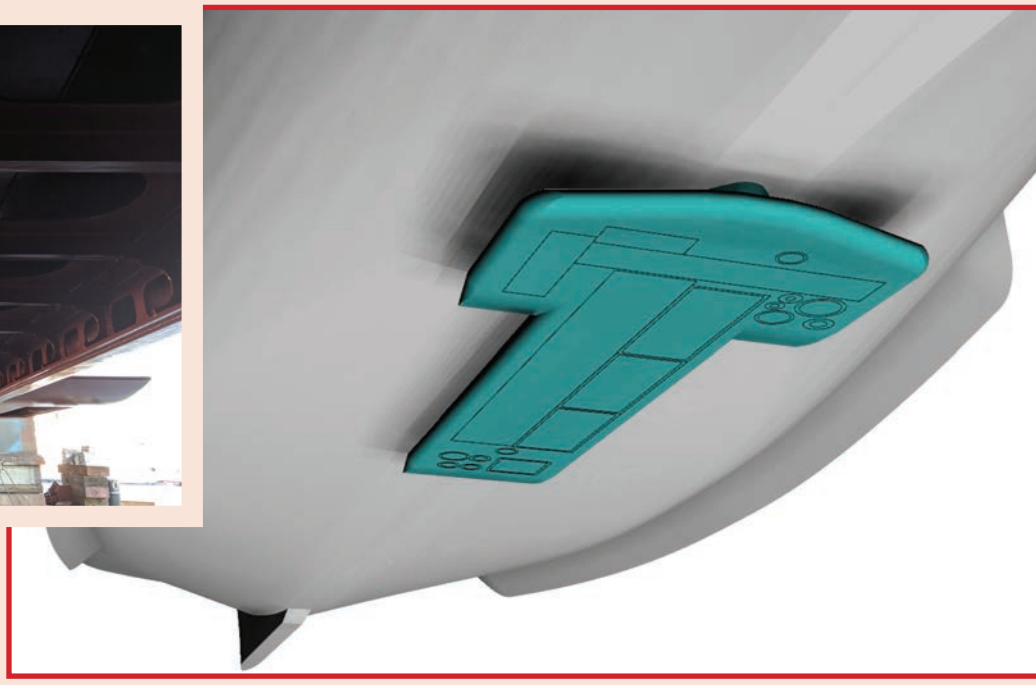
Can you tell us more about the Gondola?

The existing multibeam and other acoustic sensors was a flush installation to minimize draft. Flush installations are more prone to bubbles sweeping down and over the transducers, reducing the effectiveness of the instruments. Various options were evaluated with CFD to help improve performance, with the selection to develop a gondola to move the transducers below the baseline and allow bubbles to pass between the hull and the gondola and not over the face of the transducers. The gondola is 38 ft. long, 16 ft. wide at the widest. Glosten developed a detailed structural design and nested plates for the construction of the gondola. We also developed the installation of the internal transceivers and conduit routing from the gondola to the transceivers.

And some insights on the New Power Package

CAT engines were chosen as the existing generators were CAT and SIO was familiar with the engines. Additionally, CAT was used on the Thompson repower, so there was the ability to learn from the previous installation as well as provide some commonality across the fleet. The configuration and size of the generators was determined in a Repower Study completed for the University of Washington for the Thompson midlife. The study compared capital and lifecycle

The Gondola for Scientific Transducers

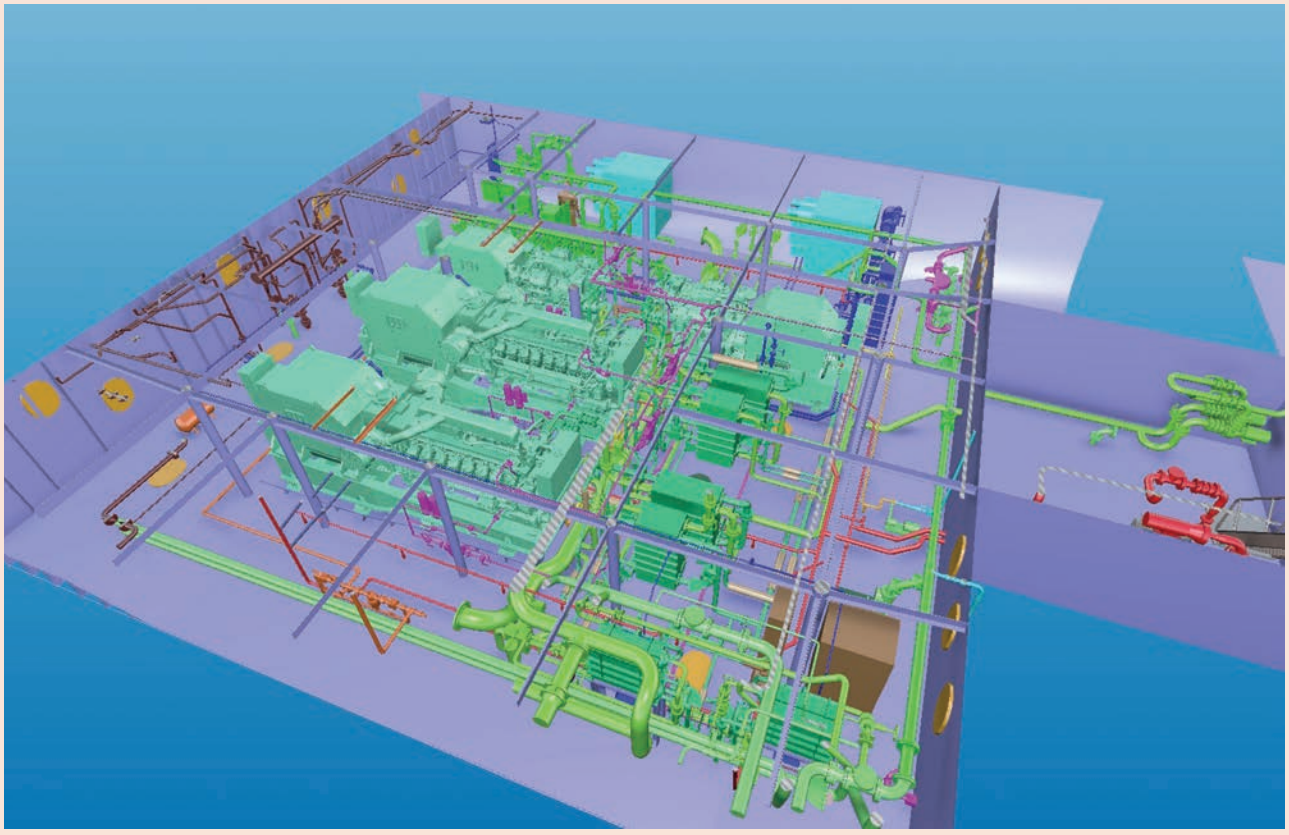


Images courtesy Glosten

Instrument	Manufacturer	Model	Details
Multibeam	Kongsberg	EM124	Tx - 1 deg
Multibeam	Kongsberg	EM124	Rx - 2 deg
Multibeam	Kongsberg	EM712	Tx - 0.5 deg
Multibeam	Kongsberg	EM712	Rx - 1 deg
Depth sounder	Massa	TR-1073A	12 kHz
	Massa	TR-1073A	12 kHz
Scientific wide band echo sounder	SIMRAD	EK80	18 kHz
Scientific wide band echo sounder	SIMRAD	EK80	38 kHz
Scientific wide band echo sounder	SIMRAD	EK80	70 kHz

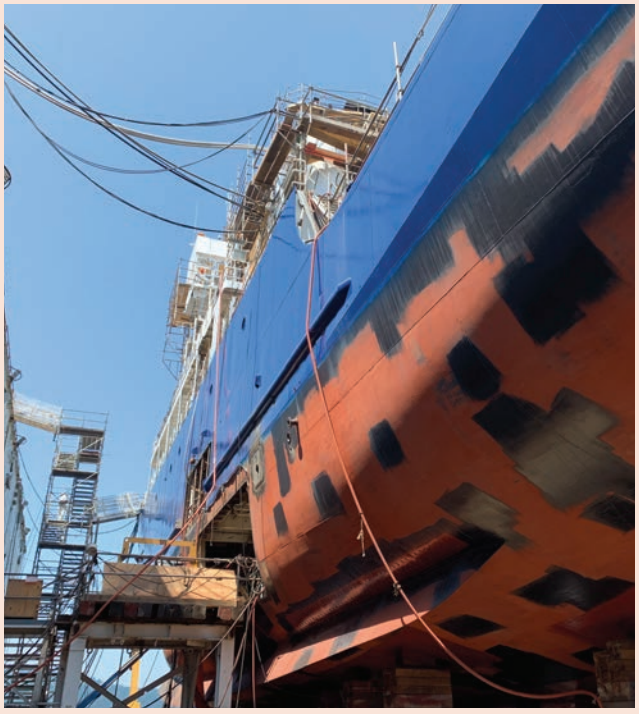
Instrument	Manufacturer	Model	Details
Scientific wide band echo sounder	SIMRAD	EK80	120 kHz
Scientific wide band echo sounder	SIMRAD	EK80	200kHz
ADCP	RDInstruments		75 kHz
ADCP	RDInstruments		150 kHz
Sub-Bottom	Massa	16 x TR-1075A	4 kHz
Ref Hydrophone			
Ref Hydrophone			
HDSS			50 kHz
HDSS			140 kHz

Inside the new Engine Room



Images courtesy Glosten

Cadmatic model of main engine room with new equipment (above) & Engine room removal access (below).



- **Two (2) CAT 3516C, 2100ekW diesel generators.**
  - Vee-16, 4-Stroke-Cycle-Diesel.
  - EPA Tier 3/ IMO Tier 2 Equivalent.
  - 78.1L (4765 cu in) displacement.
  - 1800 rpm rated engine speed.
  - 170 mm (6.7 in) bore x 216 mm (8.5 in) stroke.
  - Turbocharged and aftercooled aspiration.
  - Siemens 1DC0827-8AY02-Z alternator

- **Two (2) CAT C32, 940 ekW diesel generators.**
  - Vee-12, 4-Stroke-Cycle-Diesel.
  - EPA Tier 3/IMO Tier 2 compliant.
  - 32.1 L (1959 cu in) displacement.
  - 1800 rpm rated engine speed.
  - 145 mm (5.7 in) bore x 162 mm (6.38 in) stroke.
  - Turbocharged and aftercooled aspiration.
  - Siemens 1DC0526-8AY02-Z alternator

cost, as well as reliability and adequate redundancy for a number of configuration options. The configurations included

- Replacing propulsion alternators
- New engines
- New gensets
- Integrated bus
- Integrated bus with new alternators
- Repower
- Repower with variable speed

The goal was to find the best value, including reduction in risk of failures impacting missions, lifecycle cost, and reduction in emissions. The chosen configuration of four generators, two large and two small, on an integrated bus provided the best overall reliability and fuel economy.

Insights on the BWMS

An Optimarin Ballast System (OBS) rated to 100 cu. m./hr. ballasting and 167 cu. m./hr. deballasting was chosen for the job. A study of available ballast water treatment systems was completed. It was found that, at the time, the Optimarin Ballast System was the only appropriately sized ballast water treatment system (BWTS) which was United States Coast Guard (USCG) type-approved. While others may have obtained approval by the time of construction, Glosten recommended to design around and install a USCG type-approved system to reduce project risk and ensure a path to approval.

Insights on the Bowthruster

During the Thompson midlife, steel wastage was found in generally inspectable areas supporting the existing bow thruster. This steel repair was expensive and was something we wanted to avoid for the Revelle. One option was to assume the same steel repairs would be required. The other option was to avoid the complications for that repair by replacing the bow thruster. The replacement option was considered given the high noise levels in the forward and below deck staterooms when the existing bow thruster was above approximately 50% power – the primary noise source being cavitation.

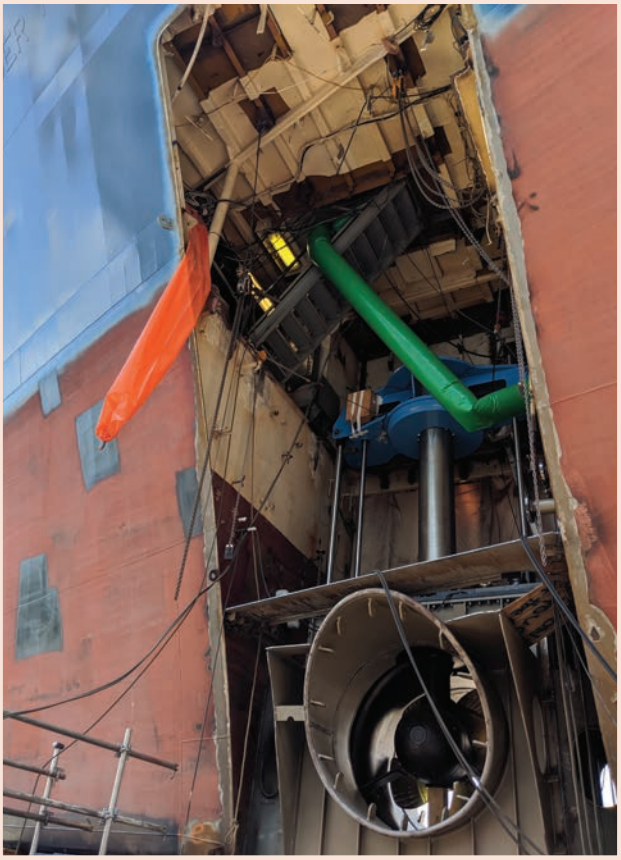
To achieve the desired noise reduction, an azimuthing retractable bow thruster was considered. When performing dynamic positioning at sea, the bow thruster would be in the lowered position. This had two primary benefits. First, the azimuthing propeller would provide more effective power at the propeller and therefore require less power from the motor. More importantly, the propeller would be in better flow and could operate and high powers without cavitation. Additionally, once cavitation started, the noise is below the vessel and would have a less direct path to noise in the staterooms.

When in shallow water, the thruster is retracted and acts as a tunnel thruster.

The Bowthruster

- *ZF Marine model AT 5011 RT TT-FP.*
  - *Azimuthing thruster capable of tunnel operation when retracted.*
  - *1600 mm diameter fixed pitch propeller, 5 bladed, within a nozzle.*
  - *L-drive configuration, with a variable-speed 825 kW jacket-water-cooled AC motor.*
  - *Electric steering motors.*
  - *Active front end motor drive, water cooled.*

Images courtesy Glosten



Oxalis.io Aims to Streamline Ship Repair Operations

In the business of ship repair, no two jobs are the same, surprises are the norm. Oxalis Ship Repair System and TIP integration aims to rationalize the process for all involved parties.

"The Oxalis Ship Repair Solution (OSRS) recognizes the fact that ship repair and maintenance is a team sport," said Micah Waldstein, Director of Product Management, Oxalis.io. "You've got folks working on the deck plate, you have subcontractors, you have the client, the owner, the certifying bodies, and OSRS exists to help coordinate and collaborate between all of those groups." As anyone in the maritime business knows, this 'team sport' is fraught with variables that, if left unchecked, can rapidly escalate in cost and complexity. The Oxalis.io solution, born to serve the U.S. Navy, is designed to make the process more efficient. "So our TIP integration, specifically, is to help shipyards in the U.S. working with the U.S. Navy," said Waldstein. "With OSRS you can collect information from wherever it's happening in your yard, perform an internal QA cycle, and then submit it directly into the system while greatly reducing the administrative overhead of having to copy from – at worst paper forms, or best shared Excel sheets – into the online interface." It's aim is to greatly reduce errors by validating, making sure that all of the data is right, before it gets to the end customer.

Time is Money

Ship repair is obviously a hands-on endeavor, but as with any other industrial operation, preparation and organization is paramount to success. "OSRS helps save yards time in a couple of different ways," said Waldstein. "First in ship repair, there's a lot of hidden administrative costs. Everyone at the yard is probably responsible for doing some amount of paperwork and using OSRS greatly reduces that time, making it a lot easier to make sure that the right data is entered the first time around."

Image courtesy Oxalis

Jonathan Malanche is the founder and leader of Oxalis.io.

MARITIME REPORTER TV **Watch the full interview with Oxalis at: bit.ly/3s7yS4D**

Data accuracy and security is paramount in any repair operation, particularly so in regards to U.S. Navy work. "In the worst case (scenario) bad information gets to the customer, and in the case of U.S. government jobs, often there's big financial penalties that come along with having that information incorrect," said Waldstein.

Jonathan Malanche is the founder and leader of Oxalis.io, a company headquartered in the Pacific Northwest, providing solutions consulting and services to multipele industries, including the maritime ship repair industry. "This (solution) is for ship repair organizations that also potentially have ship building capacity as well, doing both commercial and U.S. Government work," said Malanche. "When it comes to government interaction, that's where things get more challenging for most ship repair organizations. There's a lot of regulatory compliance. There's also a lot of integration needs and a lot of required reporting in data that needs to make its way into those government bodies. So this system is all about addressing that collaboration and teamwork that needs to happen to reduce errors and emissions. This is about communication, collaboration and teamwork in a system that encapsulates it all." While it serves other industries, Malanche maintains that "Oxalis is very much a maritime industry focused firm; it's the majority of our portfolio of clientele."

Installing the System

While no two ship repair jobs are the same, neither are two ship repair yards. "Expect about a month long implementation at the minimum, in terms of rolling out a solution," said Malanche. "You can turn on technology very quickly these days, and we do, but if you don't factor in the training of your personnel, the processes that you're trying to implement, and the successful transition of that onto the first projects or availabilities, you're going to set up your customer for failure, and you are not able to get the true value out of these tools and systems." That baseline of one month can extend to multiple months depending on the customer and the size of the ship repair organization. Another factor is the number and diversity of teams tasked with using the solutions in the field. "We have seen a successful pattern of building an understanding of the core capability, training and allowing the teams to familiarize themselves with the tools in a sandbox, a safe environment." After experience is established within the core team, the system can be scaled out across an entire organization.

Future Direction

The good news with technology is that it constantly evolves with increasing speed. The bad news with technology is that it constantly evolves with increasing speed. "Our phase one is to provide the tools to the industry that have been lacking," said Malanch, a problem that he reckons extends globally. "We are focusing on data, data capture, data entry, and making sure that it's really good quality for the business to understand what they're doing and how they're doing it. The next big capability is to allow those businesses to leverage their own data in their own proprietary way, to do more predictive analytics, to understand where their business is going and to have tools that help inform them of the right next step. With strong data, you are in a position to enhance this kind of product line to support the deep analytics and predictive capabilities that everybody's talking about with machine learning and artificial intelligence," said Malanche. "You don't just go to that, you have to start with data capture. So we see a roadmap, multi-year, that's going to really advance and transform this industry."

Image courtesy Oxalis

Micah Waldstein, Director of Product Management, Oxalis.io.

OSRS with TIP Integration

Oxalis.io added new functionality to its Oxalis Ship Repair System (OSRS) system, providing tools and guardrails for the maritime industry to meet the challenges of 009-04 regulations that require yards to use the Navy Maintenance Database (NMD) for all Test and Inspection Plan (TIP) reporting. The implementation is projected to save shipyards tens of thousands of dollars in recording errors and additional staff required for added data entry.

Oxalis Ship Repair System (OSRS) is an off-the-shelf technology solution purpose-built for shipyards to manage repair processes. Fully integrated with the Navy Maintenance Database (NMD), OSRS coordinates collection, management and communication of key repair processes from one central hub.

Image courtesy Gemi Kaydirma

Stena Line's Modernized Ferry Pair

Stena Line is lengthening and modernizing two ferries at the Sedef Shipyard in Tuzla, Turkey, upgrades that cumulatively cost approximately $85m, according to Swedish media reports. The ships are due to start operating is 2021 with a 30 percent increased freight capacity.

Meet Stena Scandica and Stena Baltica. The two RoPax vessels were originally built at Italy's Visentini shipyard in 2005, and have been operating on Stena Line's Irish Sea route between Belfast and Liverpool for the last 10 years, with the names Stena Lagan and Stena Mersey. Before they start operating on their new route in the Baltic Sea by sister company Stena RoRo, the pair have been renamed Stena Scandica and Stena Baltica, respectively.

"The new vessel names connect with our Scandinavian heritage as well as the region where they will operate. They vessels will add a brand new modern onboard experience for both travel and freight customers on the Baltic Sea," said Johan Edelman, Trade Director Baltic Sea North. The first of the two vessels, Stena Scandica (ex. Stena Lagan) is currently undergoing in Tuzla, Turkey, and the current plan is for it to join the Stena Line fleet and start operating on the Nynäshamn-Ventspils route during the first quarter of 2021.

The second vessel, Stena Mersey, is still operating on the Irish Sea where it will be replaced by Stena Line's new E-flexer, Stena Embla, when it arrives from China in 2021. It will be modernized and lengthened during the spring at the same shipyard and will rejoin the fleet and start sailing on the Baltic Sea before the summer. She will inherit the classic Stena Line vessel name Stena Baltica.

Fast Facts

- **Names:** Stena Scandica & Stena Baltica
- **Built:** 2005 at the Italian shipyard Cantiere Navale Visentini
- **Modified/Lenghtened:** by Stena RoRo during 2020/2021 at the Sedef Shipbuilding in Tuzla, Turkey.
- **Length:** 222 meters
- **Passenger capacity:** 970
- **Freight capacity:** 2,875 lane meters + car deck
- **Cabin capacity:** 200

The Conversion

The investment in the conversion was driven by strong demand in the region. "Stena Line started operating our routes from Latvia in 2012 and the growth has been huge, and we have doubled the capacity in total already," according Carl Mårtenssonm PR & Communications, Stena. "The main driver is freight in shape of production/industry and building material from east to west. The Nynäshamn-Ventspils route is also an important passenger route for people working in Sweden and Norway, as well as a growing travel market."

The two vessels will be lengthened with a 36m mid-section, and after the conversion they will be 222 meters long and have a capacity of 200 cabins, 970 passengers and 2,875 freight lane meters plus the additional car deck; adding another 30 percent freight capacity on the route. To increase the loading efficiency, they will also be modified with drive through capabilities on two levels. The vessels will also be fitted with hybrid scrubbers.

Investment in new or modernized tonnage is always a balancing act. As Stena Line and Stena RoRo is currently in the middle of an E-Flexer newbuilding program with three vessels delivered (Irish Sea) and another two coming 2022, "the decision to lengthen the ships is due to speed and cost efficient solution compared to newbuilds, with existing vessels," said Mårtenssonm. "The finished product will be in many ways similar to the E-Flexer in the service to our customers – modern and flexible."

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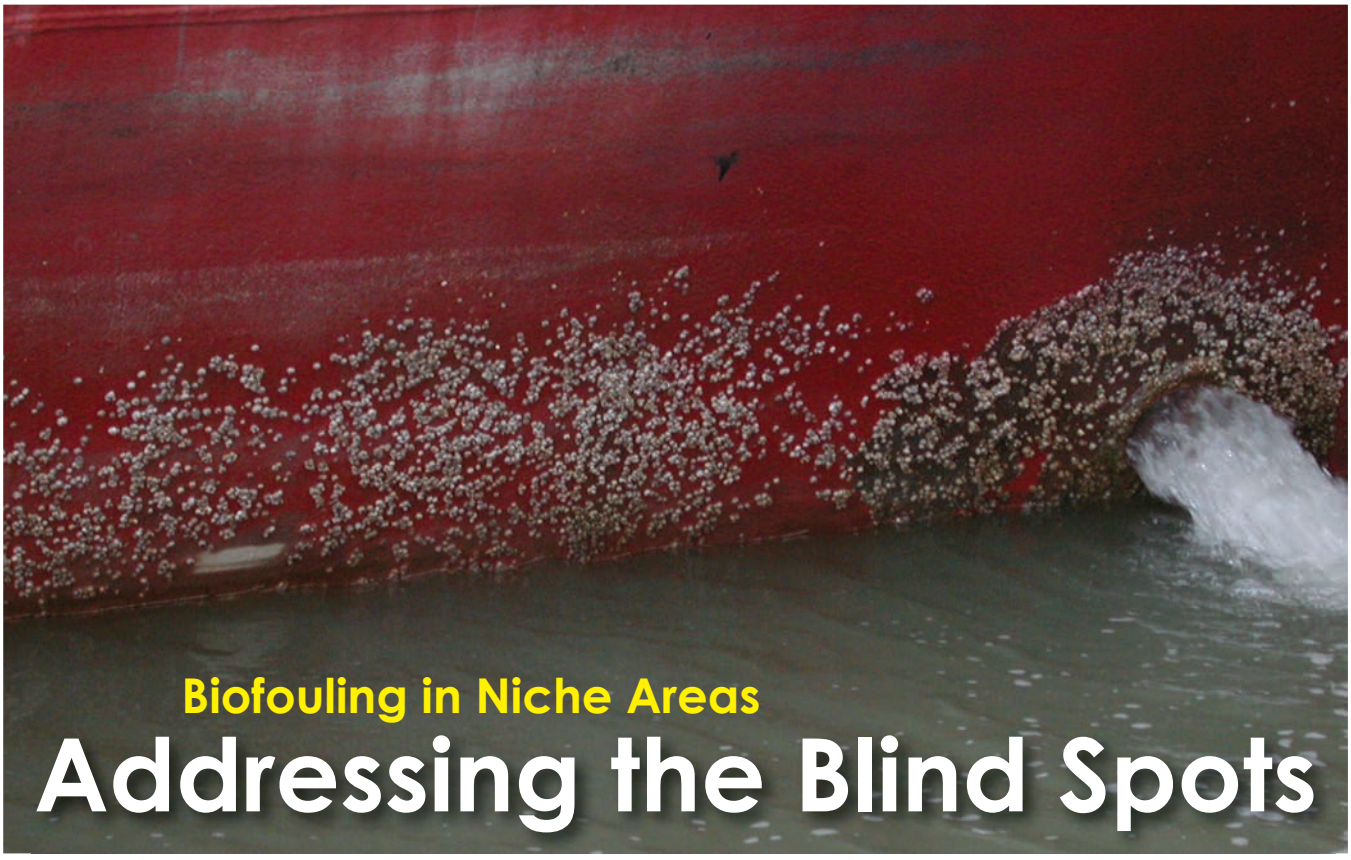


Image courtesy Hampel

Biofouling in Niche Areas

Addressing the Blind Spots

By Dr. Markus Hoffmann, Technical Director, I-Tech AB

From its potential for spreading invasive species to the negative impact it has on vessel performance, hull biofouling is already a major environmental risk. But is the industry really aware of the scale of the problem?

In a recent study that I-Tech conducted with U.K. independent marine coatings consultants, Safinah Group, we estimated that unacceptable levels of hard fouling, predominantly barnacles, across the global commercial could be responsible for at least 110 million tons of excess carbon emissions, with a significant proportion of the fleet suffering from a severe level of hard fouling.

It's a growing risk for owners; in the last few years biofouling has been thrust into the spotlight, and international legislation that looks to limit the spread of hull-borne invasive aquatic species can be expected, in replacement of current guidelines. Presently, the occurrence of mandatory ecosystem biodiversity-preserving regulations for hull biofouling levels are enforced on a regional basis.

For example, in 2017, a 33,752-dwt Korean-owned bulk carrier DL Marigold had to leave New Zealand waters after its hull was deemed a biosecurity threat due to the dense network of barnacles and tube worms. Under new biosecurity rules that entered into force in May 2018, all international vessels arriving into New Zealand must have a clean hull, or else they will be refused entry until they have sailed to another port for hull cleaning to be undertaken.

In California, from October 1, 2017, all vessels of 300-gt or more have been required to complete and submit a "Marine Invasive Species Program Annual Vessel Reporting Form" at least 24 hours before their first arrival of the calendar year at a Californian port. Additionally, from January 2018, ships must present a Biofouling Management Plan and record all management actions in a Biofouling Record Book.

Shipping is almost certainly on the cusp of transitioning from regional to global measures to tackle the spread of hull-borne invasive aquatic species. In early 2017, the IMO resolutions MEPC.207(62) and the launch of the GloFouling project that is focussing on how biofouling should be controlled and managed to reduce the transfer of invasive aquatic species represented two steps forward in the right direction.

Biofouling and invasive aquatic species transfer via ship hulls could be a real regulatory headache that affects the entire shipping industry, and it isn't just the hull of the ship that will come under scrutiny, it will be the niche areas also. Niche areas of ships, such as lateral thruster tunnels, sea chests, and propellers, are hot spots for the accumulation of biofouling organisms.

Results from our joint study with Safinah, in which the underwater hull condi-

tion of a 249-ship sample that spanned most cargo ship types while in dry dock, suggests that if strict mandatory hull fouling limits were introduced now, most vessels in the global fleet could be in breach just by niche area fouling alone. Although the data is difficult to obtain, niche areas, such as, sea chests, thrusters and gratings could account for as much as 10% [1] of the total underwater hull surface of the global shipping fleet.

In the latest white paper that we have published that focusses specifically on the scale of niche area biofouling across the global fleet, it is apparent that niche areas are a particular challenge for the shipping industry and are a collective 'blind spot'.

As well as finding unacceptable levels of hard fouling coverage on the vertical sides and flat bottom areas of the ship hulls inspected across 44% of the 249-vessel sample, heavy animal fouling (barnacles and other shelled organisms) was found in the niche areas of 95% of inspected vessels.

While biofouling in niche areas may not contribute a significant amount to excess carbon emissions from increased fuel consumption demand compared to biofouling accumulation on the flat sides and bottom of a hull, it still poses a great risk of spreading invasive aquatic species and breaching legislation intended to protect biodiversity in these areas.

As well as environmental, there are operational and efficiency risks that come with heavy niche area fouling. For example, if a sea chest for a box cooler is obstructed by dense hard fouling, the heat exchange capacity is reduced, which result in greater energy requirements to run the cooling system. Worse still, critical hardware units may undergo a complete failure with obstructed water inlets in the hull.

Niche areas represent a particular challenge for the efficacy of antifouling coatings. With reduced water flow over niche area surfaces, there is a significant reduction in the effectiveness of many coating products. Furthermore, the shape of niche areas make them an awkward area to apply coatings effectively in the shipyard or dry dock, thus diminishing antifouling effectiveness before the paint is even dry. Furthermore, the shape and protrusions within niche areas means that coatings are often significantly more damaged than other areas on the hull underwater surface.

However, there are a handful of steps that ship owners can take to address this collective blind-spot.

For example, when discussing coating specification with the shipyard, owners can opt for an antifouling coating with a higher polishing rate for use in niche areas to support improved performance in low-water flow conditions. Furthermore, owners can specify additional coats be applied in niche areas to increase the concentration and efficacy of the antifouling coating. As these areas are difficult to coat, also special attention should be spent for the surface preparation and the quality of the paint application. Also, certain technologies can protect niche areas from hard fouling accumulation, even in low water flow conditions. This includes I-Tech's antifouling ingredient technology Selektope®, which acts in very low concentrations to repel, with non-killing effect, approaching barnacle larvae looking to set up their permanent home. As such, there are now antifouling coatings on the market which offer superior protection of niche areas thanks to Selektope.

References

A [1] Moser, C.S., Wier, T.P., First, M.R. et al. Quantifying the extent of niche areas in the global fleet of commercial ships: the potential for "super-hot spots" of biofouling. Biol Invasions 19, 1745–1759 (2017). https://doi.org/10.1007/s10530-017-1386-4

The Author

Hoffmann

Markus joined I-Tech in 2019 after roles at Hempel's Antifouling Global Center of Excellence and BASF. He holds a PhD in organic chemistry from Julius-Maximilians-Universität, Germany.

Hempel, its sustainability path and using coatings to Meet Emission Targets

Image courtesy Hampel

By Tom Mulligan

Coatings specialist Hempel has adopted a 'sustainability path' strategy to support the shipping industry in meeting IMO CO2 and SOx targets through the use of high-performance anti-fouling coatings that contribute to increased fuel efficiency and give cost reductions that offset investments in SOx abatement technologies.

How can paint increase a ship's fuel efficiency? In fact, 'paint' is not exactly the right term to use in this instance, 'anti-fouling coatings' being more accurate. Such coatings have been developed because the maximum speed of a ship decreases and its displacement increases as its hull becomes fouled with marine growth, the two effects combined greatly reducing the fuel efficiency of the vessel.

Anti-fouling coatings have been in use to maintain ship performance since the 19th century. Significant developments in the technology took place during World War II as a result of US Navy funded research performed by Woods Hole Oceanographic Institution on marine biofouling and its prevention, and, in modern times, anti-fouling coatings are based on cuprous oxide or other copper compounds (and/or other biocides) to impede the growth of barnacles, algae, and other marine organisms. Historically, copper paints were red, which is why ships' hulls are still painted red today.

'Sustainability Path' Strategy

International industrial coatings specialist Hempel Group, a $1.5 billion turnover company headquartered in Lyngby, Denmark, has decades of experience in developing and manufacturing anti-fouling coatings, and has embarked upon a 'sustainability path', its strategy to enable its customers to achieve their sustainability goals with the development of highly efficient anti-fouling coatings as one of its core elements.

In addition to developing its own sustainability strategy, Hempel has joined the Getting to Zero Coalition, a joint collaborative effort between more than 90 companies worldwide within the maritime, energy, infrastructue and finance sectors working towards commercially-viable zero-emission operations along deep-sea trade routes by 2030. Hempel joined the Coalition in October 2019 to work towards a more sustainable future within maritime shipping, taking a highly active part in its technology track.

Increase Efficiency, Balance Costs

Hempel said that its newly developed Hempaguard MaX hull coating system helps shipowners offset the cost increases caused by the IMO's 2020 Global Sulphur Cap because the savings delivered by this highly advanced new anti-fouling coating help balance the cost of the more expensive low-sulfur fuel oil (LSFO) that vessels are turning to, with payback in just under four months.

Image courtesy Hampel

If the shipowner continues to use high-sulfur fuel oil (HSFO), then this usage combined with a premium hull coating such as Hempaguard MaX can generate savings giving payback on investments in scrubber systems and the coating in just over five years. In addition, shipowners can save up to two tonnes VOC per docking when applying Hempaguard MaX compared to a conventional antifoulant. "Sustainability will be a key driver for innovation and optimization of the shipping industry for years to come. As fuel costs rise due to new requirements and demands, we expect more and more shipowners to invest in proven technologies that increase fuel efficiency and limit CO2 emissions," said Michael Hansen, Hempel's Executive Vice President & Chief Commercial Officer. "In partnership with the shipping industry, Hempel has for years been committed to limiting fuel consumption using hydrodynamic hull coatings, which reduce drag and improve fuel efficiency. The increased focus on fuel savings is due to new regulation and ambitious climate targets. This creates new opportunities as customers rely on Hempel's solutions to help maximize operational excellence."

Tech: The Key to Sustainability

A 17 percent reduction in fuel consumption and associated CO2 emissions is achieved through Hempel's patented Actiguard technology which integrates silicone-hydrogel and full diffusion control of biocides in a single coating with an "extremely low" Average Hull Roughness due to the combination of its interdependent layers. The new Hempaguard MaX coating is based on Hempaguard X7, which has been applied to more than 1,700 vessels since its launch in 2013, resulting in a collective annual fuel bill reduction of more than $500 million and an associated annual CO2 emissions reduction of more than 10 million tonnes.

Besides offering hull coating solutions to reduce fuel consumption and associated emissions, Hempel offers marine customers SHAPE, a propulsion monitoring and analysis service that enables operators to document performance and make continuous improvements to reduce fuel consumption and associated CO2 emissions.

"Hempel has a very important role to play in helping our customers on their separate journeys towards sustainability. In the marine segment, our coatings have never been more in demand than they are today. As an example, this is illustrated by the demand for our Hempaguard MaX solution. As sustainability becomes ever more engrained in our customers' core business, we expect this trend to continue," said Lars Petersson, Hempel Group President & CEO. "We're an ambitious company on a strong growth curve. Our target is to double Hempel in five years, and we remain on track. We want to lead the industry in market-driven innovation, sustainability and customer focus," Petersson concluded.

Ballast Water Management Systems

Technical, logistical, business updates on BWMS.

Two topics – ballast water management systems and digitalization – have dominated the maritime industry this century. Alfa Laval helps meld the two, and MPC Container Ships ASA (MPCC) helps lead the way. The Oslo-listed company owns and operates 65 containership, 15 of which are equipped with connected Alfa Laval PureBallast 3 ballast water treatment systems. In the last year MPCC installed PureBallast 3 ballast water treatment systems with PureBallast Connect, and now the company is coming back for more. "For new equipment like ballast water treatment systems, the possibility to remotely access the systems provides several benefits," said Philipp Niesing, Managing Director at MPCC Verwaltungs GmbH. "It was important for us from the start that Alfa Laval could access and troubleshoot the systems remotely, in order to avoid deploying service technicians to cater for small needs. We want to have our systems ready for use and compliant at all times." Using PureBallast Connect's online portal, superintendents can support vessels by following the parameters, conditions and alarms of connected ballast water treatment systems.

PureBallast 2 Gets USCG Type Approval

Alfa Laval's PureBallast 2 solution is one of the more mature technologies on the market, launched a decade ago. But the system was developed long before the USCG presented its testing regime, and as a result, certain technical modifications were needed before it could undergo USCG testing. With the modifications in place, a PureBallast 2 system with a Boll & Kirsch filter completed the tests in April 2020, and the solution has now received USCG type approval as of December 30, 2020. Owners seeking to take advantage of the USCG type approval will need to perform a minor upgrade on their PureBallast 2 systems.

'Don't Delay' ClassNK Advises

The installation of regulatory mandated equipment is generally not met with enthusiasm by the ship owning community, particularly the case with BWM systems, which can cost millions of dollars with no direct economic return. At the same time, complex retrotfits across the world fleet can cause logjams of availability at shipyards, and ClassNK is advising that shipowners not wait until the last minute to install BWMS. ClassNK has analyzed the retrofit status of BWMS on its registered ships periodically since 2018. As of the end of November 2020, 7,220 of the 9,159 ships registered with ClassNK are obligated to install BWMS in accordance with the BWM Convention. Among these, 3,982 ships have completed the installation, leaving 3,238 ships that still require attention. Although the number of ships without BWMS has decreased by 1,280 since August 2019, the deadline for these ships remains largely concentrated in 2022.

Simplifying the Aftpeak Tank Retrofit

The oneTank concept was conceived by its parent company Glosten, while refitting tankers and bulkers, when it was realized that these projects were not one refit project, rather two. Even though the cargo body is where 95% of the ballast water is located, sometimes fitting the aftpeak tank proved more difficult. "We've fitted many cargo body ballast treatment systems including filter + UV, filter + EC, and more recently several of the InTank treatment plants that are supported by SciencoFAST," said Kevin Reynolds, managing director,

Melding Digitalization & BWMS

Two topics – ballast water management systems and digitalization – have dominated the maritime industry this century. Alfa Laval helps meld the two, and MPC Container Ships ASA (MPCC) helps lead the way.

Images courtesy Alfa Laval

Image courtesy oneTank

Focus on the Aftpeak Tank

This rendering shows oneTank as it will be installed for OSG. This uses a oneTank supplied circulation pump. The bulk chemical drum is shown to the right on the oneTank unit, which costs $200 and can treat the aftpeak tank twice. The chemical is bleach. The small neutralizing tote (sodium thiosulfate costing about $25) is shown to the left of the unit. It can neutralize the aftpeak tank twice.

oneTank. "These are all large and complex systems that when properly fitted and commissioned do a great job of processing many tens of thousands of cubic meters of ballast water."

The aftpeak tank is a different story. Typically, the aftpeak tank is just 5% of the total ballast water volume on the vessel, the aftpeak is separated from the cargo body tanks on tankers by gas-hazardous regulations and on bulkers by practical considerations. The ballast water flow rate to the aftpeak tanks are typically 200 cubic meters per hour, and the aftpeak tank is used for many practical purposes such as cooling the stern tube bearing, dampening propeller vibration and more recently as salty feedwater for electrolytic based ballast water treatment systems. Despite its size, it can be just as time consuming as the cargo body refit. oneTank seeks to simplify the process in terms of design, install and maintenance of this system. "We worked closely with OSG on ballast water management since 2008," said Reynolds. "Much of this work has been focused on the cargo body ballast water tanks which in this case are FRAMO style tankers. This means that the vessel does not have a cargo pump room, but rather specialty cargo and ballast water pumps similar to deepwell style pumps. There are several innovative solutions for this style tanker. However, all of them require an independent ballast water treatment system for the aftpeak ballast water tank."

oneTank is an in-tank ballast water treatment solution. It takes a small amount of ballast water from the ballast water tank, circulates that ballast water through the oneTank unit where bleach is added and circulated back into the ballast water tank. This approach can be performed at any time in-tank, meaning that it doesn't have to be performed during port and cargo periods. It also means that there are no filters to clog. Because aftpeak tank volumes are relatively small and infrequently filled, oneTank is a bulk chemical solution, or as Reynolds explained in a recent interview with Maritime Reporter TV, "about $80 worth of bleach."

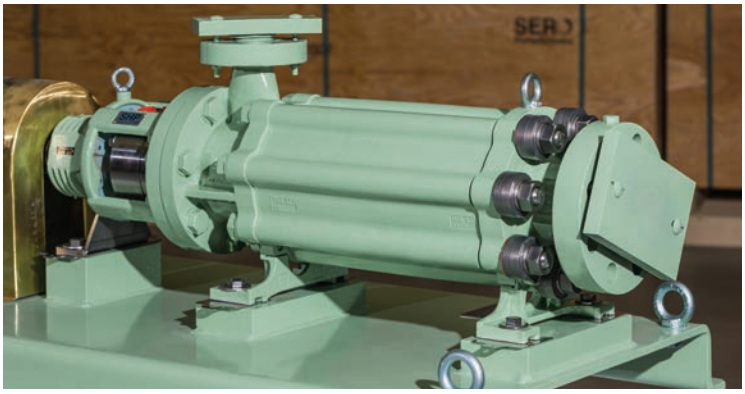
SOCP: BWMS User Guide

The Ship Operations Cooperative Program (SOCP) released the Ballast Water Management Systems (BWMS) User Guide. Developed by Glosten in cooperation with the SOCP Members and support from the United States Maritime Administration (MARAD), the Guide simplifies the complex regulatory framework around ballast water management and provides step-by-step methods for integrating and operating a compliant BWMS. Register to download the BWMS User Guide here:

https://www.socp.us/bwms

Tech Files

Innovative products, technologies and concepts



SERO

SERO SHPmarine Side Channel Pump

While the maritime industry steams toward alternative and dual fuel solutions, much of the focus, rightfully so, remains on the main movers as well as the design and logistics considerations. Here we look at the SERO PumpSystems' SHPmarine side channel pump, a pump integrated into the "Secondary Fuel Supply Systems" (SFSS) of hybrid ship propulsion units pumping LPG (propane) to the main shipboard engine.

According to the manufacturer, it is the first pump of its kind to be both Lloyd's Register accepted and DNV GL type approved for maritime dual fuel propulsion systems. This pump includes: a low suction head requirement, uninterrupted pressure-constant delivery of low-viscosity liquids and a resistance to shipboard vibrations ensuring high functional reliability of the SHPmarine in "over the water" applications.

The SHPmarine pump technology was originally developed for use in the oil and gas industry, handling natural gas liquids in a myriad of midstream production and process services. It has now been modified to meet maritime needs as the IMO 2020 initiative to reduce fugitive emissions takes hold.

COVID-19 & the need to Disinfect Your Ship

Rotterdam-based company DisinfectYour.com has launched a new service to help vessel owners and crew respond to COVID-19 outbreaks. The service includes complete disinfection of closed areas on a vessel, as well as care for the crew – including sanitized transfers between the vessel and COVID-safe accommodation in Rotterdam – during the treatment.

Vessels are treated using a highly effective equipment approved by the UN and the World Health Organization. Nebulizers create a fine disinfectant mist that quickly cover surfaces, enabling the vessel to re-enter service as soon as possible pending a safety check after surfaces have dried.

DisinfectYour.com has a strong pedigree of sanitizing workplaces – including airports, public transport facilities, shopping centres and offices as well as ships – to the highest environmental and occupational safety standards.

DisinfectYour.com

EBDG & Factory Trawler Modernization

Elliott Bay Design Group (EBDG) is supporting O'Hara Corporation as it modernizes its 204-ft. factory trawler, Alaska Spirit, which has been fishing Alaska's Bering Sea since 1989 when it was converted from an OSV to a head and gut factory trawler. The project kicked off in 2017, shortly after O'Hara acquired the vessel and selected EBDG as its engineering partner. Project planning has been intentional to ensure vessel operations were not negatively impacted, with work completed during normal down time. Upgrades have included new generator and hydraulic engines, a new factory, conversion of underutilized aft tanks to stores, replacement of pilot house port lights with windows, habitability upgrades, and a complete rethinking of the trawl deck. EBDG has provided engineering support for much of this work. For the full story visit: **bit.ly/3npDK1m**

Image: EBDG

FuelTrax/CBO

CBO Installs FuelTrax on PSV

CBO, a Brazil-based operator of OSVs, will install the FuelTrax Electronic Fuel Monitoring System (EFMS) on its Platform Supply Vessel CBO Anna Gabriella. In total, CBO operates a fleet of 32 offshore support vessels in the main Brazilian oil basins and the North Sea. CBO Anna Gabriella was first delivered to CBO in 2006, where it commenced work for Petrobras.

With the addition of FuelTrax EFMS, CBO Anna Gabriella is expected to gain a significant digital upgrade, including new visibility into vessel activities and fuel costs from direct measurement of fuel consumption. This is combined with independent vessel tracking and shore-based data delivery service for 100% of fuel data collected.

Through new access to FUELNET – the secure logistics web portal used to analyze FuelTrax data – CBO will track day-to-day operations from live updates for all fuel activities performed out at sea. Future charterers of CBO Anna Gabriella will also benefit from this new insight and data as a deliverable from CBO.

FuelTrax will also help CBO increase its fleet utilization and maintain its contractual requirements by delivering new tools and transparency.

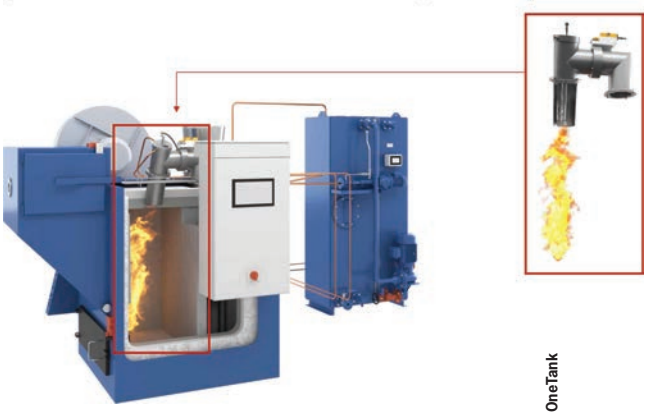
Wärtsilä LPG Retrofit

Wärtsilä's R&D has won another order for the company's LPG Fuel Supply System (LFSS). BW LPG, the world's largest LPG shipping company, has ordered the system to be retrofitted to three very large gas carrier (VLGC) vessels. BW LPG had previously ordered four Wärtsilä LFSS' in 2018, and an additional eight systems in February 2020. This latest order placed in November 2020, thus brings the total to be delivered to the same customer to 15, thereby emphasizing their satisfaction with the technology. The initial order was placed following Wärtsilä's full-scale testing of the system in 2018 with a full-sized two-stroke marine engine operating on LPG fuel. This was the world's first such testing protocol. For the retrofitting, Wärtsilä has been designated as the system integrator, which involves not only installation of the system, but also the required ship design modifications.

© Wärtsilä Corporation

The X10 Titan

The X10 Titan range from Atlas Incinerators is designed to save shipowners and shipyards money while shrinking their environmental footprint. The X10 Titan range was designed to incinerate sludge oil and simultaneously burn solid waste while consuming a minimum of energy. While there is a significant improvement in the X10 Titan's combustion specifications, the real game-changer according to the manufacturer is that the sludge oil does not have to be heated prior to being burnt, which means that the incinerator consumes a minimum amount of energy. The control system on the X10 Titanhas also been upgraded to offer the latest in HMI technology, and the specifications of the X610 offer significant improvements compared with the ATLAS 600. The X610, the first in the X10 Titan series, has obtained a MED-type approval certificate issued by DNV GL.



OneTank

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Massive Type 31 Frigate Factory Takes Shape

Babcock

Babcock awarded a $43m contract to Robertson Construction for the development of a new Assembly Hall at its Rosyth site. The Assembly Hall will initially be used for the Type 31 general purpose frigate program. Advances inside the hall include the use of hand-held devices that will underpin the efficient flow of materials. Gantry stair access inside the structure also removes the need for traditional scaffolding, enabling safe access to the vessels without leaving the building. Additionally, three new panel lines, a cornerstone of Babcock's digital transformation at Rosyth, will create efficiencies in the manufacturing process. Work has already started on the refurbishment and extension of the existing manufacturing bay which will house the panel lines. Each PEMA production line is based on modern shipbuilding technology that enables Babcock to raise its level of automation. PEMA Thin plate panel line is equipped with the latest technologies, such as plate edge milling and robotic welding which enable high-quality production of various panel types. PEMA T-beam fabrication line is designed to make straight T-beams without any additional straightening processes.

Crab Catchers Propelled by Schottel

Schottel

Ten new crab-catching vessels for the Russian crab-catching companies Antey, Merlion and Aqvainvest will be propelled by Schottel. They will be built at different shipyards in Russia and are designed by Damen as design type CC 5712. Eight will be constructed at Nakhodka and a further two at Brothers Nobel shipyard. They are scheduled to enter operation from 2020 to 2024.

Each of the 57.7 x 12.6-m ice-class vessels will be equipped with one four-bladed Schottel ControllablePropeller type SCP 774 featuring a propeller diameter of 2.8m and driven by a 1,620 kW, diesel engine (750 rpm). With this configuration, the vessels will achieve a free running speed of approximately 12 knots. For improved maneuverability, each new build will also be provided with one 400 kW Schottel TransverseThruster type STT 1 CP.

Wave MiniBOSS Bilge Water Separator

A new version of the Wave MiniBOSS IMO separator is now available. The Series II Wave MiniBOSS offers a faster flow rate, providing 0.5 cu. m./hr. across all models providing more flexibility for customers. All models of the separator are available for DC or AC power.

Approved by the IMO, ABS and US Coast Guard, it is MEPC 107 (49) certified for use on all vessels from 400 gt.

The Wave MiniBOSS is a neatly designed bulkhead mounted system. Its filter technology removes all trace of pollutants down to 15 ppm which is the IMO worldwide standard. Additionally, the system can be supplied to clean bilge water to 5 ppm if a vessel is operating in a sensitive or Particularly Protected Sea Area (PPSA) as certified by the IMO.

Once fitted, the Wave MiniBOSS is designed to be easy to operate.

The indicator panel enables users to simply set the required outflow quality. The oil water monitor retains an 18 month log of bilge pumping operations. Replacement cartridges are available globally.

Wave MiniBOSS

The Via Kaizen Project
Advancing Maritime AI

Lean Marine

Lean Marine's FuelOpt and Fleet Analytics technology and Molflow's Slipstream technology are designed to enable a higher degree of digitalization and automation.

In step with the push toward digitalization and enhancing maritime operation via electronic means, from Sweden comes news of a group of Swedish technology entrepreneurs and academics joining forces to accelerate the R&D of an AI-based, semi-autonomous system for planning and executing more energy efficient sea voyages.

Lean Marine is leading the effort, an effort aimed to deliver a groundbreaking R&D project, dubbed The Via Kaizen project, to accelerate the tech development, realization, and adoption of AI-powered ship operation support technology by ship crew and management. The Via Kaizen project is funded by the Swedish Transport Administration, Trafikverket and is being coordinated by CIT Industriell Energi AB.

Lean Marine and AI-application developers Molflow have been collaborating with academics from the Chalmers University of Technology in Gothenburg to develop the new AI-powered, semi-autonomous system for planning and executing more energy efficient sea voyages since the project commenced in August 2020.

Lean Marine's FuelOpt and Fleet Analytics technology and Molflow's Slipstream technology are designed to enable a higher degree of digitalization and automation in vessel operations. The 'on top' propulsion automation system FuelOpt optimizes the propulsion line dynamically, in real-time, based on orders given by the AI system that has been developed within the scope of the Via Kaizen project.

From an academic perspective, naval architect researchers at the Chalmers University of Technology are working with Lean Marine and Molflow on the development of new methods, models, and algorithms. Researchers from social anthropology and human factors at Gothenburg University and Linnaeus University are conducting research on what happens to practices onboard and ashore as the new technology is implemented.

The Swedish Shipowners' Association is also participating in the project. In addition to the project partners, a trio of ship owners and operators are involved in the Via Kaizen project, including chemical/product tanker owner and operator, Rederiet Stenersen and pure car and truck carrier (PCTC) owner and operator, UECC. By offering their vessels for technology and product validations, they will enable on-board testing and results evaluation

In the Shipyard

New vessels, contracts and designs

Wilson Sons

Wilson Sons to Build Six Tugboats.

Photo courtesy Wes Struble NOAA

Thoma-Sea Marine Wins Contract for Two NOAA Ships.

Photo Charlie Crane

Brix Delivers Water Taxi for NJ Golf Course.

Wilson Sons to Build Six Tugboats

Wilson Sons will start in the first quarter of 2021 the construction of six tugboats, at its shipyards in Guarujá (SP). "The new series will contribute to the renewal of the fleet and will facilitate support for large ships that will stop over the next few years at Brazilian ports. We will also be prepared for business opportunities in the oil and gas industry, such as LNG operations and dedicated terminals," said Rodrigo Bastos, director of the Tugboat business unit at Wilson Sons. The project will be by Damen Shipyards, Wilson Sons partner for more than 25 years. The IMO Tier III tugboats will feature 80 tons of static traction (DWT), and measure 25 meters long with a 13-meter of beam, with Escort Tug class notation. The first tugboat is expected to be delivered in the first quarter of 2022, and a new vessel is expected to be completed every four months until 2024.

Thoma-Sea Wins $178m NOAA Deal

NOAA's effort to recapitalize its fleet of research ships took a major step forward today with the U.S. Navy's award of a $178,082,877 contract to Thoma-Sea Marine Constructors LLC, Houma, La., for the detailed design and construction of two new oceanographic ships for the agency. NOAA is acquiring the vessels through an agreement with the Naval Sea Systems Command. The first ship, to be named Oceanographer, will be homeported in Honolulu. The second ship, to be named Discoverer, will be assigned a homeport at a future date. Designed as single-hull ships, Oceanographer and Discoverer will be built to commercial standards. They will incorporate the latest technologies, including high-efficiency, environmentally friendly EPA Tier IV diesel engines, emissions controls for stack gases, new information technology tools for monitoring shipboard systems, and underwater scientific research and survey equipment.

Brix Delivers Water Taxi for NJ Golf Course

Port Angeles, WA-based Brix Marine delivered a new 4615-CTC luxury water taxi, Liberty National I, to Liberty National Golf Club after launch and sea trials in Port Angeles Harbor. Liberty National Golf Club will use the planing catamaran to transport passengers between North Cove Marina in New York and the private club's dock in New Jersey. Liberty National I carries a USCG COI for 30 passengers + 2 crew, and features Helm Master electronic steering, an aft second station, spacious walk through cabin, Northern Lights 12kW generator, and Garmin/Furuno navigation equipment. Twin Yamaha 425hp outboards provide a cruise speed of 25 knots. The climate-controlled cabin boasts flip-down golf bag storage, an entertainment electronics package, galley with refrigerator drawers, and hot water in the head. Through the cabin, a wraparound bench seat on the foredeck allows for optimal sightseeing and photo opportunities for guests.

Meyer Turku: Mardi Gras to Carnival

Meyer Turku delivered a 180,000 gt, LNG-powered cruise ship to Carnival Cruise Line. Mardi Gras has classical ship lines and predominately blue hull. The ship's centerpiece is a three-stories-high atrium in the middle of the ship, opening up to a floor-to-ceiling window and movable LED screens. From the atrium, passengers are able to enjoy a close connection to the sea and marvel the views. While the ship has 'classic' lines, a decidedly modern amenity is Bolt, the first ever roller coaster built on a ship. Bolt lets you to do the driving, you will be able to control the speed of the ride with a top speed of 40 mph. Mardi Gras features 2600 staterooms and 180 suites across eleven categories to accomodate 5,200 passengers, and is planned to enter service from Port Canaveral, Florida in April 2021.

Photo: Meyer Turku

Meyer Turku Delivers Mardi Gras to Carnival.

Royal IHC, APC Launch CSD Alyarmouk

Arab Potash Company (APC) and Royal IHC (IHC) launched the cutter suction dredger (CSD) Alyarmouk at IHC's shipyard in Krimpen a/d IJssel, The Netherlands. The vessel is a 3,557kW CSD and a further developed copy of the dredger Jarash, which IHC delivered to APC in 2018. APC will use Alyarmouk at its site in Jordan, where it will cut and remove crystallized salt under harsh conditions. Alyarmouk is the last of three contracts signed between APC and IHC earlier this year. The first was for an IHC Beaver 65, a 2,819-kW dismountable CSD that was modified in order to work efficiently in the Dead Sea. The second was a three-year maintenance deal for the IHC dredgers Jarash and Mutah, with the purpose of achieving and maintaining an agreed level of uptime.After the launch, Alyarmouk will be commissioned and tested. Once concluded, the vessel will be lifted out of the water, demounted and transported to Jordan.

Photo: Royal IHC/Arab Potash Co.

Royal IHC, Arab Potash Launch CSD Alyarmouk.

South African Navy gets new Boats

Paramount Maritime launched its second of three Survey Motor Boats (SMBs) for the South African Navy to enhance the capabilities and infrastructure of the South African Navy Hydrographic Office (SANHO). Veecraft Marine, a subsidiary of Paramount Maritime, had been tasked with the design and manufacture of the three Survey Motor Boats, all of which having taken place in their shipyard in Cape Town, South Africa. In addition to the three Survey Motor Boats to be delivered to the South African Navy Hydrographic Office (SANHO), this program also provides for the delivery of a Hydrographic Survey Vessel and a Sea Boat as well as a third, fully operational inshore Survey Motor Boat, to remain ashore and in reserve. The 11m Survey Motor Boat features twin Volvo Penta duo-prop propellers and a Volvo Penta joystick helm control system. Survey equipment includes Multi-Beam and Single-Beam echo-sounders and Side-Scan Sonar and a Seabed Sampler.

Photo: Paramount Maritime

South African Navy gets new Paramount-built Boat.

Dr. Bucher Named CEO at Victaulic

Victaulic

Dr. Bucher Named CEO at Victaulic
Victaulic appointed Rick Bucher as Chief Executive Officer, succeeding John F. Malloy, effective January 31, 2021. Dr. Bucher was named President of Victaulic in April of 2020, following a June 2019 appointment as Chief Operating Officer. Prior to joining Victaulic in 2009 as Vice President of Engineering, Dr. Bucher worked for 15 years for W.L. Gore.

Sævik New MD of Havyard Ship Tech
Karsten Sævik has been named managing director of the New Havyard Ship Technology AS (NHST) shipyard in Leirvik, Norway, replacing outgoing managing director, Erlend Hatleberg. Sævik previously held roles as VP of projects and newbuilding at Odfjell ASA, CEO at Remøy Shipping and CEO at Ulstein Verft.

Erith is Babcock's New Marine CEO
Babcock announced that Will Erith has been appointed as CEO of its Marine sector, effective immediately. He succeeds Derek Jones who will return to his role of Corporate Services Director, Marine.

Larsen Takes the Helm at NES
Geir Larsen, 50, will take over as the new Managing Director of Norwegian Electric Systems and will further develop the company's position in energy design and smart control as part of the green shift.

Dr. Ibrahim Named CEO of OSC, ODC
ASYAD Group continues the integration of Oman Shipping Company (OSC) and Oman Drydock Company (ODC) with the appointment of Dr. Ibrahim Al-Nadhairi as Chief Executive Officer (CEO) for the Shipping and Drydock business units.

Hasås joins Kongsberg Digital
On January 1, 2021, Morten Hasås will

Havyard Ship Technology

Sævik New MD of Havyard Ship Tech

Babcock

Erith is Babcock's New Marine CEO

Norwegian Electric Systems

Larsen Takes the Helm at NES

Oman Shipping Company/Oman Drydock Company

Dr. Ibrahim Named CEO of OSC, ODC

join Kongsberg Digital as Senior Vice President for Maritime Simulation. Previously CEO of Scantech Industries, Hasås has held top management positions at ScanSense, Scanmar and Kongsberg Maritime.

Squire Patton Boggs Hires Sherrard
Squire Patton Boggs continued the expansion of its commodities and shipping capabilities with the addition of partner Kate Sherrard into its Financial Services Practice. She joins the firm from Clifford Chance where she was Head of the Asia Pacific Maritime and Offshore Group and is accompanied by senior associate Bernice Chia.

Hanscom New GM of Willard Marine
Willard Marine announced Eugene Hanscom has been appointed general manager. Willard president and CEO Ulrich Gottschling announced that he will be retiring from daily operations, but he will continue to be a member of the board of directors of both Willard Marine, and Future Mobility Solutions.

DCA Taps Balzano as CEO
Trade association the Dredging Contractors of America has hired Richard A. Balzano as Chief Executive Officer and Executive Director. Balzano recently served for three years as the presidentially appointed Deputy Administrator for the U.S. Maritime Administration.

APA Names Diamond Exec Director
The American Pilots' Association announced Clayton L. "Clay" Diamond will assume the duties of Executive Director and General Counsel effective January 1. Diamond succeeds Paul Kirchner, who has been APA Executive Director-General Counsel since 1992. Kirchner will continue with APA as Senior Counsel.

Marine Jet Hires Tegström as CEO
Waterjet propulsion systems supplier Marine Jet Power (MJP) appointed Jonas Tegström as chief executive officer to succeed interim CEO Claes Rudling, who will resume his position on the board of directors. Most recently Tegström served as the CEO of Orio AB.

Finstad Joins GMC
Gulf Marine Contractors (GMC) has appointed Peter Finstad as the company's new executive vice president. He was previously Director of Marketing at Aries Marine Corporation


Kongsberg Digital
Hasås joins Kongsberg Digital as SVP of Maritime Simulation.


Squire Patton Boggs
Squire Patton Boggs Hires Sherrard

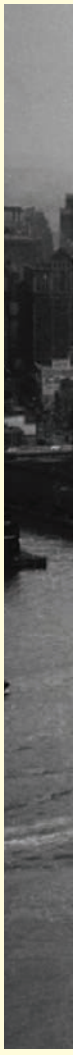

Willard Marine
Hanscom New GM of Willard Marine


DCA
DCA Taps Balzano as CEO

SS United States

The Maritime Thoroughbred

By Susan Gibbs, President of the SS United States Conservancy



There are many hallmarks of great civilizations, but perhaps none so universal as their desire to push the boundaries of human achievement through innovation. A key source of American pride has always been our ability to dream big. When it comes to ships, there is no more powerful example of this than the SS United States.

"America's Flagship" was more than a symbol of our nation's post-war strength and global reach. She remains a singular and unrivaled marine engineering and design achievement.

Curiously, one writer on the pages of this publication (*"Great Ships and the Ship Designer's Curse"* by Rik van Hemmen) recently felt compelled to claim that the vessel that bears her nation's name was merely "an emotional fabrication," "nothing special" and a "white elephant." The writer also took a gratuitous shot at the ship's designer William Francis Gibbs, the preeminent American naval architect of his time.

Such a cavalier dismissal of this historic maritime achievement not only runs contrary to basic facts about the ship's storied history but does a disservice to the profound vision of those who labored for decades to design the most advanced vessel built in America up to that point.

Van Hemmen notes that, "with very few exceptions, in their own lifetime, ship designers get to see the disassembly of most of their creations." In fact, Gibbs, was an exception. His "Perfect Ship" long outlived him and remains afloat today, over 50 years after being decommissioned.

Why? Because there's no other ship like her.

The SS United States was the largest passenger vessel ever built in America. With the participation of companies from all 48 states in the union, her construction was a truly national effort that brought the best and brightest minds together in the days before the jet age. As Secretary of Commerce Charles Sawyer said in 1952: "This ship is truly First Lady of the Seas. No other passenger ship ever built is so beautiful, so fast, so safe, so useful."

Designed as part of a Top Secret Pentagon program to build the fastest ship on earth, the SS United States could be converted from luxury ocean liner to troop transport carrying 14,000 troops over 10,000 miles without refueling. The ship's 240,000 hp engines were the largest powerplant ever installed in a passenger liner. Her long-classified top speed was generated by tandem four and five blade propellers, designed and fitted under tight security to avoid detection by the Soviets. Her high-temperature, high-pressure dual engine rooms were designed to Navy Standards and were also Top Secret. Thanks to her innovative compartmentation, she would have survived the collision that sunk the RMS Titanic. Among the SS United States' more than one million passengers on her 400 voyages were Presidents, heads of state, A-list Hollywood stars too numerous to mention, tourists and immigrants to our shores. She had a flawless service career with an on-time percentage of 99.5 percent.

The ship's fittings reflected the height of mid-century modern art and design. The vessel incorporated a host of technological "firsts". She was the first ship fully air conditioned in all public spaces and staterooms. She was the first vessel to use microwave ovens and was the first commercial application of tempered glass. Many new products and materials, from paints to flooring to fabrics were custom designed to surpass all fireproofing standards of her time.

To save weight, the United States was the first to use an innovative new process to fuse the all-aluminum superstructure with a battleship-grade, two-inch-thick steel hull. The use of aluminum in her design was unprecedented in any structure until the construction of the original World Trade Center towers. Her lifeboats were the first to be made of aluminum and also fully fireproof.

The hull's sleek design was the first to be put through aerodynamic testing, and her watertight subdivisions were also unique and set a new standard for safety. Her rakish hull form generated virtually no wake, evocative of the sleek racing hulls of the clipper ships.

On her fabled maiden voyage, she smashed the transatlantic speed record in both directions using only two-thirds

Photo courtesy SS United States Conservancy

of her power. This triumph was a tremendous source of American pride that made headlines the world over. It is a record she still holds and most likely always will. No ship before or since was feted with a ticker tape parade down New York's 'Canyon of Heroes.'

A vessel the size of the Chrysler building moving at the equivalent more than 40 miles per hour across the North Atlantic is an exhilarating engineering achievement that anyone who dedicates themselves to designing, crewing or commanding ships can appreciate. For passengers and onlookers at ports around the world, the SS United States' red, white and blue funnels heralded the arrival of not just another ship, but a symbol of her namesake nation, a post-war superpower making a splash on the world stage.

The SS United States Conservancy saved the ship from certain destruction when it purchased the vessel in 2011. Since being withdrawn from service in 1969, the ship has been the focus of numerous books, articles, works of art and documentary films. The breadth and depth of this attention is a testament to the ship's unique hold on the historical imagination. The Conservancy has grown the ship's global community of supporters and attracted strategic partners who believe she deserves as future as bright as her storied past. Together the effort to save America's Flagship is real and progressing

More than any other vessel, the SS United States remains a symbol of American resilience. She has stood the test of time. The plans being advanced for her potential rebirth as a vibrant stationary mixed-use destination are as visionary as those that created her.

Even at her current Philadelphia pier as she awaits restoration, this "Lady in Waiting" reflects the very best of what our nation can achieve. The SS United States should be on any list of ships to be prioritized for preservation. She has waited long enough. Now, her fate is up to us.

The Author

Susan Gibbs is the President of the SS United States Conservancy and granddaughter of William Francis Gibbs. To learn more about the SS United States and the effort to save and repurpose her visit www.ssusc.org

BUYER'S DIRECTORY

This directory section is an editorial feature published in every issue for the convenience of the readers of MARITIME REPORTER. A quick-reference readers' guide, it includes the names and addresses of the world's leading manufacturers and suppliers of all types of marine machinery, equipment, supplies and services. A listing is provided, at no cost for one year in all issues, only to companies with continuing advertising programs in this publication, whether an advertisement appears in every issue or not. Because it is an editorial service, unpaid and not part of the advertisers contract, MR assumes no responsibility for errors. If you are interested in having your company listed in this Buyer's Directory Section, contact Mark O'Malley at momalley@marinelink.com

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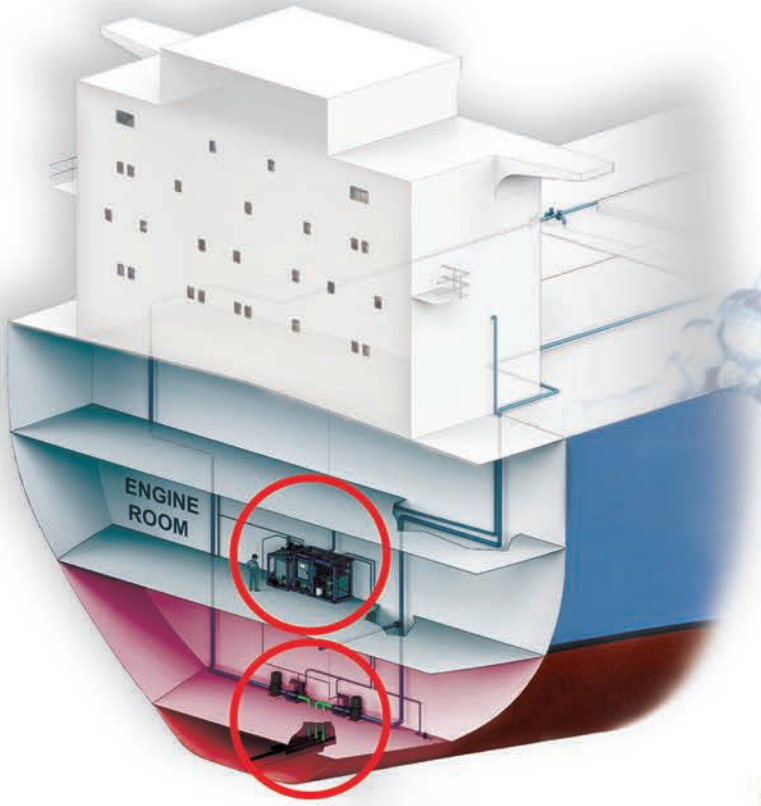

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