June 2021

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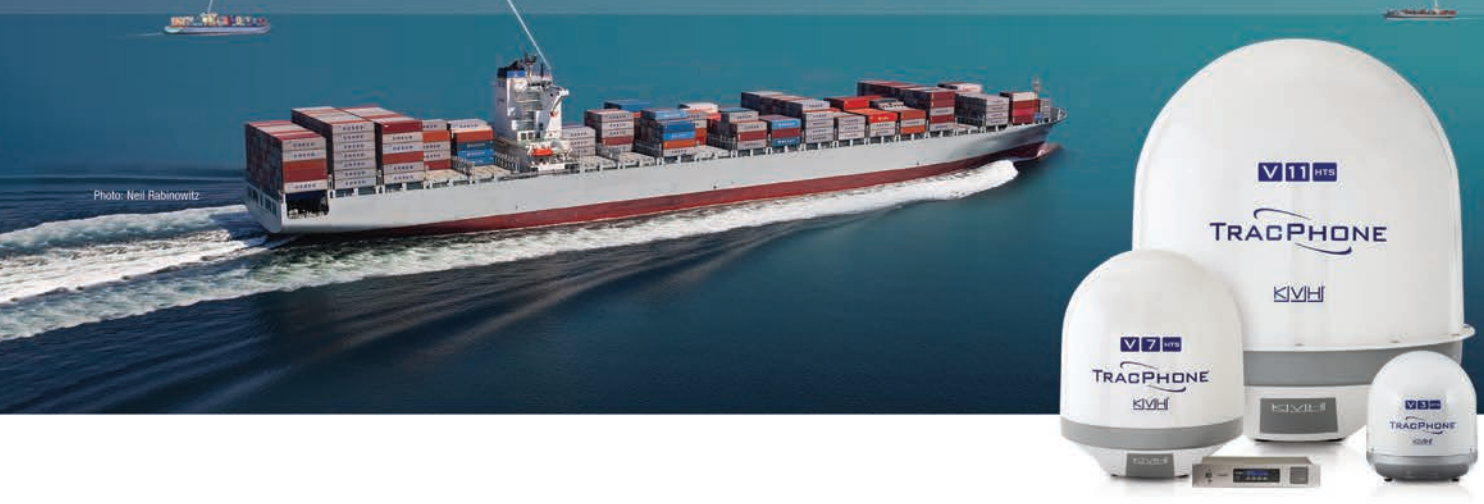

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**Source: Euroconsult, Prospects for Maritime SATCOM, 2021, market share VSAT units

NO. 6 / VOL. 83 / JUNE 2021

The Legend Class
The Legend-class cutter USCGC Hamilton (WMSL 753) arrives at Naval Station (NAVSTA) Rota, Spain, April 14, 2021. They are on their way to Bahrain to join Patrol Forces South West Asia.

Photo Source: U.S. Navy photo by Mass Communication Specialist 1st Class Nathan Carpenter

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MARITIME REPORTER AND ENGINEERING NEWS

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As this is our USCG annual with a focus on patrol boats, it naturally stands to reason that Offshore Oil and Gas graces the cover! As you read through the June 2021 edition, you're sure to find the lion's share of coverage dedicated to all matters USCG, from the fleet to the tech to the future.

But we could not resist planting an offshore oil and gas photo front and center, as the offshore market – left for dead by more than a few industry pundits – has enjoyed its strongest rebound to over $70 per barrel following, in **Jim McCaul's** words: "the mother of all dips".

While the emergence of the offshore wind market has, and will continue to garner coverage across all of our media family pages, print and electronic, it is undeniable that for the foreseeable future that fossil based fuels will dominate the world of transportation. McCaul, head of IMA/WER, has covered the energy markets closely, daily for more than 30 years, and he said during a recent interview:

"The deepwater market over the last 30 years has gone through a number of dips, some major. The 'mother of all dips' has been over the last five years or so, and it was horrendous, basically putting many companies into big financial problems. But we're in a rebound now, and I see this market rebounding very quickly. It's accelerating, and it's accelerating faster than I expected six months ago."

The full story, including insights on nearly $40 billion in investment opportunities in the floating production sector, starts on page 22.

Turning attention to the United States Coast Guard recapitalization is Edward Lundquist, who in typical fashion delivers in inside-out look at the USCG investment in more capable cutters, and not a moment too soon as the service's legacy fleet of icebreakers, high and medium endurance cutters has reached and in some cases far exceeded retirement age.

Last, but certainly not least, we take a deep dive on the future of gas carrier design starting on page 40. It is an understatement to say that **Peter Fitzpatrick**, VP, Strategic Development at ABS, knows a thing or two about gas ships. Prior to joining ABS, Fitzpatrick was VP Ship Design and Construction for BG Group, responsible for the technical operations of the company's LNG vessel acquisition programs. He spoke recently with Maritime Reporter TV regarding the future technical trends for the sector, and while there are a plethora of hardware and technology initiatives driving efficiency throughout the sector, he said that

"I think the biggest change which has the most impact will be the software, the digital innovations we need to embrace to make efficient operations."

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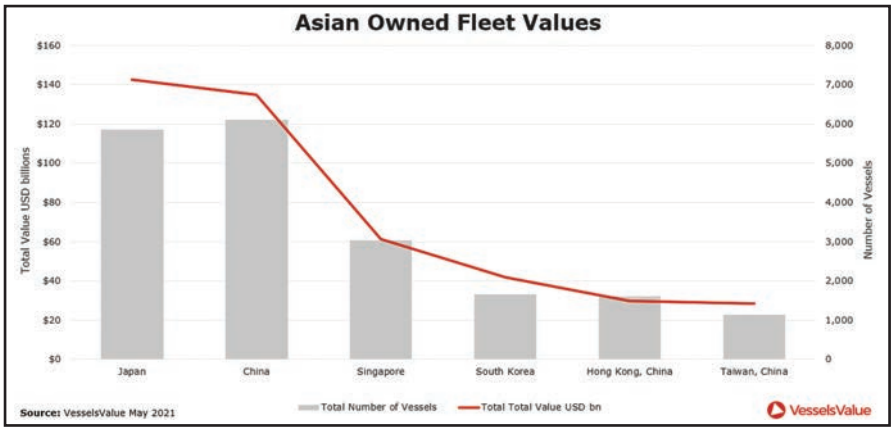
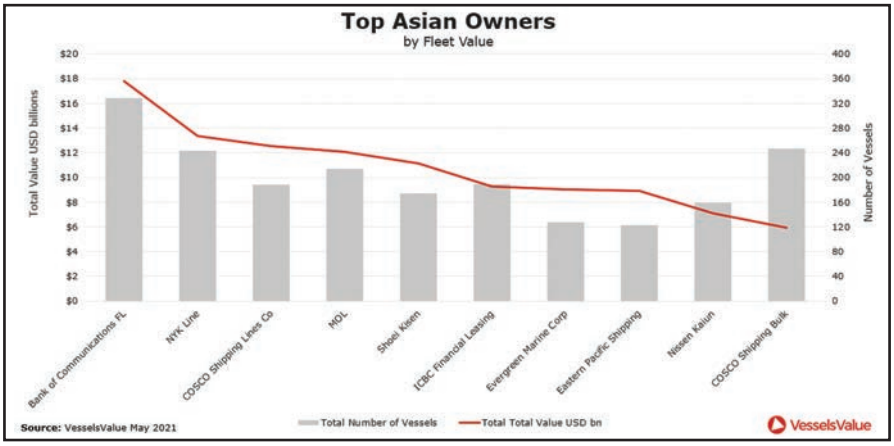
Asia

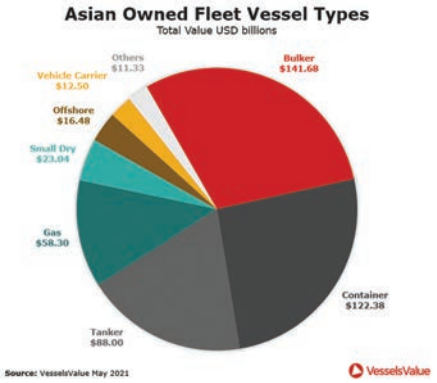
We have been discussing, dissecting and projecting the impacts of the migration of shipbuilding to the Far East for decades, but what about ship ownership? Courtesy of our friends at VesselsValue, we provide here a snapshot on the trends in owning and operating ships from owners in and around Asia.

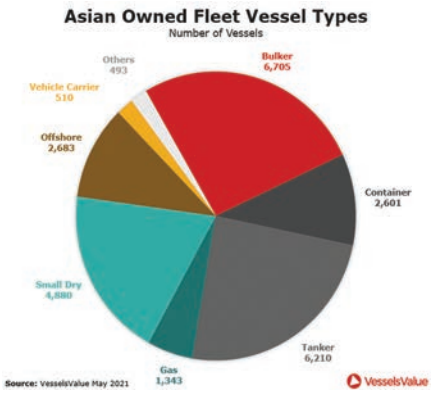
Asia Countries Fleet Values

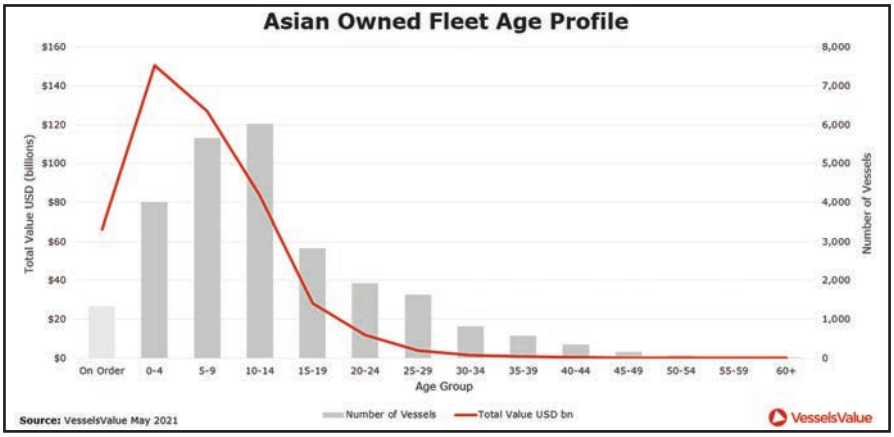
Country	Live		On Order		Total	
	# of Vessels	$B	# of Vessels	$B	# of Vessels	$B
Japan	5,598	$127.46	263	$15.12	5,861	$142.58
China	5,719	$118.34	386	$16.60	6,105	$134.94
Singapore	2,813	$50.36	214	$10.90	3,027	$61.26
South Korea	1,546	$33.51	107	$8.37	1,653	$41.88
Hong Kong, China	1,546	$23.85	67	$5.90	1,613	$29.75
Taiwan, China	1,023	$21.44	106	$6.87	1,129	$28.30
Indonesia	1,836	$8.24	14	$0.26	1,850	$8.50
India	768	$7.28	16	$0.16	784	$7.44
Malaysia	724	$5.56	81	$1.35	805	$6.91
Others	2,511	$11.48	87	$0.66	2,598	$12.14
Grand Total	**24,084**	**$407.51**	**1,341**	**$66.19**	**25,425**	**$473.70**

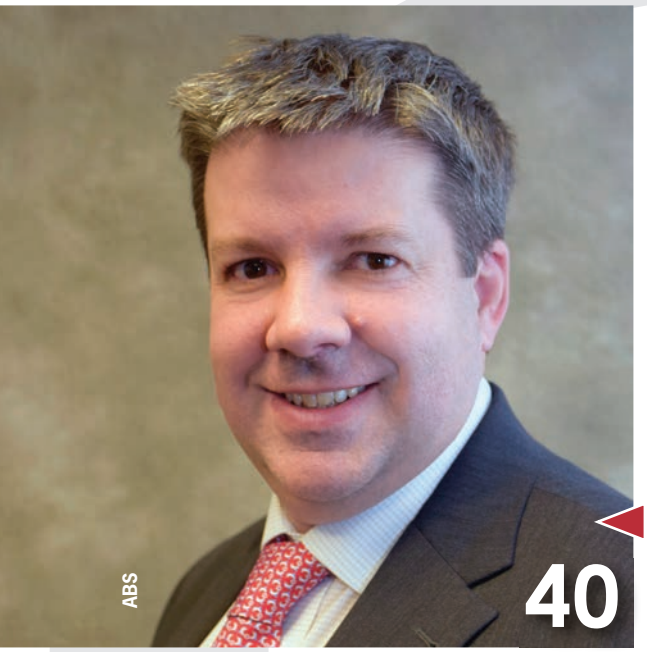












"Digital will be a key enabler to make the next gigantic leap in how we make improvements in emissions and efficiency."

Peter Fitzpatrick,
VP, Strategic Development, ABS

"Evaluating a 260-m trimaran sealift ship, **comparing the cost of a titanium vessel with a steel vessel**, found that the acquisition cost of the titanium vessel would be $2.3B compared to $1.5B for a steel ship. **However, the lifecycle savings of the titanium vessel would be $2.74B.** In other words, once you build the first vessel in titanium, with the savings you can build the next vessel for free."

Rik van Hemmen
President, Martin & Ottaway

22

"Almost two dozen deepwater projects requiring either an FPSO or production semi look likely to proceed to development by end next year. **EPC contracts for the production units will have an aggregate value of $35 to $40 billion.** This is a much higher near term ordering pace and contract value than anticipated six months ago."

Jim McCaul
Director, IMA/WER

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Tip #25

Assessment 101

Are Your Exams Valid?

Assessments are critical. But when we create them, what strategy do we use? Many of us simply rely on intuition: what should our trainees know? Let's ask it! This may or may not work. But if we just consider two simple, yet critical measures of assessment quality, we will produce better assessments, which means we will have more accurate information about whether our officers and crew have the knowledge and skills required to perform safely and effectively. What are these two core attributes of a high-quality assessment? Validity and reliability.

When creating an exam, always have these two words in mind: Valid and Reliable. If we think of little else other than validity and reliability when creating exams, and if we manage to get those right, we will likely be producing excellent assessments. Let's look at validity first in this edition of Training Tips for Ships. Then in next month's edition, we will look at reliability.

A valid exam is one that tests what we actually want to know about the trainee. So, if we are writing a test in the hope that it will reveal whether an employee will successfully fulfil a certain role in the organization, then the result he or she achieves on a valid test will correlate well with their job performance. That sounds simple, but there is some nuance to it.

The validity of assessments naturally breaks down into two parts. First, we must know what knowledge and skills are important to the job at hand. Interestingly, we can determine this accurately by mining results of past exams and correlating the performance of individual questions to job performance assessments. This is the field of learning analytics which was discussed in past editions of Training Tips for Ships. If that kind of analysis is beyond the current reach of your organization, then the best approach (until we get there) is to rely on our expert trainers. They will have good, intuitive ideas of what mariners need to know in order to perform well. And if the course is well designed to support job performance, then the learning objectives of the course will be an excellent resource and all exam questions should be aligned with those learning objectives.

The second part of achieving exam validity is to take the list of required knowledge and skills identified above, and then formulate questions which appropriately test that knowledge and those skills. There are several parts to this. First, in order to cover the knowledge or skill proportionately well, the number of questions we ask should correlate with the complexity of that knowledge / skill. Likewise, the difficulty of the questions should roughly match that which is required for real world performance. And in scoring the exam, we should consider the weight of each question or section. Questions covering competencies which reveal more about likely job performance should be weighted more heavily than those which are less revealing. Questions covering critical knowledge or skills should be weighted such that the exam cannot be passed without acceptable performance on those - otherwise we risk hiding safety or performance risks. In the end, for a valid exam, ensure that each and every question is there because it tells us something important about job performance (or whatever the goal), that it is presented at a difficulty level that correlates with the difficulty of the task, and that it is weighted to be correlated with its contribution to the performance of the task it supports and how critical that task is to performance and safety. If you do these, you will be well on your way to writing a valid exam.

As a concluding thought, always keep in mind that except in the simplest of circumstances, exams can never provide full coverage of all knowledge, or the entire skill set identified as being important. Exams are never comprehensive, but instead are more like auditing processes designed to reveal problems that require further evaluation. Thus, in choosing questions based on the important criteria of validity, avoid the temptation to ask "everything" and instead focus on those valid questions which will identify any areas requiring a deeper investigation.

Next time, we will look at the second core attribute of a high-quality exam: reliability. Until then, be healthy and sail safely.

The Author

Goldberg

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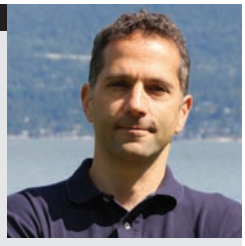
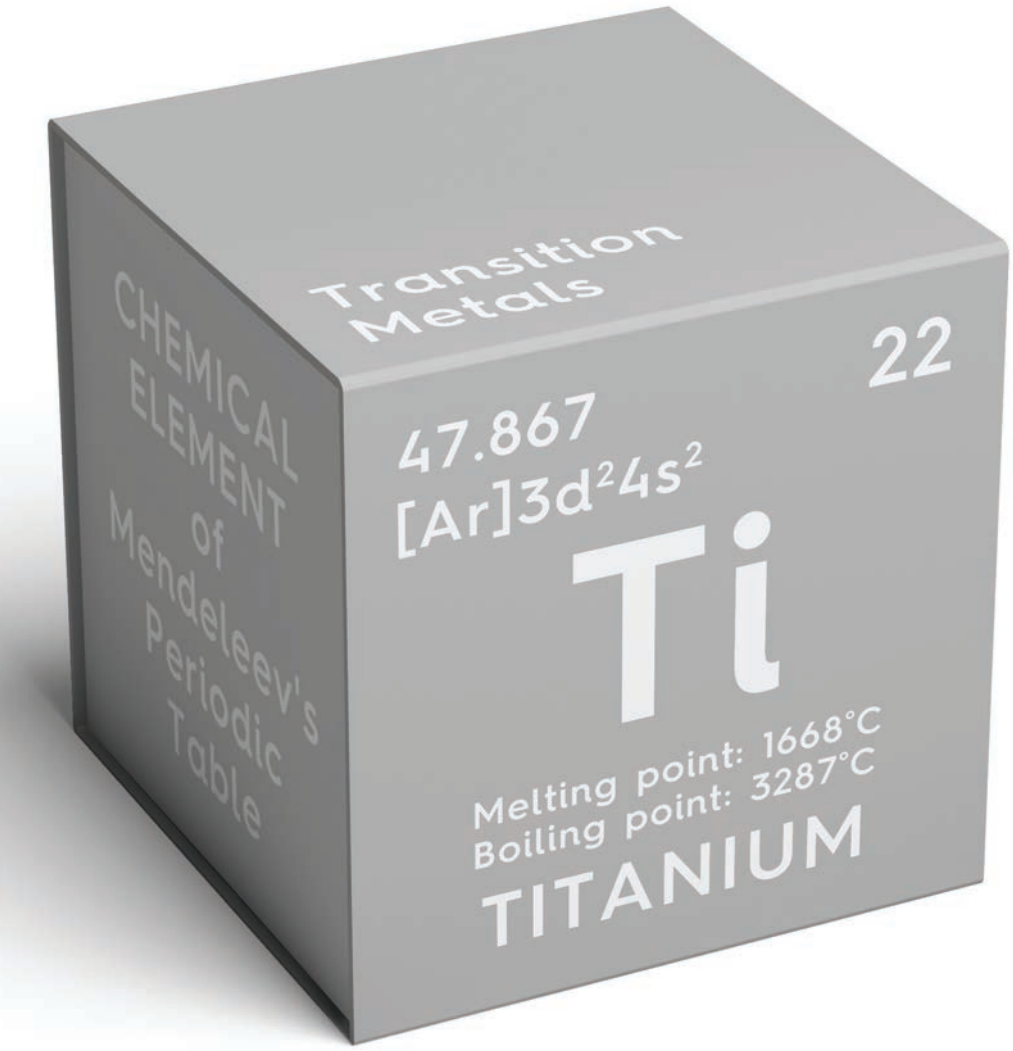


Enterprise Revisited: Titanium is the USCG Vessel Procurement Magic Bullet

By Rik van Hemmen



In my May 2020 *Maritime Reporter & Engineering News* USS Enterprise column I made a reference to the benefits of titanium as a hull structural material. It related to the life of the USCG cutter Bear and I concluded the column with a suggestion that titanium would be a particularly useful and cost-effective structural material for sail training vessels, aircraft carriers, research vessels, cruise vessels, tugs and Staten Island ferries. I made this suggestion assuming that the hull design (shape) would have to be mature, and its technology upgrade expected.

I made a WAG estimate of the cost increase of a titanium hull and came to the conclusion that, from a life cycle point of view, titanium is a great deal for certain vessels. After writing the column I did not spend a lot of time thinking about it, until I came across a paper by my friend and occasional collaborator Dr. John Daidola in the December 2020 Naval Engineers Journal titled "Construction Costs of Titanium Hull Variants – Game Changer?"

John performed a much more detailed study of the lifecycle cost of a variety of vessels, but particularly a 260-m trima-

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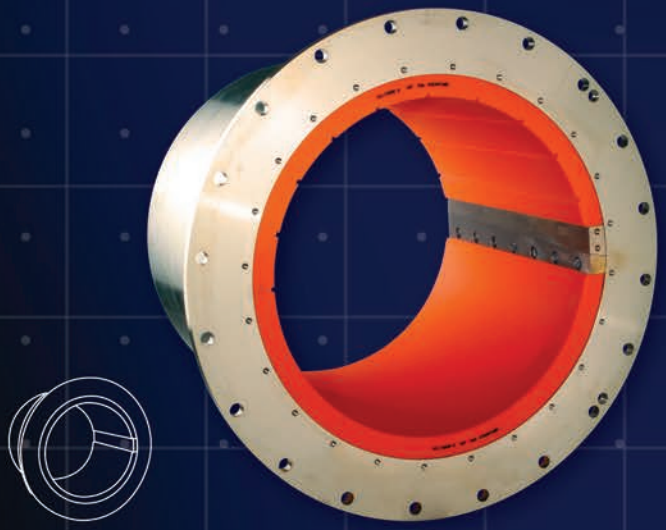

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Evaluating a 260-m trimaran sealift ship, comparing the cost of a titanium vessel with a steel vessel, found that the acquisition cost of the titanium vessel would be $2.3B compared to $1.5B for a steel ship. However, the lifecycle savings of the titanium vessel would be $2.74B. In other words, once you build the first vessel in titanium, with the savings you can build the next vessel for free. That is called a two-fer!

ran sealift ship. He compared the cost of a titanium vessel with a steel vessel and concluded that the acquisition cost of the titanium vessel would be $2.3B as compared to an acquisition cost of a steel vessel of $1.5B. However, the lifecycle savings of the titanium vessel would be $2.74B. In other words, once you build the first vessel in titanium, with the savings you can build the next vessel for free. That is called a two-fer!

Remarkably, on vessels with a lower hull structure cost fraction, the savings are even better.

Note that in one of those weird tunnel vision moments, I did not include USCG cutters in the list of titanium hull candidates in my column. But USCG cutters are the epitome of mature hull designs that see service periods that are almost measured in human lifetimes with little change in hull design in the next generation.

Based on John's study, USCG cutters are particularly suitable for titanium construction. The savings would be quite dramatic.

While John looked at lifecycle cost savings in the conventional sense, there is actually another savings magic bullet that can be applied to USCG cutters if we look at the cutting edge of life cycle cost savings in series combat vessels.

That bullet was explained to me by another deep-thinking engineer, Norbert Doerry, at the 2017 SNAME Annual Meeting's presentation of Dr. Doerry and Dr. Koenig's paper "Framework for Analyzing Modular, Adaptable and Flexible Surface Combatants."

To me the title translates as: "How to Mix and Match your Fleet to get the Best Tactical Outcome for a Fixed Dollar, but one that can Change from Year to Year." (Still not a great title)

This Navy conundrum is ancient, and actually the original six frigates are an early version of this debate.

An ideal Navy mixes and matches fleet units (combat vessels). A small Navy cannot afford to do this, but the U.S. Navy combined with the USCG can. (The U.S. Navy is the largest Navy in the world. The USCG, by itself, is about the size of the German Navy)

The real question is: What am I going to build for the money I have, so that, when the shooting starts, I will have the most capable Navy? And then there is a secondary question: What should my fleet look like in times of peace to scare the bejeezes out of potential opponents?

Interestingly, this secondary question is even more pressing for a USCG cutter, since it has distinct peacetime and distinct war time functions. In so many words, depending on the national threat level, a USCG cutter may perform rescue missions or fire missiles, but always should tell a potential enemy that while the vessel may look nice and cuddly in rescue mode, it can become very mean indeed in a short period of time.

In practice, that has meant you scrap old ships and always build fancier new ones with newer technologies aboard. But note that, with the USCG, fancier new hulls on the outside look the same as the older ones. It is the stuff that goes inside of them that really drives fleet renewal design.

The decision when to build new ones generally is analyzed in Present Value terms (Is it cheaper to upgrade or maintain the old ship, or to build a new one) and John Daidola's steel versus titanium comparison follows that path and shows it is cheaper to build in titanium.

However, Doerry and Koenig add another cost saving when these longer life hulls are used in series construction. Instead of using PV analysis, they propose the use of Real Options Valuation. This method differs from PV because it attempts to analyze the best approach when there are additional options on a project in the future (think in terms of stock options). Real Option Valuation is not new, but to apply it to naval fleet mixes and procurement is really clever. The most obvious question in Navy (and even more so, USCG) vessels is: What if I think in terms of PV (my available dollar) but in the PV include an option to upgrade vessels later in their life? I may or may not spend the option amount depending on my fleet needs at any one stage, and since I may not spend it, my PV becomes lower and in the future I would have a more

capable fleet.

For example, the authors show that building good simple hulls, but waiting to fit fancy weapons until they are really needed is the better deal. And if the threat of war develops, the latest and greatest package can be fitted quickly on existing hulls to dominate the battle space, instead of limping along with less than the state of the art.

The bigger the Navy (and USCG combination), the cooler it gets. It especially argues for building lots of USCG cutter hulls, but leaving them mostly unoutfitted for naval combat. One can build 20 titanium USCG cutters for the life cycle cost of 10 steel hulls, and make them ready for sea, but only install one ship with the best weapons package. The world will know that you can build something that can dominate the battle space, but there is no need to fit all 20 with the latest and the greatest (which saves enough money to build a couple of additional hulls) if there is no immediate threat of war. Meanwhile the "enemy" will know that when they start to rattle their sabers you will not have 10 (if built in steel) obsolescent hulls, but instead will have access to more than 19 hulls that can be fitted with the hottest weapons much more quickly. This is a much better result than having 10 old "fancy steel" units and actually will defer cost until it is needed. This thinking already works with steel hulls, but if the hulls do not waste away it becomes even more cost effective and further strengthens Dr. Daidola's argument. So here we have three clever engineers who have developed two independent USCG procurement approaches, which each save incredible amounts of money, and, when combined, save even more money.

Is anybody paying attention in USCG procurement? I have long known and admired the USCG for its ability to do more and more with less and less. Why not use this bit of engineering to do even more?

For each column I write, MREN has agreed to make a small donation to an organization of my choice. For this column I nominate the NGO Shipbreaking Platform https://shipbreakingplatform.org/. Shipbreaking is a dirty and expensive mess. Reducing shipbreaking with titanium hulls reduces the mess.

Driving Real Change Through Actionable Data Insights

ZeroNorth

In today's shipping industry, the need to demonstrate action on sustainability is not an option; it's a requirement. Faced with new regulatory and supply chain pressures to act on their carbon footprint, owners and operators are racing to source solutions that are not only effective in reducing emissions now but that are also prudent investments for a profitable long-term future.

For a sector used to commodity fuels and a standard way of operating, the challenges of profitable decarbonization require us to embrace a whole range of solutions, including clean technologies, alternative fuels, and, importantly, the intelligent use of data and digital technology to underpin effective decision-making. It is here that we should be excited because if done right, digitalization is an immediate first step we can take on the path to sustainability.

With the IMO's emissions reductions targets set out for 2030 and 2050, it's easy to suggest that sustainability is a longer-term goal that can be slowly chipped away at. This is far from the case. We are now less than a decade away from the initial 40% emissions reduction target of 2030 and the urgency of climate change is very real and present. Equally urgent is the industry's efforts to remain commercially viable, particularly in light of the challenges and periodic downtime of the past twelve months.

To put the scale of the challenge into perspective, the tramp shipping sector – which ZeroNorth serves - emits around 400m tons of CO2 emissions each year. Some of these emissions can be tackled immediately by turning data into actions.

DATA INTO ACTIONS

The industry's vast – but widely underutilized – data resource holds the answer to a number of challenges operators and owners face. Without the need to alter a vessel or the infrastructure of a fleet, the right applications can leverage data to truly enhance vessel performance and optimize operations, increase earnings and reduce CO2 emissions.

Turning data into actions is central to our industry's success as we continue to digitalize. Data alone is not an asset. Instead, shipping must do more to make its data tangible and actionable, turning ones and zeros into dollars and cents.

The blueprint for turning this data into actionable insights must be based on several key principles, including aligning data and its usage to growth and business targets, creating richer and more specific insights, and presenting actions and

information in a clear and understandable way.

In doing so, data can be turned into a true commercial differentiator and driver, and we will collectively begin to find more diverse use cases for shipping's data asset, unlocking greater cumulative cost and efficiency savings.

In simple terms, the data points on weather, fleet positions, bunker prices, market rates and more which can be challenging to convert into relevant information in and of themselves suddenly become actions that owners and operators can take, with a clear and transparent view of the cost and emissions up or downside of any decision.

ZeroNorth's Optimize, for example, leverages data to provide 'actionable' insights for operators and owners into vessel performance and optimal speed. Through our software, we believe that around 5-10% of emissions can be addressed today. This is a significant total given the low barrier to entry and scalability of digital solutions.

COLLABORATION AND PARTNERSHIPS

It is also important to recognize that the challenge is so vast that it would be impossible for any single data or applications provider to tackle it alone. In fact, shipping's ecosystem of digital organizations must work based on the principles of partnership and collaboration; working together to drive greater shared impact than could reasonably be achieved alone.

By utilizing the complimentary skills and expertise of data companies and software developers, alongside experts who deal with data specific to the maritime domain, shipping will be able to make the most of its digitalization trend.

These partnerships are becoming increasingly common as the sector becomes more transparent and comfortable with the idea that collaboration can work hand-in-hand with commercial performance.

Through these partnerships, we are discovering the true power of maritime data. This data should be recognized for its power and ability to enable effective decision-making across a fleet, from a commercial, and an environmental perspective.

In this way, digitalization is enabling owners and operators to direct their future course in a considered, meaningful way – with all the profitability and environmental upsides of embracing cutting edge technology.

The Author

Meyer

Søren took on the Chief Executive Officer role for ZeroNorth in January 2020, a newly independent spin-off of Maersk Tankers with the mission to digitalise shipping for the climate.

Vessel Inspection and Condition Reports


EBDG

Ships, boats, ferries, tugs, barges: all represent significant capital investments that are worth regular evaluation to ensure maximum return and lifespan. A key effort to ensure the expected life of a vessel is regular condition monitoring. An inspection serves to document the vessel's condition at a point in time. It may be used to establish value for financial institutions, support insurance matters, confirm the suitability for a mission, identify deficiencies, or provide a reference for a charter.

Depending on the purpose, the inspection may be conducted by: a classification society; a broker; a cargo surveyor; or an engineering firm.

Using an engineering firm for inspection work has several advantages if the purpose extends beyond merely documenting the condition. Engineers can evaluate regulatory compliance and functional conditions. They can advise on repairs, improvements, or substitutions that will benefit the client. They can also help build a business case for making changes. In some cases, the engineer can save the client substantial costs as presented in the following examples.

At minimum, an inspection must be based on some set of requirements to determine whether items pass or fail. For example, the requirements of 46 CFR Subchapter T, Small Passenger Vessels, requires that a vessel larger than 65 feet be equipped with at least one fire pump that is self-priming and power driven, capable of producing a flow of at least 50 gallons per minute at a pressure of 60 pounds per square inch. An inspection would determine whether those requirements are satisfied or not. In addition to verifying compliance requirements, an inspection can be a document that informs and recommends. Using the example of the fire pump, an inspection report might go on to say whether the pump is in good condition, whether the piping is well arranged and clear in its function, and whether future maintenance would be simple or difficult. These additional observations require the inspector to have experience in the design, operation, and maintenance of pumps.

An inspector must have knowledge of requirements and should have experience in their application. What else does an inspector need? Given the reliance of others on their judgement, an inspector must have integrity. In 1834, Lloyd's Register of Shipping established a General Committee. One of the duties of this committee was to appoint inspectors (surveyors) who would represent Lloyd's Register in certifying the suitability of ships and their machinery.

They took those appointments seriously:

"The utmost care and discrimination have been exercised by the Committee in the selection of persons of talent, integrity, and firmness as Surveyors, on whom the practical efficacy of the system and the contemplated advantages must so materially depend; the Committee have in their judgement appointed those persons only…who appeared to them to be most competent to discharge the important duties of their situations with fidelity and ability, and to ensure strict and impartial justice to all parties whose property shall come under their supervision."

To properly conduct an inspection, the inspector needs access. Whether it is a whole vessel inspection or a review of specific damage, the owner can facilitate the process by preparing access. This includes moving things out of the way, gas freeing tanks and voids, providing light and ventilation, arranging staging as needed, and having ship's crew available to open access plates or operate machinery as necessary. Another aspect of the survey is to ensure the surveyor has the requisite knowledge and even specific experience. Some surveyors may be strong on steel inspections but weak on aluminum structure and welding. Others may know diesel

EBDG

engines but would be stumped by a steam plant or a system using a cryogenic fuel. Electrical installations of significant size, complexity, or novel features may require an electrical engineer for the inspection. One advantage of working with an engineering firm is that such specialized areas of knowledge can be provided by different members of the staff rather than trying to find a genius in all things nautical.

Over the past three years, Elliott Bay Design Group (EBDG) has performed numerous inspections. One of our largest projects was supporting the New York City Economic Development Corporation (NYCEDC) in the development of a fleet of passenger-only ferries. NYCEDC contracted with Hornblower Cruises in 2016 to build and start operation of an initial fleet of 19 vessels within an aggressive time frame of 14 months. EBDG was retained by NYCEDC to provide a third-party oversight of the construction in two different shipyards. This program expanded to 38 vessels constructed in six different yards. EBDG's role included periodic inspection while the vessels were being built as well as post-delivery inspections in New York to benchmark the vessels' condition before beginning service. EBDG has also been involved in reviewing the maintenance management systems for this fleet as well as providing engineering advice on repairs or changes to address emergent issues. Both NYCEDC and Hornblower have benefited from EBDG's consistent, independent role.

As another example, a hull thickness survey (audiogauge report) for an older tug identified extensive areas of wasted structure that exceeded the ABS allowable limits. The vessel owner was faced with an expensive repair bill. However, the engineer who oversaw the survey knew that the tug had heavier original scantlings than required by current ABS steel vessel rules. Instead of spending big dollars on a repair job, the engineering team submitted revised scantling calculations to ABS which demonstrated that the existing structure, even with the wastage, exceeded class requirements. Some steel did get replaced, but the overall cost was significantly less.

Inspections are a routine but vital aspect in the world of maritime transportation and littoral infrastructure. An inspection should not just be a box to tick at insurance renewal time. The data from the inspection should result in better planning and less life-cycle cost to the owner. A good inspection benefits all parties on the waterfront: vessel owners, insurers, regulators, other operators, shipyards, and (most important) customers. Inspecting vessels is not a simple job or one for the faint of heart. Crawling through lightening holes in eighty feet of double bottom structure with a flashlight, clipboard, and safety gear is a workout. Good inspectors and good inspection reports are to be treasured.

The Author

Waterhouse

John W. Waterhouse is the Chief Concept Engineer and a founding partner of Elliott Bay Design Group. EBDG is a full-service, employee-owned naval architecture and marine engineering firm that supports owners, operators and shipyards.

Floating Production Rebound

EPC contracts for the production units will have an aggregate value of $35-$40B

By Greg Trauthwein

The deepwater sector is rapidly accelerating out of the great market downturn. That's the conclusion of an in-depth market analysis just completed by IMA/WER, which has followed the floating production system market closely, daily for more than 25 years.

"The deepwater market over the last 30 years has gone through a number of dips, some major. The 'mother of all dips' has been over the last five years or so, and it was horrendous, basically putting many companies into big financial problems," said **Jim McCaul**, head of IMA/WER, in a recent interview with Offshore Engineer TV. "But we're in a rebound now, and I see this market rebounding very quickly. It's accelerating, and it's accelerating faster than I expected six months ago."

The Outlook

Oil inventory has been brought to below seasonal average, crude is now trading in the $70s, deepwater E&D has been rebounding and the number of deepwater projects lined up for investment commitment in 2021/22 is growing.

"The price of oil has been going up. Brent crude, which fell below $10 in April last year, has clawed its way back to the low $70s. Rising oil prices have spurred renewed interest in deepwater E&D activity. Over the past few weeks I have talked with a number of offshore drilling and seismic contractors. Many see the E&D market rapidly improving and are optimistic that E&D expendi-

OETV **Watch the full interview with Jim McCaul on OE TV @ bit.ly/3ceg7pH**

Get the Latest Floating Production Systems Report

IMA/WER's floating production report has up-to-date details and contracting status for more than 200 floater projects in the planning stage. Around 55% of these envisage use of an FPSO. Another 10% will require a production semi. The rest are LNG and floating storage projects. The report also has details for 44 production or storage floaters on order, 300+ floating production units in service and 44 production floaters available for redeployment contracts.

www.worldenergyreports.com/reports/

© Igor Kardasov/AdobeStock

tures will grow significantly over the next six to 18 months. Deepwater E&D is a strong leading indicator for floating production. If the E&D market is improving rapidly, then floating production will follow."

According to McCaul, "more than two dozen deepwater projects requiring either an FPSO or production semi look likely to proceed to development by end next year. EPC contracts for the production units will have an aggregate value of $35 to $40 billion. This is a much higher near-term ordering pace and contract value than we anticipated six months ago."

Explaining the more optimistic outlook, McCaul says "when we made our five-year forecast of production floater orders in November, the virus was spreading fast, a vaccine was not yet available and the global economy was sputtering. Rebound in the deepwater sector appeared to be 2 to 3 years off -- and our five-year forecast of production floater orders was skewed toward the 2023/25 time frame."

McCaul adds "the early period of our forecast – where we projected only a dozen or so orders in 2021/22 -- is clearly looking conservative, given the strong pick-up in activity now being seen."

Marginal FPSO Projects Come Alive

According to McCaul, an interesting new wrinkle in the market is the appearance of small, marginal FPSO projects entering the pipeline.

"This to me is very interesting, and it's still in the developing stage," said McCaul. "I'm not totally clear as to whether these projects are firm or not, but there's been a number of opportunistic, marginal small projects that have come into play that look like they could advance within the next 12 to 18 months."

He said these projects typically occur when the market is buoyant, when prices of oil are up, and the opportunity is presented to lift and sell oil quickly.

"The Timor-Leste Buffalo is a very small project that looks like it's going to advance," said McCaul. "There's another one in Nigeria called Okwok. I've been following it for some time, but I've never really been optimistic about its prospects as it's always difficult to get financing for these types of projects. But it looks to me like Okwok could actually move forward now with the price of oil going up."

"I find this interesting. It's not just the very big, long life projects, like the ones in Guyana or Brazil. Now we're seeing smaller ones," said McCaul. "It brings us back to the days in the late 1990s, where loads of small projects involving FPSOs were being put into play."

Beyond the Tip of the Iceberg Tech:

RDT&E's Annual Arctic Technology Evaluation

U.S. Coast Guard photos by SN Kate Kilroy

By Karin Messenger

The Coast Guard Research and Development Center (RDC) teamed up with Coast Guard Cutter Campbell's crew last summer to evaluate five technologies as part of the RDC's annual Arctic Technology Evaluation. The Campbell crew conducted the evaluations during their two-month deployment supporting joint Arctic operations off Greenland's western coast, returning to their Kittery, Maine, homeport on Sept. 29, 2020.

"Testing various technologies by cutter crews for operation in cold and Arctic environments provides highlights on what works and what may need improvement, and can help influence tactics, techniques and procedures," said Brian Dolph, who heads the RDC's Surface Branch. "This work directly contributes to two lines of effort in the Coast Guard Arctic

U.S. Coast Guard Cutter Campbell deploys their Over the Horizon (OTH) Small Boat during operations with the Royal Danish Navy near the Jacobshavn Glacier in West Greenland on September 06, 2020.

Strategic Outlook: 'Enhance Capability to Operate Effectively in a Dynamic Arctic' and 'Innovate and Adapt to Promote Resilience and Prosperity.' "

The RDC adjusted its testing approach because of the COVID-19 pandemic; typically, at least one RDC staff member would be onboard the cutter as the lead scientist during testing. The year the RDC relied on detailed user manuals and technical reports produced for training and remote connectivity with the Campbell during testing. Matthew Lees served as the RDC demonstration director while Lt. Mathew Lara, Campbell operations officer, assigned duties aboard the ship.

The technologies selected for evaluation:

- **Insight Mini Thermal Monocular (MTM) and AN/PSQ-20 Monoculars (enhanced night vision devices) for improved law enforcement and ice detection.**
- **Handheld Glare Helios laser for stand-off hailing capabilities.**
- **FiFish Remotely Operated Vehicle for underwater inspections in cold weather.**
- **Long Range Acoustic Device 500X-RE for enhanced communication with vessels at longer distances.**
- **Iridium Certus Terminal, which helped provide internet access for the crew to maintain communications with Atlantic Area.**

Monoculars

The AN/PSQ-20 fused monoculars were evaluated on their ability to determine ice edge and targets of interest during normal watch operations; the technology was successful, especially at night. This technology allowed crew members to sight an iceberg quickly and give accurate data on size and shape.

The MTM was integrated via adapter cable to broadcast to the Campbell's displays to support law enforcement and flight operations. "These tools functioned well to identify land, shipping and icebergs at night, providing detailed images of objects. Highly recommend future use," said Capt. Thomas Crane, Campbell commanding officer.

Handheld Glare Helios

The Glare Helios laser was tested in both day and night operations using a manned over the horizon (OTH) boat. During daylight hours, crewmembers onboard the OTH small boat detected the laser up to 8,000 yards from Campbell. During night hours, the laser was even more effective and could been seen over the horizon (approximately nine nautical miles). The Arctic environment did not hinder the operational ability of the Glare Helios.

The OTH crew reported it was immediately apparent the laser was pointed at them and believed the laser would be a valuable part of a boarding kit, especially when pursuing non-compliant vessels.

FiFish Remotely Operated Vehicle (ROV)

The Coast Guard recently authorized the use of low-cost ROVs to enhance the effectiveness of the fleet; this demonstration proved this technology is also viable in polar environments. The demonstration highlighted maintenance efficiencies by reducing the number of crew-hours and risk to personnel required to perform time-consuming dives and providing on-demand inspection of hulls and piers.

Long Range Acoustic Device (LRAD) 500X-RE

Underscoring the challenges faced during Arctic operations, weather conditions were generally not favorable for small boat operations, but the LRAD provided clear hailing and communication to small boats up to 500 yards away.

Iridium Certus Terminal

One of the biggest challenges for polar operations is effec-

U.S. Coast Guard Cutter Campbell engages In joint Arctic exercises with the Royal Danish Navy vessel HDMS Knud Rasmussen near the Jacobshavn Glacier in West Greenland.

ENS Liam Middleton, LT Stephen Hills and ET1 Douglas Locklear run the FiFish Remotely Operated Vehicle (ROV) to inspect under the waterline of the CGC Campbell.

.S. Coast Guard photo by SN Kate Kilroy

tive communication. The Iridium Certus Terminal was used in this evaluation to provide a communication method every day, allowing for the easy transmission of multimedia messages and even the establishment of phone communications within the contiguous United States for the crew. "We tested this frequently throughout the patrol to analyze and document the operational suitability. Integrated into the shipboard telephone system, it provided clear communications for command and crew to make operational and emergency calls. It also proved to be highly effective as a back-up internet option when our high latitude operations challenged other technology," Crane said.

Final results from these five technology evaluations are due at the end of the year.

Campbell also deployed 13 scientific research buoys ranging from the eastern shore of Nova Scotia to the Davis Strait. Daily images of icebergs were provided to the International Ice Patrol to validate and improve satellite reconnaissance. This effort allowed for real-time tracking and iceberg avoidance. "Varied scales of the operation area were readily available and provided over weekends, holidays and after work hours. This well-received, detailed, exceptional support greatly assisted in our operational planning and was critical to mission success," Crane said.

Campbell's crew also contributed to joint search and rescue exercises with the French and Royal Danish navies, facilitated key diplomatic engagements, and supported National Oceanic Atmospheric Administration and International Ice Patrol iceberg research during the 11,500-mile deployment. Campbell became the first 270-foot medium endurance cutter to earn the Arctic Service Medal.

"This effort strengthens international partnerships and provides a foundation for standard operations in the rapidly developing Arctic maritime environment," said Vice Adm. Steven Poulin, commander U.S. Coast Guard Atlantic Area. "As interest and maritime traffic in the area increase, the importance of the U.S. Coast Guard's interoperability with allied partners becomes more critical to ensuring we protect national and shared security interests. Exercising our unique blend of polar operational capability, regulatory authority, and international leadership across the full spectrum of maritime governance is vital to the future of the Arctic."

Coast Guard recapitalizes fleet with more capable cutters

New cutters allow Coast Guard to project and maintain presence

By Edward Lundquist

From work boats to patrol boats to heavy icebreakers, the Coast Guard is recapitalizing its fleet with new and more capable ships. It can't happen too soon. The service's legacy fleet of icebreakers, high and medium endurance cutters has reached retirement age, and then some.

USCGC Munro (WHEC 724), the last of the 12 Hamilton-class, 378-foot high-endurance cutters (WHECs), was decommissioned on April 24 in Kodiak, Alaska. Commissioned in 1971, she served for five decades.

The high-endurance mission is now being performed by nine "Legend Class" 418-foot National Security Cutters (NSCs) now in the fleet, with two more under construction. The multi-mission NSCs are the largest of the "white hull" cutters. All NSCs have been or are planned to be built at Huntington Ingalls Industries' Ingalls Shipbuilding of Pascagoula, Miss.

The Coast Guard's medium endurance cutters (WMECs) are also at or near the end of their service lives. There are 13 vessels in the 270-foot Famous-class and 14 vessels still in active U.S. service of the 210-foot Reliance class. The first 270 was commissioned in 1983, and the first 210 in 1964. The WMEC fleet also includes USCGC Alex Haley, a converted salvage ship that was transferred from the Navy, serving from 1971 to 1996 before entering Coast Guard service in 1999.

The replacement for the aging WMECs is under construction. The 360-foot Heritage-class Offshore Patrol Cutter (OPC) is one of the service's highest acquisition priorities.

Designed to complement the capabilities of the NSC, the 25-ship class of OPCs will have much greater sea-keeping, range and endurance and will eventually comprise more that 70% of the Coast Guard's offshore presence. Like the NSC, the OPC will have a flight deck, hangar and aviation facilities for helicopters and unmanned aircraft.

Three OPCs are under construction at Eastern Shipbuilding Group (ESG) in Panama City, Fla, and long lead-time materials for a fourth are on contract.

ESG won the competition to do the detailed design and construction of up to nine ships. Heavy damage from Hurricane Michael in October 2018 disrupted production. ESG requested extraordinary contract relief under the authority of Public Law 85-804 as a result of the effects on the shipyard from the category 5 storm. Limited extraordinary relief was approved by the Department of Homeland Security, and the Coast Guard moved forward with an adjustment to the OPC detail design and construction contract to cover production of the first four hulls. After soliciting industry for ideas in 2020, a new request for proposals to build up to 11 OPCs was issued in January,

U.S. Coast Guard Cutter Mackinaw breaks ice in Whitefish Bay, Mich., in support of Operation Spring Breakout, March 16, 2009. Spring Breakout encompasses northern Lake Michigan, northern Lake Huron, the St. Marys River and helps facilitate the spring shipping season in the Great lakes.

U.S. Coast Guard photo/Petty Officer 3rd Class George Degener

The Legend-class cutter USCGC Hamilton (WMSL 753) arrives at Naval Station (NAVSTA) Rota, Spain, April 14, 2021. After a two-week transit across the Atlantic Ocean, the cutters arrived in-port to resupply, before continuing to conduct operations in U.S. Sixth Fleet. They are on their way to Bahrain to join Patrol Forces South West Asia.

U.S. Navy photo by Mass Communication Specialist 1st Class Nathan Carpenter

USCGC Smilax (WLIC-315), the oldest active Coast Guard cutter, travels through Hatteras Inlet. The inland construction tender turned 75 in 2018.

U.S. Coast Guard photo

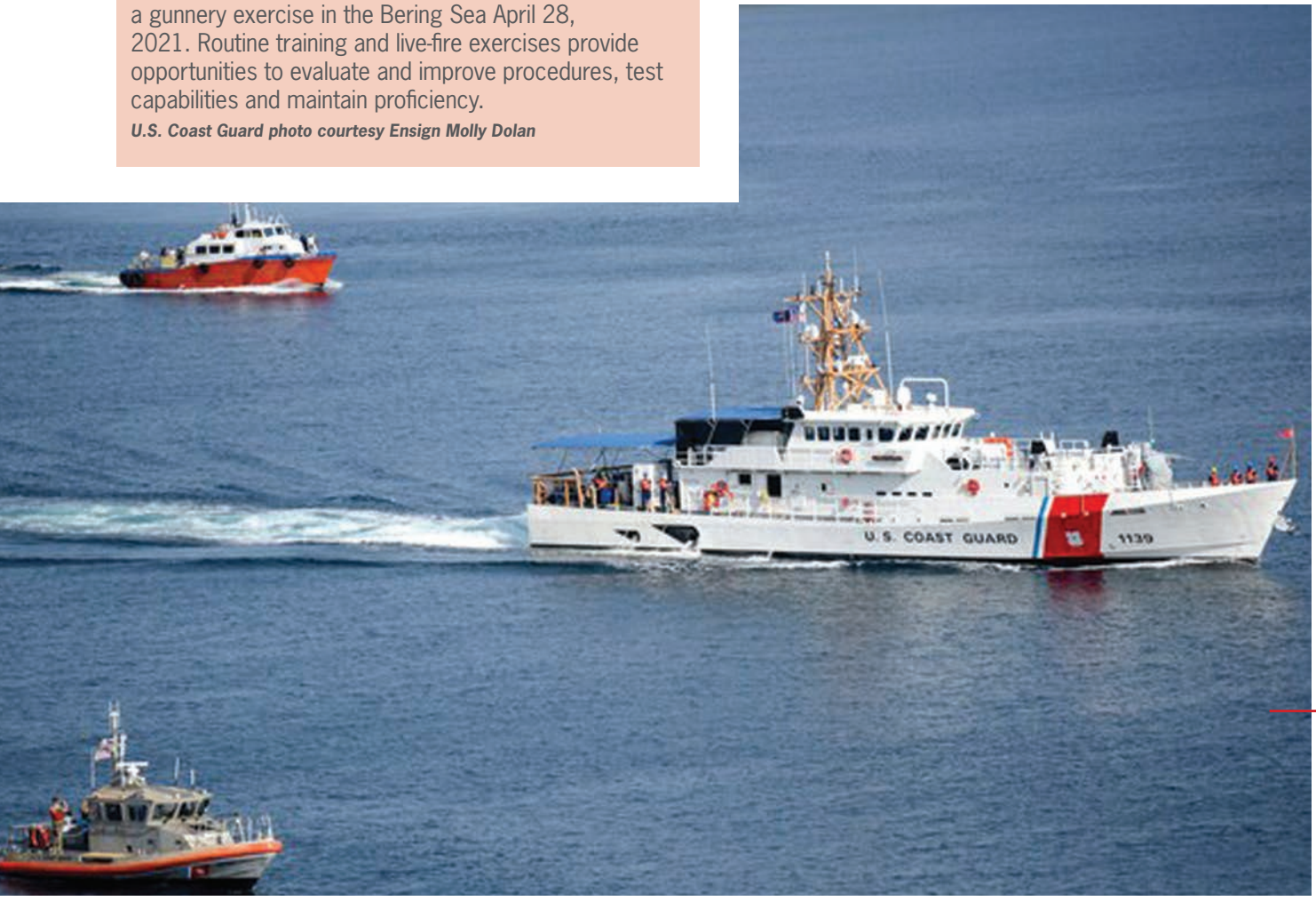
Coast Guard Cutter Stratton fires its MK 110 during a gunnery exercise in the Bering Sea April 28, 2021. Routine training and live-fire exercises provide opportunities to evaluate and improve procedures, test capabilities and maintain proficiency.

U.S. Coast Guard photo courtesy Ensign Molly Dolan

with offers to be submitted by June 11, 2021. The keel for the lead ship, USCGC Argus (WMSM 915), was "authenticated" in April of 2020.The second OPC, USCGC Chase (WMSM 916),is currently in production. The Coast Guard recently modified the contract to begin construction of the third OPC and to acquire long lead-time material (LLTM) for the fourth OPC.

The 154-foot Sentinel-class fast response cutter (FRC) is replacing the 110-foot Island-class patrol boats (WPBs), which are at, or approaching, 30 years of service. 64 are planned, with 40 already in service. The FRC can deploy independently to conduct maritime security; fishery patrols; search and rescue; and national defense missions. The FRC is being built at Bollinger Shipyards in Lockport, La., and is based on the Damen Stan Patrol 4708 "parent-craft" design. FRCs have been assigned at homeports from the continental U.S. to Alaska and Hawaii, with the latest cutters going to Guam and Bahrain.

Compared to the WPBs, the FRCs have improved C4ISR capability and interoperability; stern launch and recovery (up through sea state 4) for a 40-knot Over-the-Horizon, 7-meter cutter boat



instead of the WPB's 17-foot RHIB boat; a remote operated, fully stabilized MK38 Mod 2 25-mm main gun; improved sea keeping; and enhanced crew habitability. In fact, the FRCs are able to do some missions previously assigned to larger cutters.

The much-needed replacement for the Coast Guard's heavy polar icebreakers (WAGBs), the Polar Security Cutter (PSC), is underway. The Coast Guard awarded a contract to Halter Marine, Inc., to acquire up to three multi-mission PSCs to recapitalize the service's heavy icebreaking capability. USCGC Polar Star (WAGB 10) is currently the Coast Guard's sole operational heavy icebreaker. Polar Star's sister ship, USCGC Polar Sea (WAGB 11), has been taken out of service. The two Polar-class icebreakers were commissioned in in 1976 and 1978, and are now far older than their 30-year expected service lives. Commissioned in 1999, USCGC Healy (WAGB 20) is a medium icebreaker used primarily to support polar research.

"Our new Polar Security Cutters will ensure year-round access to uphold United States' sovereignty, represent national interests, and vigorously compete for advantage in the remote polar regions," said Coast Guard Commandant Adm. Karl Schultz.

The "Black Hull" fleet of buoy tenders and construction cutters carries out the difficult but unheralded jobs of maintaining the system of aids to navigation (ATON) at sea, along the coast, and throughout the nation's intracoastal and inland waterways.

This mission is accomplished by 16 Juniper-class, 225-foot seagoing buoy tenders used to maintain aids to navigation and also assist with ice breaking, law enforcement, and search and rescue. They entered service between 1996 and 2004, with two of them being stationed on the Great Lakes. There are 14 Keeper-class 175-foot coastal buoy tenders that entered service between 1996 and 2000.

The inland and river construction tenders are the oldest

Coast Guard Cutter Myrtle Hazard (WPC 1139) steams through Apra Harbor before arriving at its new homeport in Santa Rita, Guam. The new Fast Response Cutter (FRC) is the first of three scheduled to be stationed on Guam and is replacing the 30-year old 110-foot Island-class patrol boats. FRCs are equipped with new advanced command, control, communications, computers, intelligence, surveillance, and reconnaissance systems and boast greater range and endurance.

Photo by U.S. Navy photo by Mass Communication Specialist 3rd Class MacAdam Kane Weissman

cutters in the Coast Guard inventory, with an average age of 56 years, and the oldest being more than 76 years old. There are three classes—inland buoy tenders (WLI); river buoy tenders (WLR); and inland construction tenders (WLIC)—in various versions from 65 to 160 feet (20-49 meters) in length, and along with their respective work barges can reach up to 190 feet (58 meters). Together these vessels and their associated work barges place and maintain buoys; construct towers, drive and extract pilings; along with generally support maintenance of more than28,000 navigation aids along America's 12,000-mile Marine Transportation System (MTS) of rivers, canals, and intracoastal waterways.

The inland tenders are being replaced under the Coast Guard's Waterways Commerce Cutter (WCC) program, which is under an "accelerated program schedule" to reach initial operational capability by 2025 and full operational capability by 2030. The request for proposals for the WCC program was released May 3, 2021.

Although the nine 140-foot Bay-class icebreaking tug boats (WTGBs) were built between 1979 and 1988 they just completed a service-life extension as part of the Coast Guard's Inservice Vessel Sustainment Program to extend their service life by another 15 years. The WTGBs are assigned to the northeast and Great Lakes regions of the country.

"The acquisition of 11 National Security Cutters, 25 Offshore Patrol Cutters, 3 heavy Ice

Breakers, and 64 Fast Response Cutters provides our Nation with over one hundred highly

capable ships that model the rules-based order," said Schultz in his "State of the Coast Guard" address in march. "While the Department of Defense is rightly focused on hard power lethality, the U.S. Coast Guard provides soft power, multi-mission flexibility, trusted access, and non-kinetic options to advance U.S. interests, preserve U.S. security and prosperity, and address wide-ranging threats and challenges. We bring a range of maritime capabilities to bear across what I like to refer to as

Coast Guard 270-foot Medium Endurance Cutter Escanaba (WMEC 907) departs Boston Harbor in 2018.
U.S. Coast Guard photo by Petty Officer 2nd Class Lara Davis

the ""cooperation-competition-lethality continuum.' While we train and operate across the entire continuum, it is in the 'cooperate and compete' areas where we thrive and best demonstrate our value to the nation in support of the Tri-Service Maritime Strategy – 'Advantage at Sea' -which the Chief of Naval Operations, the Commandant of the Marine Corps, and I jointly released in December. The future of our Naval Services is joint. We are truly more effective when we work together!"

Color-Coded Cutters

Coast Guard cutters can be classified by function and size...and color. The **"white hull"** ships conduct patrol operations. The **"black hulls"** are buoy tenders and work boats, servicing aids to navigation at sea, along the coast, and in inland waterways. The **"red hull"** cutters are icebreakers that work in the polar regions or on the Great Lakes.

The Coast Guard Cutter Smilax (WLIC 315) at the Coast Guard Yard in Baltimore in 2015.
USCG photo by Charles Wilso

Metal Shark 38' fireboat for Orange Beach, Alabama.

Metal Shark

On Patrol: Patrol, Fire Boat Technology Takes Off

By Barry Parker

Throughout the pandemic of 2020 into 2021, activity has remained strong at shipyards, declared early on to be "essential businesses"; and builders in the maritime patrol boat sector are no exception. The builders produce a spectrum of vessels, ranging from boats with top speeds of 50 knots and above, typically used in military or drug interdiction settings, to patrol and fire/rescue boats that can proceed at a very respectable 25 knots.

In early 2021, a leading builder of metal boats, Metal Shark, delivered two welded aluminum fireboats, dubbed FB-21 and FB-73, to Miami Dade Fire Rescue in Florida. These 50 Defiant boats, with 55-ft length and 17.5-ft. beam, are powered by twin, 16-liter, 1,200-horsepower MAN D2862 LE456 inboard V8 diesel engines coupled via ZF500 transmissions to Marine Jet Power (MJP) 350X waterjets, enabling a top speed in excess of 44 knots. Features include Marine JetPower's Combinator digital controls and joystick Vector Control System, which enable pinpoint maneuvering in close quarters situations, and a Zipwake dynamic trim and ride control system.

The traditional "fireboat" has evolved, as marine fire departments take on security-related roles, especially in ports in populated areas with extensive trade flows. The Miami boats include kit from Raymarine with multiple 12" and 16" AXIOM multifunction displays, with units installed at multiple operator stations providing radar, GPS, engine and systems data, and displaying video feeds from onboard cameras. These screens also pull the feed from the gyro-stabilized Forward Looking InfraRed (FLIR) M400 XR multi-sensor thermal night vision cameras. This specialized firefighting package defines target temperatures and provides heat maps (isotherms) to aid firefighters by locating the focal point of the fire.

A display from Humminbird Helix displays depth, sonar and 3-D side scan imaging. Highlighting their multi-mission capabilities, Metal Shark says: "The new vessels will aid the crews in detecting and identifying any Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) threat as the vessels are equipped with the latest in detection meters and equipment necessary to prevent such an event."

Safe Boats Town of Hempstead Patrol Boat.

Safe Boats

Lake Assault police boat for Superior, Wisconsin.

Lake Assault

Greg Trauthwein

Form follows functionality in other ways.

Metal Shark proudly points to its visibility enhancing features, including a windshield that significantly reduces blind spots compared to fireboats with smaller, framed windows in conventional pilot-houses, and visibility both downward (with a lower row of windows) and upward (through a skylight).

While boatbuilders serve customers all over the country, and internationally, sometimes the buyers are local. Such is the case in a recent patrol boat deployment in the Great Lakes; Lake Assault Boats, a supplier of aluminum boats based in Superior, Wisconsin, put a 30-ft. patrol boat into service with the Superior's police department (which provides patrol and emergency response services on portions of Lake Superior). This boat, powered by two 350-hp Mercury outboard motors, with stainless steel propellors (and a top speed estimated to be 50 knots), combines an aluminum alloy welded hull with "an inflatable air collar… attached to all sides of the craft to provide 360-degree protection." The 30-ft. boat includes a pilothouse with a narrow aluminum

Other recent Silver Ships deliveries include 30-ft. Endeavor series fire rescue boats to Bayport, also in Long Island.

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Lake Assault

Lake Assault patrol boat for the U.S. Navy.

hard top, and includes a built-in seat in front of the console, a weapons storage box, a waterproof electronics box and an adjustable windscreen. The console is outfitted with two Garmin 12-in. multi-function displays with ample room for electronics, throttles and switches. Lake Assault (part of the Fraser Shipyards family) also recently delivered a 36 ft. fireboat to Marathon Petroleum Company for its Garyville, La., refinery (between New Orleans and Baton Rouge on the Mississippi River). The 36-ft. vessel, with a bow door for offloading equipment that includes an ATV, is described as a "… modified V-hull craft…powered by twin 300 hp four-stroke outboards." The 1,500 gallon/minute (gpm) pump is powered by a separate 365 hp engine.

In February, 2021, Lake Assault announced that it had been selected by the U.S. Navy to provide up to 119 Force Protection-Medium (FP-M) 33-ft. patrol boats, each powered by twin 225 hp outboards.

With the summer recreation season arriving, along with warm weather, boating safety on the lakes and bays is of paramount importance. The Candlewood Lake Authority (CLA), in Connecticut, at a late 2020 public hearing regarding the purchase of new patrol boats, explained that aluminum boats are highly durable (with long life spans and good resale values), are well suited for towing, and, reflecting the recreational usage pattern, with groups of people gathering on islands, noted: "Lake usage has changed, island use is increasing and aluminum boats can land on the islands with increased durability." In the same meeting, local officials opined that deploying fiberglass hulls for patrol boats was not an optimal strategy.

Summer is also the season for maintenance; in New York's suburbs, the Town of Hempstead (in Long Island) took delivery of a 6.8-m "Porter 68S" workboat built by Safe Boats International, based in Tacoma, Washington, under a license from the Dutch builder Stormer BV. With this new arrangement, Safe Boats now says that it can offer: "the full line of Stormer workboats to U.S. operators … in a Jones Act compliant licensing arrangement." As explained by Safe Boats, uses for the new craft will include towing pilings, resetting buoys, pulling floats, recording depth findings, and assisting in moving barges.

Silver Ships, an Alabama-based maker of boats, one of three under consideration by Connecticut's CLA, also serves fire/rescue and law enforcement. Its product line includes its Endeavor series of boats up to 65 ft. in length. A 38-ft. model, used by the marine unit of Lake Ozark Fire Protection District, in Missouri, is powered by three Mercury 350 hp outboards, while a similar-sized multi-mission patrol boat with three Yamaha 300 hp engines, used by the East Hampton Harbor Patrol, in eastern Long Island, includes a hull strengthened for ice resistance. Other recent Silver Ships deliveries include 30-ft. Endeavor series fire rescue boats to Bayport, also in Long Island, and League City, Texas. Both are powered by twin outboard engines. Silver Ships also has a long history of building

Metal Shark

Metal Shark fireboats for Miami Dade, Florida.

for the military including riverine patrol and coastal response boats; it recent delivered a 28-ft. catamaran patrol vessel to the U.S. Army Corps of Engineers – Little Rock District. Outfitted with an extensive array of electronics, it will be used for hydrographic survey work.

Safe Boats, with its recent expansion into workboats, continues to offer boats for its traditional customer base, including the military. The U.S. Navy had previously purchased its MK VI 85-ft. patrol boats for deployments in the Middle East. Through Foreign Military Sales transactions, they can also be sold abroad. In early 2021, Safe Boats announced a $20M lead contract award, to start construction of two Mark VI patrol boats for the U.S Navy; ultimately, these boats will be sold abroad to the Ukraine (with delivery anticipated to be in late 2022) as part of a large aid package. The manufacturer explains that these boats, are "… equipped with ballistic protection, armor plating around the engines and fuel storage." The boats are powered by twin diesel engines (MTU 16V2000M94, providing 5,200 horsepower, which can burn JP-5 jet fuel, in addition to marine diesel) and waterjets.

Washington State is also the home of Munson Boats, is well known for building landing craft, with a square bow design. Its welded aluminum boats, used by police and fire departments around the U.S., range in size from 21 up to 48 ft.; its craft are also used for oil spill response and utility/workboat functions benefitting from the bow ramp. These boats are powered by outboard engines, typically pairs of 200 hp – 300 hp, though the larger size links an inboard diesel plant with a waterjet.

Digital technology, featured in boats from all the builders, goes way beyond onboard displays and electronic controls. The trend towards autonomous vessels, where routine tasks can be reshaped digitally, and crews can be reduced, has been an important topic across transport modes. Where the element of danger or hostile environments is added, the use case for autonomy becomes more compelling. Like much of the maritime tech space, "winning" technologies have not emerged; there is no "industry standard" for software and systems. Metal Shark has taken the lead in this space, having established its Sharktech Autonomous Vessels division in 2018- which it describes as having a mission of: "…deliver<ing>

Metal Shark

Metal Shark 70' multipurpose boat for Port Canaveral.

vessels capable of supporting multiple autonomy software systems, bridging the gap between the shipbuilder and the software developer, streamlining the path to autonomy and simplifying the process for all clients…" Initially the uptake will be from the government (not uncommon as technologies find their way to commercial users). In late 2020, Sea Machines Inc., a Boston based developer of robotics applications, announced that it was partnering with Sharktech on developing a version of the 29 Defiant to the U.S. Coast Guard's Research and Development Center. Metal Shark says that it was selected by the U.S. Marine Corps, in early 2021, to develop its future autonomous naval defense system, the Long Range Unmanned Surface Vessel (LRUSV) system, utilizing technology developer Spatial Integrated Systems (SIS, recently acquired by Huntington Ingalls Industries) to provide the autonomy solution.

Miami Dade's purchase of the Metal Shark boats highlights the interplay of local funding sources with Federal support from the Port Security Grants Program (PSGP administered through FEMA), with input from local US Coast Guard Captains of the Port. In the case of Miami Dade, the Federal grants (awarded in 2017 and 2018) were used, in conjunction with the Fire Rescue budget, to fund the purchase of the two Metal Shark boats (at a cost of approximately $1.7 million each). At waterfronts across the U.S., the grants have been vital. Perth Amboy, New Jersey (the site of multiple oil products terminals), benefitted from a $900 thousand PSGP award, using the funds to procure a 44-ft. boat capable of pumping around 9,000 gpm. Other ports using PSGP awards in recent years include Port Canaveral, Fla, which applied PSGP funding toward the purchase of a multipurpose fire and rescue boat, a 70-ft. Metal Shark Defiant, delivered in January, 2021. Funding sources for the boat (which the port says cost $4.6 million, and would serve the burgeoning commercial space industry besides the re-starting passenger cruise business) also included $1.5 million from the State of Florida. A Munson boat delivered in 2020 to the Fall River, Mass. fire department benefitted from a $472 thousand Port Security grant (with the local department funding the $158 thousand balance). Metal Shark's fireboat for Orange Beach, Alabama, with 3000 gpm capability, delivered in March, 2021, also benefitted from a $750 thousand award from the PSGP 75% of the total cost.

In this sector of the market, impacted by technological and political winds, there is still room for good old-fashioned resourcefulness. Local authorities can be creative; in the case of Candlewood Lake, Connecticut, a $100,000 donation from FirstLight, a local provider of hydro-electric energy (with a keen interest in the local lakes), eased the burden of the $150,000 price-tag on an aluminum patrol boat, a stretch for the CLA.

The Evolution of Gas Carrier Design

MISC

Peter Fitzpatrick, VP, Strategic Development, ABS, knows gas ships.

Prior to joining ABS, Fitzpatrick was VP Ship Design and Construction for BG Group, responsible for the technical operations of the company's LNG vessel acquisition programs. He spoke recently with Greg Trauthwein on **Maritime Reporter TV** regarding the future technical trends for the sector.

"Digital will be a key enabler to make the next gigantic leap in how we make improvements in emissions and efficiency."

Peter Fitzpatrick,
VP, Strategic Development, ABS

MARITIME REPORTER TV **Watch the interview with Mr. Fitzpatrick @ bit.ly/34DqnUa**

While we're here to talk about the future, I understand that experience with gas transport ships is hardly new within the walls of ABS.

ABS was involved the LNG transportation right from the start. The first LNG carrier, Methane Princess, was delivered in 1964 was classed by ABS. And we were heavily involved at that time in developing the rules and regulations around classification of new carriers with the Coast Guard. We've continued that relationship with both the US Coast Guard and through other organizations, and we were really helpful in re-developing and improving the international gas code, which was re-released and updated in 2016.

ABS has been involved in a number of gas carrier 'firsts', so we take part quite pride in working with companies as they develop new ideas and concepts and bring them to market.

What do you see as the macro trends that are driving LNG carrier design today?

That's a good question, but let me take a step back. The LNG shipping industry has been under constant change for the last 15 years. The LNG industry was a very traditional one from the 1980s to 2005, where you built project specific ships. We had steam propelled LNG ships and the technology and the trading patterns did not change. But around 2005, a number of companies started changing as the number of importing countries for LNG increased. So suddenly we see that different market dynamics. Traders began to understand that they could sell cargoes to more clients, and we needed to embrace new technology. So over that period of the last 15 years, we've embraced change from different propulsion systems. We've gone from steam to diesel/electric to dual fuel gas engines. Also, we can change the cargo containment system. We've switched out many of them a moss type and the round spherical spheres to a membrane containment system so it can carry more volume for the same size of vessel. We've reduced the cargo containment boil off system from 0.15 to 0.1. This has all been driven by the need to have a flexible shipping approach to meet the new trading demands coming forward. So we've been in a constant state of change for 15 years, and we've now kind of standardized on a new size of ships. As we look forward, I think we're going to see another set of changes coming. Instead of being driven by market forces, this change is going to come from how regulations, for example 'what is my CO_2 footprint from a cargo?'

Seri Everest, the first in a series of three 98,000 cbm Very Large Ethane Carriers (VLECs) built in Samsung Heavy Industries Co., Ltd. (SHI) and classed by ABS, the ship was delivered to MISC in late 2020.

MISC

Lets move from the macro to the micro. And in that, I mean, looking at one specific ship: the very large ethane carrier Seri Everest classed by ABS and the world's largest ethane carrier. Can you discuss some of the outstanding technical highlights of that ship?

You are right, it's a really important vessel, and I think it's a very important sector. Ethane has become a major gas of export transportation and we're seeing it as a real growth area. I think the vessel embraced the lessons learned out of the LNG industry and translated them into an ethane industry; like the LNG ships, its able to burn use its own cargo is fuel.

We also see this one is now ready for future-proofing. I think any ship owner today really needs to think about future-proofing their design. How do you now have your design available for the next 10, 20, 30 years? How do you approach 2050? So if the ethane trade changes for any particular reason, these vessels will be able to change their operations and maybe switch from being an ethane carrier to an LNG carrier.

A good example of how markets can change is the US, which used to be an LNG importing country and quickly switched to being an LNG exporting country. So I think this (Seri Everest) is a really good vessel: flexible enough to deal very effectively with the vessel and the cargo today, burning its own cargo, consuming it and lowering its emissions. But it has the flexibility to change if the market forces change.

As gas carrier designs are optimized to meet the ever-tightening emission targets, can you give insights on the characteristics and the shape of the gas carriers to come in the coming decades?

We've seen standardization driven by the market; a standard 174, 180 size that gives maximum vessel flexibility, and maximum number of terminals you can arrive for trading. We've concentrated today on a slow speed gas engine, which is the most efficient type; halving the fuel consumption from previous steam propelled vessels. We've optimized the hull form to be as efficient as possible at multiple speeds. We've improved the cargo containment and the cargo handling system? Maybe we add a reliquefaction system.

Going forward we may see a few other things. I think the adoption of shaft generators will be constant, using the main engine to power the auxiliary engines. I think we're going to see a decoupling of the cargo containment system from the main propulsion. We are starting to see that with ships adding reliquefaction systems. I think that's going to come more of the norm and that's about future-proofing your design. So in the future, you can then have a reliquefaction system which maintains the cargo tank temperature and pressures, and you have a separate fuel system for the main engine.

Today that can be LNG, but as I look ahead 15 years, maybe it's bio-LNG. Maybe in 20 years I have to switch to ammonia or hydrogen. By decoupling the cargo containment system from propulsion, it allows me to have other options. Another area we're seeing is the adoption of LNG saving devices in the hull form. Things like air lubrication, where we use air bubbles to reduce the skin friction, have been fitted on a number of vessels, and I think it will become more common. I think we will see more embracing of electrical and batteries. Again, LNG ships have a natural tendency to use a lot of electricity in port. So we might see the use of batteries on a hybrid ship to generate power for use in port.

I know you've just discussed many of the technologies – the hardware – that are going to drive the gas carrier in the future, but what about software?

Great question. I think the biggest change which has the most impact will be the software, the digital innovations we need to embrace to make efficient operations. LNG ships are quite interesting; as we consume LNG to keep the cargo in its liquid format, every time the vessel stops, every time the vessel has a delay, every time we're consuming additional LNG, if we want to optimize this, we need to embrace a digital approach. We have to have a connected fleet, the sensors to understand the performance of the vessel. The use of digital allows us to optimize the cargoes, the routes, the ships and the fleet for specific cargoes and routes. And how do we really streamline that kind of logistics train to optimize the vessel? I think digital allows us to do that.

We've developed a system called My Digital Fleet which is a platform system, a system where you can embrace many different digital tools and connect them together to see what provides you the best opportunity to optimize your fleet looking forward. Traditional performance systems look retrospectively. The digital solutions of the future are going to say, "how am I best to perform as I go forward?" I think digital will be a key enabler now to make the next gigantic leap in how we make improvements in emissions and efficiency.

Bollinger Shipyards

Vessel Stability is Control

By Greg Trauthwein

Vessel stabilization is a holy grail problem for many ship designers, regardless if the vessel is a warfighter, a cattle carrier or a megayacht. There is no 'silver bullet' solution to keeping a vessel stable across a range of sea conditions, but companies like Quantum Marine Stabilizers are dedicated solely to the challenge, working to devise stability solutions regardless of vessel size, shape, route or mission. John Allen, the founder & president of Quantum Marine Stabilizers, and his global team offer more than three decades of vessel stabilization experience. Well-known in the yacht market, the business today extends across military, commercial and private sectors. "A big field for us is the yachting industry, but also, the military and commercial markets are moving steadily," said Allen, particularly in the overseas military applications, specifically in the patrol boat business. "Quantum has a great product range that fits into the patrol boat market."

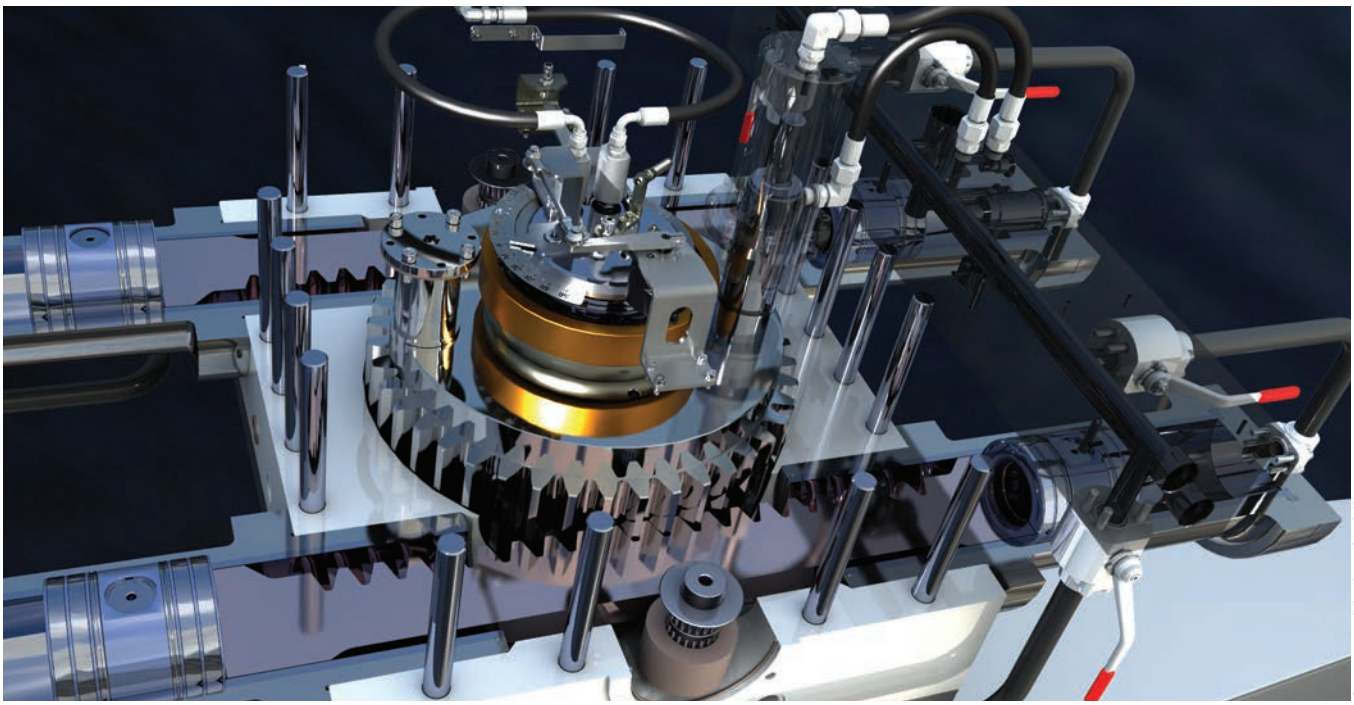
While sharing explicit details of military boat building is not possible for any supplier, Allen points to the U.S. Coast Guard FRC program as one of the most successful of all time, with 44 ships in service and more to come. "I think Bollinger delivers a ship every six to eight weeks; it's a great program and all indicators say that there could be 100+ ships." Quantum has found strong business in the oversea markets, too, as "we are moving steadily along with the Australian Navy OPV program," said Allen. In addition to these programs, Allen anticipates a growing business for military ships, foreign and abroad, and importantly not just newbuild, but refurbishment, too, as decommissioned U.S. military ships are sold to other countries.

"There's a lot of work there for everybody because generally, when boats are recommissioned for sale through foreign military sales, they invest in the ship," said Allen. "They put new hardware on the ships, they rebuild things, and they might upgrade (or replace) stabilizers.

Invest in Tech

Continual investment to improve products and systems is the norm for Quantum. The new Rack & Pinion actuator, currently used on the MAGLift Rotor has been under redesign and development for standard and XT fins. The new version called the R Series has proven to show significant advantages in performance, maintenance and the passenger comfort. Some highlights include:

- Zero speed performance is enhanced via greater swing capacity
- Extended roller bearing service period to 15,000-hours
- Hydraulic locking mechanism provides double security for locking the fin and shaft in place when not being used or out of the water.
- With four pistons and dual racks, it exerts the full range of motion with



Quantum Marine Stabilizers

The Rack & Pinion actuator, currently used on the MAGLift Rotor has been under redesign and development for standard and XT fins. The new version called the R Series.

constant torque on both sides of the gear wheel

- Rapid acting relief valves, transfer the oil and rotate the fin to initiate the release of the drive mechanism should the vessel encounter unexpected loads, and
- To simplify the operation and maintenance, the gear case is lubricated with the same hydraulic oil that is used in the hydraulic system.

In addition to the machinery, Quantum filed a patent in 2020 for its new Dynamic Load Control, an application that involves a control system that is designed to reduce the cyclical loading and the amount of accumulator storage required by varying the target pump pressure. "The dynamic load control system allows us to smooth the power requirements for our equipment," saod Allen. Managing the various load demands on a vessel has it challenges and can cause "brown outs" which is noticeable by dimming lights. The DLC limits the horsepower draw on the electric motor and helps to balance the load between multiple pumps within the same hydraulic systems.

The Impact of COVID

As COVID has challenged all industries for the past 15 months, Quantum is no exception, said Allen. But there's always a silver lining, an done 'benefit' of the global shutdown has been an uptick in Quantum's ability to provide remote support. "Currently, we don't build a system that doesn't have remote access," said Allen. "We can 'dial into a stabilizer' and see what's going on if the client has issues. We can't always resolve everything," but the remote access can put owner and technician on the same page.

"Something we're starting to work on now is live feed," said Allen. "We can now equip an engineer onboard the ship with a set of goggles, and they can go right to the product, look at the product, and we can see what they see," allowing Quantum's shoreside personnel the opportunity to communicate and potentially talk them through a problem.

"It does not completely eliminate us having to go on site, but it can really ratchet it back and we can support the product." Anytime there is an open line to a ship at sea, naturally cybersecurity concerns come to the fore, particularly in military markets.

"Vessels are always a little careful about allowing companies access into their system because essentially, you're dialing into the ship's net system and then finding your piece of equipment," said Allen. To that end the company isolates its service servers, and "the internet modules that we use can only connect to that server … you couldn't dial in from any of the locations, they only recognize that one server," said Allen

In addition, Quantum records every communication, every time it connect to a remote access device, and it can record the duration of the connection as well as service activity.

"So we have a real log and a record that's maintained here," said Allen. "If there is any issues, we can address them."

Connectivity is Ki

When Norwegian fish farming support vessel operator DESS Aqua wanted to improve connectivity on its vessels, it had some demanding criteria. Now, just over a year later, it has installed a wireless system from ScanReach across most of its fleet and is likely to continue installations into the remaining vessels and three newbuildings. Bjørn-Inge Engene, COO, was looking for more than just technical connectivity: he wanted business connectivity across the company. "We have invested a lot of money into having one system to run our entire company," he said. Everything can be managed from a mobile phone, "so why should I spend money in having yet another system?," he said. That management system can integrate with third party software, such as the company's accounting system. Invoices display on his phone for approval and, thanks to its face recognition ability, he can approve them at a glance. As long as a potential new system has an open application programming interface (API), "we can do whatever we want with it," Engene said.

That is how ScanReach's system operates and the company's chief business development officer Jacob Grieg Eide believes that open APIs are now essential for successful business relationships. It is not realistic to expect a supplier or partner to adapt to a particular customer's way of working because that would hinder innovation, while open

DESS Aqua's fish-farming customers demand high safety standards (image: DESS Aqua)

ng for DESS Aqua

systems make it simple to aggregate, transmit and visualise data "and that's how we build trust," he said.

ScanReach initially installed the system on one vessel, which involved fitting a number of wireless nodes throughout the hull. Engene subsequently spent some time on that vessel and crawled "absolutely all over the boat" with a wearable sensor. "I clicked the panic button and it connected to the system every time," he said. It convinced him that ScanReach's wireless technology was reliable even in the depths of a steel hull so, although the pilot was intended to last six months, DESS signed a fleet-wide agreement after just three.

Personnel Tracking

Its main use of the system so far has been to run ScanReach's ConnectPOB personnel tracking system, which makes use of the nodes and the mesh they create specifically to keep track of personnel onboard (POB).

When they are called to their muster stations, for example, ConnectPOB automatically records each person as they arrive and displays this information on the bridge. In the event that someone does not muster, ConnectPOB will show which node their sensor is currently – or was last – linked to, reducing the time needed to find them.

Eide believes that ConnectPOB is good for business, which Engene confirmed. His customers are fish farmers for whom DESS Aqua provides services such as harvesting and transporting salmon from fish farms. "They want to see a good safety culture," he said, so "using this technology promotes interest and shows why we are different." This distinction is important in a growth sector such as fish farming, which has doubled in volume since 2005 and is still growing.

Its vessels typically have eight-to-10 crew on board, many of them working along the vessel's side during fish handling operations and sometimes stepping off the vessel to stand on the fish cages. This makes it likely that, over time, someone will fall overboard, Engene said, prompting DESS Aqua to support a ScanReach project to develop a man-overboard (MoB) sensor.

This is not straightforward: it should not alarm every time a crew member intentionally steps onto a fish cage and the system should not rely on, for example, an accelerometer detecting a water impact as its sole MoB indicator because a fall may not be from sufficient height to produce a significant deceleration from ships with low freeboards.

ScanReach's sensors do have accelerometers, Eide said, and the company is working with its suppliers to develop the next generation of wearable devices which may check for salinity or another parameter to detect an MoB situation. "There is a lot of functionality in the wearable and in the node that is not yet deployed" so they could be enhanced, which can be done remotely via satellite, he said.

A further project that DESS Aqua is supporting is developing gas measurement sensors that would link with ScanReach nodes to report the environment inside a confined space before it is entered. ScanReach is conducting a global technology survey to find suitable environmental sensors for this purpose, which will probably be calibrated remotely, and it is discussing with DESS Aqua and other clients what gasses should be monitored and other operational details.

Eide stressed a key benefit of linking sensors to the ScanReach wireless system, especially in a situation where drilling holes for cables is impracticable, such as into fish tanks: "that would be the end of the business case." Wireless monitoring is also cheaper: "I know how much we paid to instal the fixed probes we have today and I'm not installing any more," said Engene.

Being able to combine POB information with environmental data "will be gold in our industry," he predicted, because of the frequency that crew have to enter the fish tanks. Doing it correctly with all the necessary pre-entry checks takes time, so it can be tempting to cut corners. Automating those checks would remove that risk, he believes, and he is hopeful that the Norwegian flag authorities might be willing to view such a system to be acceptable instead of the current arrangement that uses set procedures that may be viewed as time-consuming.

"We have to make it easy for our crew to do the right things," he said. He is also keen to take advantage of ScanReach's next project, ConnectFleet, which will provide fleet-wide surveillance that will "dramatically increase safety," said Eide. It will deliver real-time information from across a fleet of ships to the shoreside office from where support can be offered in an emergency.

"When the alarm goes off, the captain is alone on the bridge, because everybody else is occupied, so to have that link between the office and the bridge during emergencies will be incredibly important," Engene said.

"The first hour in any emergency is the golden hour," especially "on our ships with limited numbers of people on board," he added.

Environmentally Friendly Alte

The shipping industry has been searching for the next best solution to control biofouling ever since 2001, when the IMO banned the use of tributyltin (TBT) as a biocide in antifouling coatings. Biofouling control measures are a high priority investment for shipowners since fouling growth on a ship's hull can significantly decrease energy efficiency. During a ship's journey, fuel consumption constitutes 50-60% of its operational cost and this cost is only further increased from fouling's negative impacts on the hull's drag performance (84% increase in shaft power for a heavily fouled containership) [1].

Currently, the most popular method of biofouling control for the underwater hulls of marine vessels is to coat them with "antifouling coating systems". The drag performance of a vessel's hull can be significantly improved by choosing the proper coating system for the intended application and environment. Each marine coating system is different as they use various mechanisms to protect a ship's hull from biofouling and corrosion. The main type of marine coating used to protect against fouling organisms is a biocide-based antifouling. These coatings are used for vessels which undergo long stationary periods to prevent a heavy buildup of fouling over time. The two main types include Controlled Depletion Polymer (CDP) and Self Polishing Copolymer (SPC) coatings which vary by the mechanisms they use for leeching toxic chemicals into the ocean [2].

Soft foul release coatings are an environmentally friendly alternative which use the sheer force of water to remove fouling organisms without leeching biocides into the environment. These low friction topcoats are primarily silicone-based and can effectively prevent fouling under dynamic conditions (when the ship is in motion) due to their low surface energy, slip, and elastomeric properties. Soft foul release coatings have become increasingly popular due to their inherent fuel savings as they maintain a lower average hull roughness throughout their lifetime [3]. One drawback is these coatings contain silicon oils (1-10%) which can persist in the ocean [4]. The long-term environmental impact of these silicon oils is still not fully understood.

Hull Cleanings

Hull cleanings both in drydock and in-water are effective alternatives to control biofouling growth. In-water cleanings have recently become popular since they avoid the cost of added labour and extra days of drydock. However, many jurisdictions strongly regulate in-water cleanings to prevent the release of toxic substances from antifouling paints during cleaning and the spread of invasive species. Transversely, in-water hull cleanings have been recognized by the International Maritime Organization (IMO) and the United States Environmental Protection Agency (USEPA) as a measure to limit the transfer of invasive species when performed appropriately.

Historically, antifouling coatings have not been designed to be cleaned by any existing underwater hull grooming method [6, 7]. After each hull cleaning these coatings will mechanically degrade which cuts down their lifetime, decreases their functionality and pollutes the marine environment. For this reason, ship owners are forced to wait for the next drydock period to clean the hull and re-apply the antifouling system, sacrificing their fuel savings and increasing GHG emissions.

Soft foul release coatings are heavily reliant on their ability to maintain a defect-free surface. However, due their weak adhesion between layers and softness of the topcoat, they can be damaged during underwater hull cleaning operations. As a result, shipowners opt

rnative for Biofouling Control

not to clean their hulls even when a heavy layer of slime has built up. Heavy slime on a ship's hull has an associated fuel/power penalty which in some cases can be as high as 20% [1].

Ultra-hard coatings use resins reinforced with glass flakes and other armouring fillers to solve this issue, as they are mechanically robust, long-lasting under periodic abrasive cleanings, and non-toxic. The coating is usually applied in two coats at a dry film thickness (DFT) of 500 µm to a properly prepared hull, either at new build (ideal) or in drydock for an in-service vessel. However, these coatings offer no anti-fouling or foul release properties which contributes to a high surface roughness when compared to the other systems and adds an associated fuel penalty of its own.

To solve this problem, the latest development by Graphite Innovation & Technologies (GIT) is a "hard foul release" coating which was designed to combine the benefits of the ultra-hard coating and the soft foul release products. The new XGIT-Fuel allows shipowners to enjoy the benefits of a hard cleanable surface while obtaining significant fuel savings from its foul release properties without leaching biocides or silicone oils. XGIT-Fuel is specifically designed to be cleaned by most hull grooming methods and water jet pressures. This composite smart coating was built on the recent advancement of graphene as a nano-scale armouring additive. Graphene is well-known for its high mechanical strength, ultra-low friction, and incredible toughness.

	Hard Foul (XGIT-Fuel)	**Soft Foul Release**	**Biocidal/Ablative SPC Antifouling**	**Hard/Ceramic Coating**
Biocide or Leaching Material	None	Silicone oil	Cuprous oxide, Zinc oxide	None
Ability to Clean in Port***	Yes	Yes	No, depends on the port jurisdiction	Yes
Static Immersion at CCBC (Average Surface % Coverage)	4% - Hard fouling	15% - Hard fouling	No data	No data
Suitable Hull Cleaning Equipment	Plastic Scrapers, water-jets, ROV (brush, jets)	Water-jets	Not recommended	Special tooling required for the underwater cleaning
Maintenance &	A layer of primer & a topcoat required	A layer of primer, tie-coat & a top-coat required	A layer of primer & a topcoat required	One layer required
Applied Cleaning Force: (CCBC, Florida)	10KPa - brush 3000 KPa - jet	10KPa – brush 1000 KPa - jet	10KPa - brush	N/A
Paint Damage & Roughness Post-	Jets – no visible damage Brushes – no damage	Jets – no visible damage Brush – mechanical damage	N/A	Polishing effect as a result of mechanical cleaning
Pencil Hardness (ASTM D3363)	>8H	6B	2H	>8H

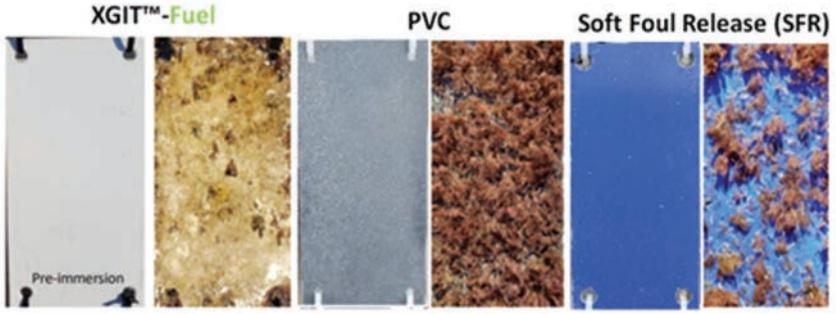


Figure 1: Static biofouling growth of Hard Foul Release (white panel), polyvinyl chloride (PVC) negative control, and a soft foul release coating.

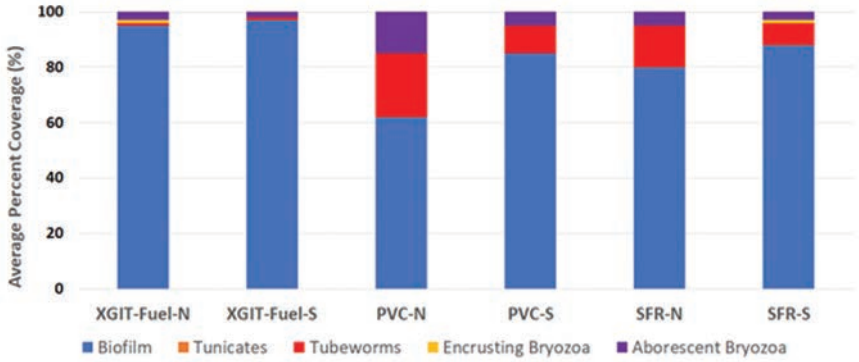


Figure 2: Fouling rate comparison of XGIT-Fuel, PVC, and Soft Foul Release. This table shows a comparative analysis of the leading premium marine coating types based on their cleanability and antifouling performance [6-7].

Scratch Resistance Testing

The pencil hardness test (ASTM D3363) is a simple and universal method to quantify and grade the abrasive resistance of current marine coating technologies and XGIT-Fuel. The pencils are moved at a fixed pressure of 750g and a contact angle of 45° to the panel. The XGIT-Fuel system showed no visible damage at a pencil hardness of 9H, followed by a minor scratch on the icebreaker at 8H and major scratches on each of the soft foul release systems at 8B (the softest pencil lead available).

Static Biofouling growth & Surface Cleaning Performance

To validate the cleanability of XGIT-Fuel as a "hard foul release coating", a series of tests were conducted at the Center for Corrosion & Biofouling Control at the Florida Institute of Technology under the supervision of Prof. Geoffrey Swain. The panels were left stationary for a period of one month and then cleaned using a water jet with a controlled pressure gauge. On the previous page are the results of the newly developed Hard Foul Release coating in comparison with a Soft foul Release system and the PVC negative controls.

Figure 2 displays the average percent coverage of each species of biofouling the North (-N) and South (-S) facing panels were exposed to for the stationary period.

Key Takeaways

The future of biofouling management is moving towards hard coatings that are designed to be cleaned underwater and are neutral to the ocean environment. Using this class of coating, shipowners avoid added cleaning\labour costs during drydock and do not need to replace their coating system due to damage from hull cleanings.

The results above show the efficient abrasive robustness and foul resistant properties of XGIT-Fuel and solidifies the value of this technology in a new class of cleanable hard-foul release topcoats. The coating provides fuel savings through its low hull roughness, low fouling adhesion and improved ability to undergo cleaning and maintenance. The achieved fuel savings using this coating system will lower the cost to shipowners, decrease their environmental impact and improve their bottom line.

Authors

Ryan Ingham is a Master of Applied Science student in Mechanical Engineering at Dalhousie University. **Marciel Gaier**, Ph.D. is CTO; **Mo AlGermozi** is Co-founder; & **ILia Rodionov**, PhD is lead R&D Formulator at Graphite Innovation & Technologies, which is a startup established in Dalhousie University.

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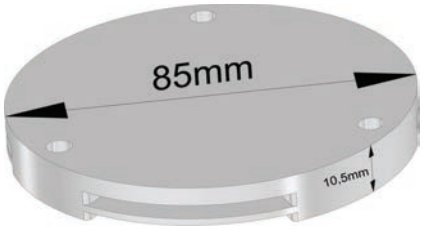
Tech Files

Innovative products, technologies and concepts

Batteries

tmax patents valve for Lithium-Ion Battery Housing for improved safety in the event of fire.

The use of lithium-ion batteries is associated with high thermal risks, an important topic as batteries increasingly pop up in maritime vessel design. With the newly developed and patented pressure compensation and pressure overload valve (PCO valve), tmax provides increased fire protection in case



tmax

of a so-called thermal runaway. Since lithium-ion batteries are currently made primarily with oxidic cathode material due to the high charging density, an ignited fire will continue to supply itself with oxygen. It will keep burning even inside the closed housing, which creates the risk of propagation, i.e. the ignition of other, neighboring battery cells.

Without appropriate measures in the design, the pressure generated inside the housing becomes too high, there is a risk of bursting or a failure of the sealing systems and the highly toxic flue gases can escape uncontrolled. The valve is designed to prevent such an event and instead release the flue gases into the environment in a controlled process once a defined overpressure has been reached.

www.tmaxgroup.com

Damen, Hydromaster Develop New Ferry Thruster

In 2020, Damen signed a contract with Blue Amigo for the delivery of nine passenger vessels to operate on a Dutch ferry service known as the Waterbus. Damen identified that six of the vessels – hybrid carbon fiber water buses that will operate fast, inter-city routes – would require a fully azimuthing, 360-degree thruster to make docking easy and propulsion fast. Damen approached Hydromaster, and the companies joined forces to develop the new thruster. "We had already been working on something that would meet these requirements," said Jan Terlouw, commercial manager, Hydromaster. "A 375kW thruster, able to operate at speeds of up to and beyond 25 knots and durable enough to cover over 4,000 hours each year. But we had never built it." Before that, however, Hydromaster went to MARIN to develop the hydromechanics necessary to produce the thruster. MARIN was able to come up with the solution – a propeller of 840mm diameter with a clearance of 23% diameter from the hull -reducing vibration to a minimum and allowing for increased efficiency. For control of the thruster, Damen has developed in-house a single joystick controller.

Damen & Hydromaster

Kongsberg Debuts New Waterjet Control Systems

Kongsberg Maritime launched a pair of waterjet control systems based on its new JCS (Jet Control System) common technology platform: **JCS Compact** and **JCS Extended**. JCS Compact is a closed-loop control system solution designed to manage the steering, reversing bucket and optional interceptor functions on small- to medium-sized waterjets. It can be used with either one or two control stations and a single or dual waterjet propulsion configuration. JCS Extended applies the same functionality but on a larger, more advanced scale. **www.kongsberg.com**

A high-contrast 2.8" display panel provides steering angle and reversing bucket position. Variable brightness control for direct sunlight and night-time ops.

Kongsberg Maritime

Tech Files

Innovative products, technologies and concepts

Hydrogen

ClassNK AIP for large hydrogen cargo containment system developed by KHI

Kawasaki

Large liquefied hydrogen carrier (cargo carrying capacity: 40,000 m3 x 4 tanks).

ClassNK issued an Approval in Principle (AiP) to Kawasaki Heavy Industries, Ltd for the design of a cargo containment system (CCS) of the world's largest capacity (40,000 cu. m. class per tank) developed for use on a large liquefied hydrogen carrier.

The main features of the CCS announced by Kawasaki are as follows:

1. Enables transportation of cryogenic liquefied hydrogen in large amounts thanks to tank capacity on par with tanks used on large LNG carriers

2. Uses an independent, self-supporting design with a structure capable of responding flexibly to thermal contraction that occurs when loading cryogenic liquefied hydrogen

3. Features a newly developed, high-performance heat insulation system that mitigates boil-off gas (BOG) which occurs in response to heat ingress

4. Designed to effectively utilize BOG as fuel to power the ship, thus contributing to reduced CO2 emissions from liquefied hydrogen transport operations.

classNK.com

PureBallast Deckhouse Solution Gets DNV Nod

Alfa Lava

DNV issued a Type Approval Design Certificate for Alfa Laval PureBallast 3 Ex deckhouse solutions, the first design approval for the installation of ballast water treatment systems on the weather deck, a potentially attractive installation solution for many ship owners and shipyards alike.

According to the manufactuers, placing ballast water treatment systems in a deck-mounted enclosure is necessary on many modern tankers due to lack of a pump room or other suitable internal space. While the system type approval applies to the ballast water treatment system itself, both the enclosure and the installation within it must also be approved by a classification society. The DNV Type Approval Design Certificate means PureBallast 3 Ex deckhouse deliveries will have this approval in advance.

Alfa Laval's approved design includes the deckhouse enclosure itself, as well as the system's internal installation on fixed rails and all of the internal piping and electrical connections. Its specifications go far beyond those of standard containers, which lack the protective features and longevity needed to ensure performance over the vessel lifetime. **www.alfalaval.com**

World First Barge-to-Ship Methanol Bunkering

NYK Line

On May 10, the methanol-dual fueled chemical tanker Takaroa Sun, owned by NYK Bulkship (Asia) Pte. Ltd., a wholly owned subsidiary company of NYK, participated in the world's first barge-to-ship bunkering of methanol fuel. The bunkering of methanol fuel was conducted in Rotterdam port under the leadership of the charterer Waterfront Shipping Company Limited, together with the cooperation of the Port of Rotterdam, Royal Vopak N.V., and TankMatch B.V.

Tech Files

Innovative products, technologies and concepts

Shock

Allsalt Maritime introduces new shock monitoring systems for safer operations at sea.

Allsalt Maritime launched four new Kinetix models, each designed to provide easily assimilated guidance for maritime professionals to operate safely within designated shock and vibration exposure limits, reducing the risk of damage to vessels or injury to occupants.

High speed watercraft and their crews experience severe shock and vibration levels when operating at sea. Vessel hulls, onboard equipment, and, most importantly, human occupants are subject to damage from overexposure to wave impacts caused by abrupt accelerations from unpredictable rough water. Kinetix, a vessel shock monitoring system by Allsalt Maritime, allows maritime agencies to monitor short- and long-term accelerations, investigate high-impact incidents, and predict vessel maintenance intervals.

The Kinetix product line now includes four models, each featuring a marinized sensor network and proprietary analytics software.

AllSalt.com

AllSalt Maritime

Wärtsilä Cargo Handling, Fuel Supply Systems for VLGCs

© Oriental Energy/Wärtsilä Corporation

Wärtsilä will supply the Cargo Handling and LPG Fuel Supply Systems for two new very large gas carrier vessels (VLGC) being built for China-based Oriental Energy, a company mainly focusing on operation of PDH (Propane Dehydrogenation) factories and LPG trading.

The ships are under construction at the Jiangnan yard in China. The order with Wärtsilä was placed in April 2021. The 93,000 cbm capacity vessels are among the largest of their type ever built.

In addition to the Cargo Handling System, Wärtsilä will also deliver its unique LPG Fuel Supply System (LFSS) as an integrated element within the entire gas handling installation.

wartsila.com

KDI: K-Sim ECDIS Cloud-based Training

Kongsberg Digital

Kongsberg Digital (KDI) launched the K-Sim ECDIS, the latest in a line of cloud simulation solutions for the maritime training sector.

K-Sim ECDIS was designed to provide generic ECDIS training in compliance with the requirements laid out in the IMO/STCW Model Course 1.27.

Accessible as an online training solution via the company's digital platform K-Sim Connect, it enables schools and training centers to efficiently provide their students with ECDIS training anytime and anywhere, without the need for major hardware investment.

K-Sim ECDIS' route planning and validation application, K-Sim Planning Station, will be available as a stand-alone system in June this year, followed by a roll-out of the complete K-Sim ECDIS solution by fall 2021.

ksimconnect.com

In the Shipyard

New vessels, contracts and designs

BMT

BMTs design for Isles of Scilly Steamship Company.

Moose Boats

Moose Boats delivers for the Rochester, NY Fire Dept.

UECC

LNG/Battery Hybrid PCTC takes shape in China.

BIDS TO GO OUT TO SHIPYARDS

New Designs for Isles of Scilly Steamship

BMT introduced new passenger and cargo vessel designs to replace older tonnage in the Isles of Scilly Steamship Company fleet. Designed to replace the 44-year-old Scillonian III, a new 72-m Scillonian IV will be designed to carry 600 passengers over three decks @ 18 knots, with anti-roll fins; increased cargo capacity with the ability to carry chilled and frozen goods; and a hybrid propulsion system to reduce emissions.

BMT also unveiled a 45-m dedicated cargo ship to replace the Gry Maritha, designed to sail @ 12 knots, with a 50% increase in cargo capacity and will have a reduced fuel consumption of 55%.

Up next will be discussions with shipyards on potential build programs. International shipbroker Blair Reid, which specializes in the sale and procurement of new ferries, is currently in contact with 32 shipyards across the U.K., Europe and the Far East to acquire Expressions of Interest and to identify potential build slots and build cost.

Moose Boats Delivers Fireboat

Moose Boats delivered a new fireboat to the Rochester, NY Fire Department. The M2-38, dubbed "Marine 1" is the first Moose in the Great Lakes, and is fitted with a roof monitor, a cockpit monitor, a 5-in. large diameter hose Storz discharge, and the ability to pump over 1,500 gpm.The navigation and electronics suite is comprised of three multifunction navigation screens, radar, 3D side scan sonar, AIS, VHF radios, a radio direction finder and a thermal imaging camera. A heavy-duty push knee enables the M2-38 to come in contact with larger vessels and piers.

Keel Laid for PCTC LNG/Battery Hybrid

Construction of the third in a series of newbuild LNG battery hybrid PCTCs for United European Car Carriers (UECC) reached a milestone with keel-laying at Shanghai's Jiangnan Shipyard of hull H2665. This is the third of three ordered, with the first newbuild due for delivery later this year after being launched at the yard last month. With an overall length of 169 meters, a width of 28 meters and a car carrying capacity of 3,600 units on 10 cargo decks, the new vessels are highly flexible, enabling them to accommodate a wide range of high & heavy and breakbulk cargoes, in addition to cars and trucks.Battery power will improve operational efficiency and further reduce emissions through peak shaving, in addition to handling partial accommodation load and driving auxiliary equipment. This will enable them to recharge batteries while at sea using a shaft generator in order to use battery power for maneuvering in ports in line with port requirements to cut emissions. The use of LNG will reduce emissions by around 25% as the fuel emits zero SOx and negligible amounts of particulate matter and NOx.

Stena E-Flexer *Côte d'Opale* Delivered

Six weeks ahead of schedule, the RoPax vessel Côte d'Opale – Stena's fifth E-Flexer vessel from the China's CMI Jinling (Weihai) – was delivered. Stena RoRo signed a long-term charter agreement with DFDS, and the ship, at 214 meters, will become the longest ferry operating in the English Channel. To date, Stena RoRo has ordered nine large RoPax vessels of the E-Flexer type, five of which have now been delivered. Côte d'Opale, measuring 214.5 x 27.8 m with a 6.4-m draft has the the capacity for 120 cars and 1,000 passengers. It will serve the Dover-Calais line as a day ferry. Instead of cabins, there are extra-large areas devoted to activities and passenger comfort. The bow and stern are especially designed to fit the quayside facilities in both ports, and in addition, it is equipped with a third bow thruster to facilitate the many daily maneuvers in port.

Stena

Stena E-Flexer Côte d'Opale delivered.

Mitsubishi Launches *Ferry Kyoto*

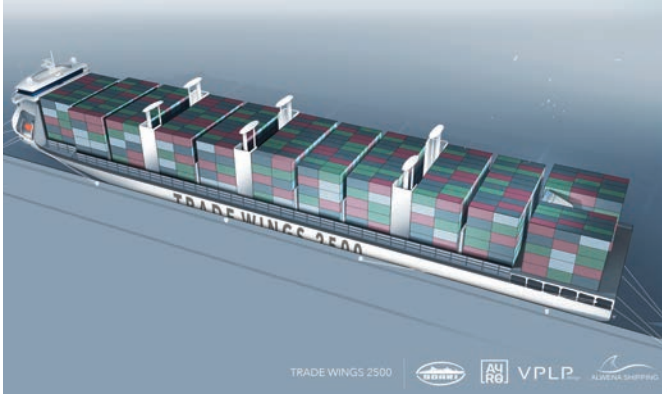
Mitsubishi Shipbuilding Co., Ltd., held a christening and launch ceremony May 13 for the first of two large ferries being built for Japan Railway Construction, Transport and Technology Agency (JRTT) and Meimon Taiyo Ferry Co., Ltd. Delivery is expected in December 2021. The ship is jointly owned by Meimon Taiyo Ferry and JRTT, an Incorporated Administrative Agency to support the provision and maintenance of transport facilities and other infrastructure based on Japan's transport policy. Ferry Kyoto measures 195 x 27.8m and is 20.3m deep, with gross tonnage of approximately 15,400. The largest ship ever operated by Meimon Taiyo Ferry, the vessel has passenger capacity for 675, and vehicle capacity for approximately 162 12-meter trucks and 140 passenger cars. The propulsion plant uses a hybrid-type azimuth propulsion assist method, which combined with an air lubrication system achieves considerable energy efficiencies.


MHI

Ferry Kyoto will be delivered in December 2021.

Bureau Veritas AIP for *"Trade Wings 2500"*

The "Trade Wings 2,500" is a 197 x 32m, 32,500mt containership design with a capacity of 2,500 TEU, designed jointly by VPLP Design, Alwena Shipping, SDARI, and AYRO. The design received Approval in Principle (AIP) from Bureau Veritas. The design fosters the combination of a wind-assisted propulsion with six Oceanwings with an LNG-electric propulsion with pods. The wingsails are installed on a vertical sliding mechanism to retract them partially while the vessel is in port, thus minimizing the impact on cargo operations. The LNG storage tank is based on GTT' Mark III containment system and the LNG power plant is designed with pure gas 4-strokes gensets only. On a typical transatlantic route of 4,000 Nm, the Trade Wings 2,500 is projected to save on average 35% CO2-equivalent emissions compared to a conventional design, with a 2-stroke engine, single shaft and without wingsails, at the same speed.



Bureau Veritas

Ferry Kyoto will be delivered in December 2021.

WIND POWER for VALE

First Ore Carrier Equipped with Rotor Sails; 8% Emission Reduction Anticipated

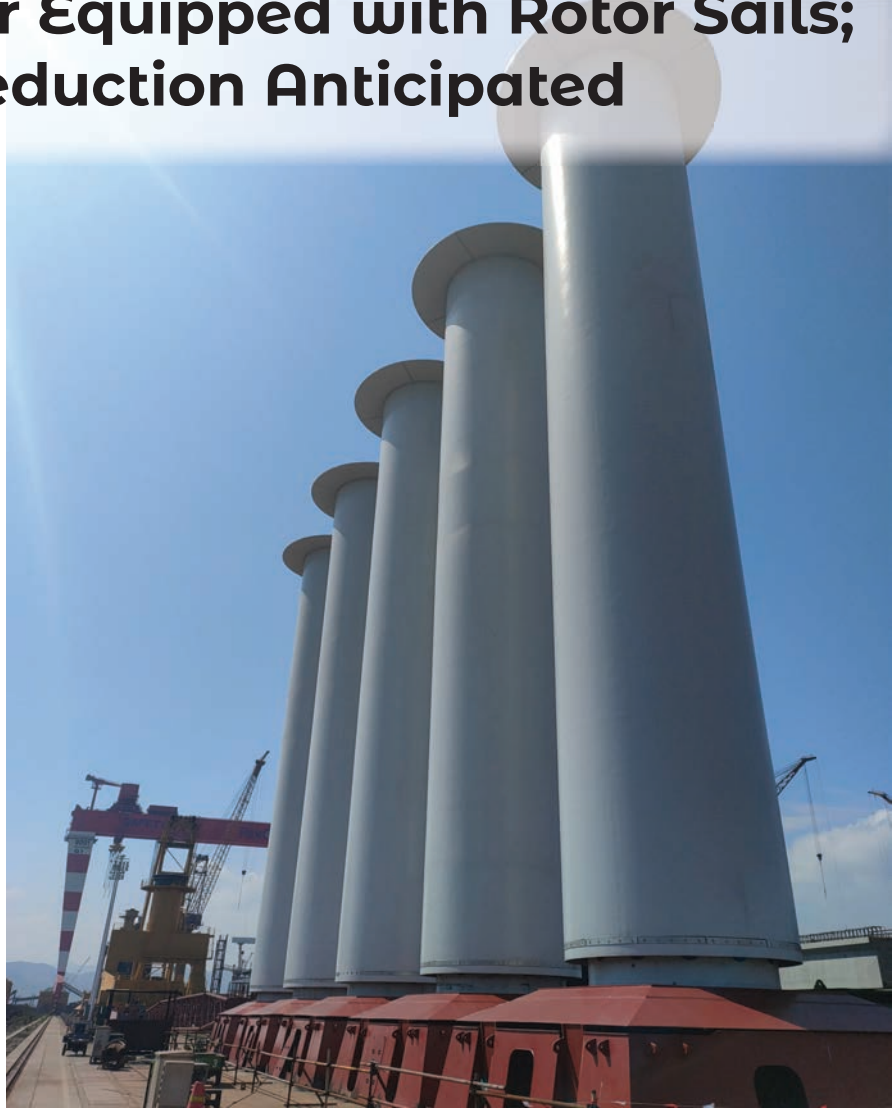
Vale S.A. announced that the first Guaibamax vessel equipped with a rotor sails system at Vale's service started operating. The vessel, with a cargo capacity of 325 thousand tons of iron ore and pellets, has five rotor sails installed, which is designed to allow an efficiency gain of up to 8% and a consequent emission reduction of up to 3.4 thousand tons of CO2 equivalent per vessel per year.

If the project proves to be effective according to design, it is estimated that at least 40% of the fleet at Vale's service will be able to use the technology.

The start of operation of vessels equipped with rotor sails is part of Vale's portfolio of initiatives in shipping, which also includes the Air Lubrication technology and the adoption of multi-fuel vessels.

These actions contribute to achieving the commitment to reduce 15% of net Scope 3 emissions by 2035. Additionally, Vale seeks to reduce its absolute Scope 1 and 2 emissions by 33% by 2030 and achieve neutrality by 2050.

The rotor sails are cylindrical rotors, four meters in diameter and 24 meters high. In contact with the rotating sail, the air starts to move at different speeds along its surface, resulting in a pressure variation that in turn propels the vessel forward, in an effect similar to that of spinning football, tennis and golf balls, which curve in flight, a phenomenon known as "the Magnus effect".



All Photos courtesy VALE

Book Review: *Steaming to Djibouti*

By Captain Sean P. Tortora

The following excerpts are from the new travelogue by **Captain Sean P. Tortora**, titled, *"Steaming to Djibouti…My First Hitch on an Underway Replenishment Ship."* Join a motivated young merchant marine officer on his first journey onboard a venerable navy auxiliary steamship. Accompany him through the convoluted reporting for duty process through his truly surreal first tour onboard. Meet the oddball characters in the crew and follow their outlandish daily routine. Listen in to the truly jaw-dropping crew interactions. Follow along through the myriad of hilarious adventures and astonishing experiences that can only be described as unbelievable. Along the way, you will find yourself alternating between shock and chuckles as you can't wait to see what happens next!

"…Standing on a pier, alone, waiting for a ship... How did I arrive here…? I came into this world Francis Kowalski Natale…

…I stood statue straight in the middle of pier with my suitcase at my right side, my briefcase hanging in my left hand, wearing my chino slacks, blue blazer, tie, and Vuarnet brand cat-eye sunglasses, all the while drenched with perspiration running down my face. I could see the ship making its approach to the pier as I stood there silently waiting, thoroughly soaked to my skin in sweat…

…The ship was the USNS SHINNECOCK T-AOK 1, which was built as an experimental class, loosely based on the design of the U.S. Navy's MISPILLION AO- 105 class of underway replenishment ships built after World War II. At 40,000 tons the SHINNECOCK was 725 feet in length overall, with a beam of 96 feet, and a deep draft of 37 feet. Her 35,000-horsepower steam turbine powered twin screws with a single rudder for a design speed of 25 knots. The ship was painted U.S. Navy haze gray and had a big number "1" on each side of the bow next to the anchors…

…As I stood outside the Captain's office door with the Chief Mate while he knocked, I felt a sense of nervousness combined with a bit of excitement and adventure. Here I was getting ready to meet my first Captain on my first ship as Third Officer… As I prepared to walk into the Captain's office, I contemplated that I always had an idealistic characterization of my first Captain. He would be a maritime academy graduate, maybe even a Ft. Schuyler alum, middle-aged with a weathered look, but very dignified and masculine. He would be well-spoken, witty, maybe even in an aloof sort of way; he would be wearing a neatly pressed uniform with eagles on his collar, clean shaven, with salt-and-pepper colored hair. He would be medium height and medium build and, finally, would be of the utmost intelligence…. With that the door opened, and there sitting in a filthy room, at a desk covered in papers that were in no real order and bedraggled, sat a huge Cro-Magnon-like man. He had the head of a bulldog, with the jowls and frown lines to match, the little hair he possessed was gray and in a comb over, and he had the body of Jabba the Hutt from those Star Wars films. He wore a way too small dingy, food-stained, yellowed under-shirt with rips under his huge armpits. His immense fat rolls billowed out from under his t-shirt. But the worst was yet to see, for when he stood up, as I entered the office, he was not wearing pants; rather, he had on a pair of underwear, briefs at that, the old "tightie-whities." You would think this objectionable mess would have had the decency to, at the very least, wear boxers, being so inclined to go so informally. Nope, not this cretin; he was sticking with the bikini bottoms for men. They were God-awful, stained yellow, with blowouts around the legs and rear, including strategically placed holes.

They were nasty and funky, again with his rolls of fat bulging over the overstretched waistband between where the grimy undershirt ended and his beastly briefs commenced….

…recall the SHINNECOCK, being an old girl, had two Engineers on watch at all times, one at the control board in the engine room proper and another in the boiler room at the boiler's front to direct the Fireman. Engineers have very complicated names for shipboard equipment, which sound extremely impressive and intricate, requiring oodles of skill and knowledge to operate, or God forbid, repair. Of course, any complicated machinery, either actual or just by nature of the name, requires a great amount of overtime to repair…just ask an Engineer. Sometimes I think the Engineers love confusing the Deck Officers with the use of three-syllable gobbledygook machinery terms. Case in point, the Engineers thoroughly enjoy speaking of the intricacies of the air handler or for us mere mortals, the fan. Then there is the purifier, which sounds a bit more impressive than a filter. There is the heat exchanger, when discussing a radiator. The common dimmer switch for a light goes by the moniker rheostat. Fiber- glass insulation is way too easy; better to use the convoluted nomenclature of lagging. These examples are a few of the Engineers attempts to confuse, befuddle, and confound the Deck Officers.

As my watch was progressing without incident, the dial tele- phone rings on the bridge. "Bridge, Third Mate," I belch out.

I then hear the voice on the other end of the line, "Hey, this is the 3rd in the engine room. We are having a problem with the number three air handler."

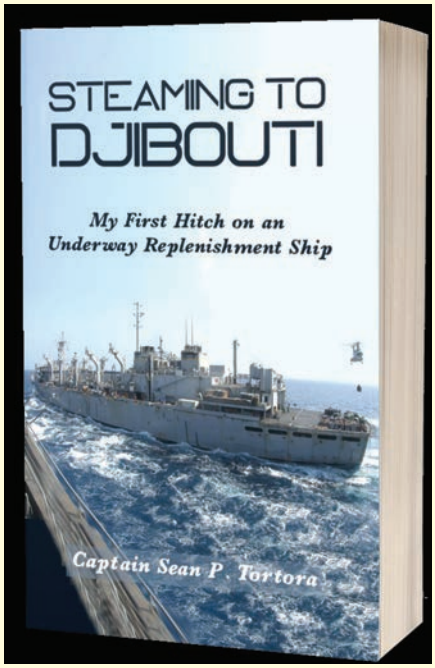
I perk up with this warning, "Is that serious?"

The old 3rd shoots back, "You better let the Captain know."

Now I am fully aware of the (perceived) seriousness and reply, "Ok, I'll let him know, call me when you get it fixed." With that, I hung up the phone and immediately dialed 7-1-1, the number for the Bulldog's stateroom. Even though I knew it was not a good idea to wake the sleeping bear, and he made that quite clear to me on my first watch, I had to notify him of an equipment problem or what I thought was such.

"WHAT DO YOU WANT?" Stone howled into the phone.

"Captain, my apologies, the 3rd just notified me that he is having an issue with number three air handler," I accurately reported. However, there was a distinct silence for what seemed like an inordinate amount of time, and then Stone blew his top, and I literally had to pull the phone receiver away from ear due to the din…"



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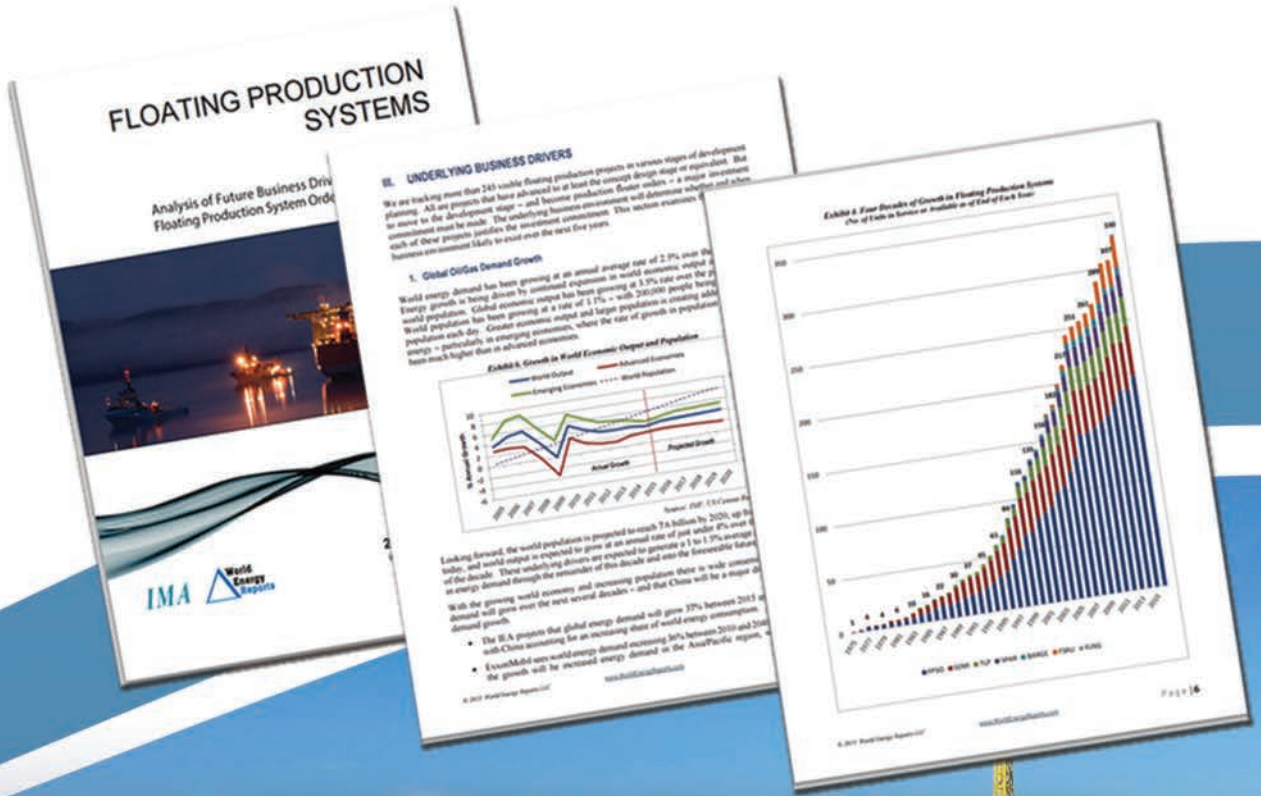

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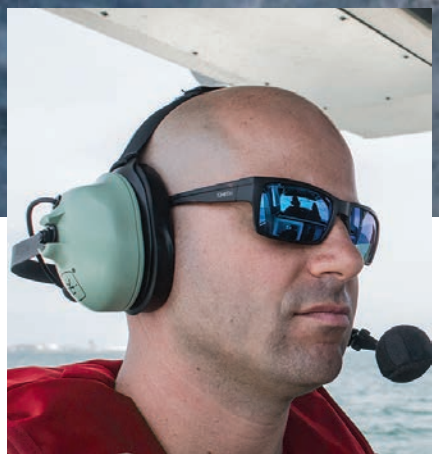

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