September 2020

MARITIME REPORTER AND ENGINEERING NEWS

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A World First
Keppel O&M's conversion of Hilli Episeyo, the world's first converted FLNG, saved around 33% of GHG emissions compared to an FLNG new build.
Photo: © Keppel O&M

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Authors

Bryant

DiRenzo

Ewing

Goldberg

Guild

Kunkel

Mulligan

Nicol

Paschoa

Peter

Stoichevski

van Hemmen

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

DiRenzo
Dr. Joe DiRenzo is the director of research partnerships at the U.S. Coast Guard Research and Development Center. A retired Coast Guard officer, DiRenzo teaches for American Military University and Northcentral University. He is the former Coast Guard chair at the Joint Forces Staff College.

Ewing
Tom Ewing specializrd in energy and environmental topics.

Goldberg
Murray Goldberg is CEO of Marine Learning Systems, maker of MarineLMS.

Guild
Tony Guild, LCDR, USCG, Ret., has been the principle at Maritime Technical Services for the last 12 years. His background in the marine industry stems from his 29-year career with the United States Coast Guard where he spent the first half of his 30-year career as a ship engineer and then the second half as a Marine Inspector.

Kunkel
Robert Kunkel, President of Alternative Marine Technologies, is currently serving as the technical advisor to Coastal Connect, a U.S. company actively developing LNG propulsion as a maritime component of short sea shipping. He is a past VP of the Connecticut Maritime Association, Past Chairman of the Federal Short Sea Shipping Cooperative Program and a member of the ABS Special Committee on Ship Operations.

Mulligan
Tom Mulligan, based in Ireland, serves as Maritime Reporter & Engineering News' science and technology writer.

Nicol
Dr. David Nicol is the director of the Department of Homeland Security Center of Excellence at the University of Illinois – Critical Infrastructure Resilience Institute (CIRI) and a Franklin W. Woeltge Professor of Electrical and Computer Engineering. He is internationally recognized for his work in security policy and analysis.

Paschoa
Claudio Paschoa is Maritime Reporter & Engineering News' correspondent in Brazil. He also writes for sister publications Offshore Engineer and Marine Technology Reporter.

Peter
Commander Brian Peter, USCG (Ret.) retired as a Traveling Senior Marine Inspector from the USCG HQ (2011) after gaining a wide variety of experience as a certified Marine Safety Officer. Commander Peter holds a BS in Nautical Science and Marine Engineering (Kings Point '76), and an MSA (Central Michigan University '09). He earned a USCG Master of Towing Vessels (4 regions), holds a current USCG licenses as Master (Oceans – unlimited tonnage/ STCW) and Second Assistant Engineer (Steam/Motor- unlimited/STCW).

Stoichevski
William Stoichevski began working for the Associated Press in Oslo. William lives and works in Oslo. He started writing for Maritime Reporter in 2014.

van Hemmen
Rik van Hemmen is the President of Martin & Ottaway, a marine consulting firm that specializes in the resolution of technical, operational and financial issues in maritime.

MARITIME REPORTER AND ENGINEERING NEWS

MARINELINK.COM

ISSN-0025-3448
USPS-016-750
No. 9 Vol. 82

Maritime Reporter/Engineering News (ISSN # 0025-3448) is published monthly (twelve issues) by Maritime Activity Reports, Inc., 118 East 25th St., New York, NY 10010-1062. Periodicals Postage Paid at New York, NY and additional mailing offices.

POSTMASTER:

Send all UAA to CFS. NON-POSTAL AND MILITARY FACILITIES send address corrections to Maritime Reporter, 850 Montauk Hwy., #867, Bayport, NY 11705.

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In U.S.:
One full year (12 issues) $110.00;
Two years (24 issues) $190.00

Rest of the World:
One full year (12 issues) $189.00;
two years $228.00 (24 issues)
including postage and handling.

CONTACT INFORMATION:

Email: mrcirc@marinelink.com
Web: www.marinelink.com
t: (212) 477-6700
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Everything you own and operate, everything you build, everything we cover, starts first with an idea. The Marine Design edition is a personal favorite, as I enjoy picking the brains of technologists and innovators for insight and background on how they go about the business of taking an idea from the back of a napkin to the world's waterways.

Rik van Hemmen, president of Martin & Ottaway, has been a regular contributor to our pages, providing a steady stream of thought-provoking articles from his unique perspective. This month the focus of his design feature starting on page 22 discusses the history behind the adoption of the light bulb on ships at sea. While at a glance, with the two-page spread of **Thomas Edison** and some historic looking bulbs, it may appear a simple historical recall. But the core of the feature is on the essence of innovation and effectively navigating the naysayers, whether they be from the regulatory, finance or manufacturing.

Today's maritime industry certainly has its fair share of big problems to discuss, discover and solve, with decarbonization and all that it entails leading the charge.

Simon Tarrant of Lubrizol discusses large marine engine lubrication in our Path to Zero interview starting on page 16. Perhaps more accurately he discusses some of the engine problems ship owners have experienced in the switch to VLSFOs, and some potential solutions premised on more than four years of study by Lubrizol. As the maritime industry collectively trials a long list of alternative fuels, the only certainty is that new problems will arise, new solutions will be offered.

Flip the page to 18 and our interview with **Søren Andersen**, CEO, StormGeo. Andersen comes at the decarbonization issue from a different angle, as StormGeo is a leader in weather routing, with more than 65,000 voyages routed via its system last year alone. Weather routing offers real, quantifiable efficiencies in navigation, with Andersen contending a potential savings of 3 to 10% with the requisite environmental benefits, too. Andersen comes with vast experience from big shipping, but he contends the StormGeo value proposition lies in its ability to deliver real economies in consumption and emissions to small and medium sized companies.

Finally, our cover story this month is an interview with **Chor How Jat**, Managing Director, Conversions and Repairs, Keppel O&M in Singapore. Keppel O&M is working on a conversion project for Golar of an LNG carrier to an FLNG, the second such conversion ever, which offers obvious cost advantages. This project is unique as the companies engaged the services of an environmental consultant to measuyre the Greenhouse Gas emission savings for the world's first LNG to FLNG conversion – the Hilli Episeyo – versus newbuild, and the results are eye-opening. Read more starting on page 34.

Gregory R. Trauthwein
Editor & Associate Publisher
trauthwein@marinelink.com

MARITIME REPORTER AND ENGINEERING NEWS

MARINELINK.COM

HQ
118 E. 25th St., 2nd Floor
New York, NY 10010 USA
T +1 212 477 6700; F +1 212 254 6271

FL Office
215 NW 3rd St
Boynton Beach, FL 33435-4009
T +1 561 732 4368; F +1 561 732 6984

Publisher
John C. O'Malley
jomalley@marinelink.com

Associate Publisher/Editorial Director
Greg Trauthwein
trauthwein@marinelink.com

Vice President, Sales
Rob Howard
howard@marinelink.com

Editorial Contributors
Tom Mulligan - UK
Claudio Paschoa - Brazil
William Stoichevski - Scandinavia

Production
Irina Vasilets
vasilets@marinelink.com

Nicole Ventimiglia
nicole@marinelink.com

Corporate Staff
Mark O'Malley, Marketing Manager
Esther Rothenberger, Accounting

Information Technology
Vladimir Bibik

Subscriptions
Kathleen Hickey k.hickey@marinelink.com

Sales
Lucia Annunziata
annunziata@marinelink.com

Terry Breese
breese@marinelink.com; +1 561 732 1185

John Cagni
cagni@marinelink.com; +1 631-472-2715

Frank Covella
covella@marinelink.com; +1 561 732 1659

Mike Kozlowski
kozlowski@marinelink.com; +1 561 733 2477

International Sales
Scandinavia & Germany
Roland Persson
Orn Marketing AB, Box 184 , S-271 24
Ystad, Sweden
roland@orn.nu; +46 411-184 00

Germany, Austria & Switzerland
Tony Stein
tony.r.stein@btinternet.com
+44 1892 512777

United Kingdom
Paul Barrett
Hallmark House, 25 Downham Road, Ramsden
Health, Essex CM11 1PU UK
ieaco@aol.com; +44 7778 357722

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p. 18

"You've seen Maersk launch the Zero Carbon shipping foundation; but you don't have to be Maersk to reduce your emissions ... you don't have to be Maersk to become more efficient."

Søren Andersen
CEO, StormGeo


p. 34

"Jointly developed ... the concept of using sponsons was an innovative game changer, creating new acreage to house additional equipment on the vessel and segregating the hydrocarbon and non-hydrocarbon systems to meet safe design requirements."

Chor How Jat, Managing Director (Conversions & Repairs), Keppel O&M

"Environmental limits are available which are aimed at reducing underwater noise emissions without imposing onerous design limitations and the need to put damping on every panel, stiffener & dinner plate."

Jesse Spence, President, NCE

p. 42

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Maritime Risk Symposium 2020

Maritime Resilience in Black Swan Events

In 2007, scholar Nassim Nicholas Taleb, who holds a doctorate from the University of Paris, wrote a bestselling book titled "Black Swan," which proposed a theory involving unpredictable events with significant impact. Taleb believed that a black swan event was an outlier with significant impact and, once it occurs, is the source of deep reflection and rationalization.

Since the book's publication, a significant number of research efforts have been developed to consider possible black swan events that significantly impact the Maritime Transportation System (MTS) and the Maritime Global Commons. In April 2020, Marine Money held a webinar series on navigating risk in a "Bevy of Black Swans." Award-winning journalist Terry Macalister wrote about maritime black swans in May 2020 in a global shipping news source. A May 2020 article in *Physics World* provided a framework for learning from black swans.

The global onset of COVID-19 and its impact on the MTS has further heightened a strong need for a rigorous discussion of maritime resilience and black swan events. It has reinforced the fact that the nation's ability to trade internationally depends on the collective maritime infrastructure of ships, ports, the industries that use them or support their use, and the government agencies responsible for their safe, continuous operation. What is at stake is staggering.

According to the Maritime Administration, there are 25,000 miles of navigable channels and 3,500 marine terminals. According to a 2018 report to Congress titled "An Assessment of the U.S. Marine Transportation System," the U.S. marine transportation system annually:

- Moves more than 2 billion tons of domestic and international freight
- Imports 3.3 billion barrels of oil.
- Transports 134 million passengers by ferry
- Serves 78 million engaged in recreational boating
- Hosts more than 5 million cruise ship passengers
- Supports 110,000 commercial fishing vessels and recreational fishing that contribute $111B to state economies.

The risks to maritime infrastructure, along with associated threats, vulnerabilities and consequences, have many facets. That is why, for more than a decade, the Maritime Risk Symposium (MRS) has met annually, bringing together domain experts from the maritime industry, U.S. Coast Guard leadership and researchers from industry, think tanks, government, international stakeholders and academia. An invitation only event, MRS is structured each year around a theme using keynote addresses, invited talks and panel presentations to talk about emerging risks, identify gaps where research is needed, and share experiences with mitigating the risk of particular interest that year. Themes have been diverse, including:

- (2016) Risk in the Western Hemisphere and Southern Border Approaches
- (2017) Coastal Resilience, Cyber-security and Maritime Risk
- (2018) Energy and Maritime Risk
- (2019) Understanding and Managing Risks in the Maritime Transportation System

The U.S. Coast Guard partners with many organizations in addressing pressing maritime issues, and each year one of these partners hosts MRS. Each MRS has crafted a discussion of a vital aspect of risk and risk understanding within the MTS. Proceedings from these events have shaped research in many forms.

In October 2020, MRS will be hosted by the DHS-funded Critical Infrastructure Resilience Institute (CIRI) at the University of Illinois at Urbana-Champaign (UIUC). CIRI's selection as host was made in 2018; owing to CIRI's mission, a theme of Resilience in the Maritime Transportation System was selected early in the planning process. We developed the notion of looking at different attributes of resilience (e.g., robustness, adaptability, recovery) in difference segments of maritime organizations, and began the planning process.

The theme took on new meaning as the COVID-19 pandemic grew this spring, which also led to the symposium becoming a virtual event. MRS 2020 leadership saw a unique opportunity to shape MRS 2020 to enable reflection and thought on the general issue of maritime resilience in so-called black

swan events, using the experience of COVID-19 as a driver for thinking about maritime resilience for future black swan events, not just the pandemic.

The MRS 2020 planning committee embraced this notion, and the program of MRS 2020 has taken shape. MRS 2020 has developed panels of experts to discuss resilience in infrastructure, the human element, the supply chain, cyber-security, inland waterways, lessons from recent disasters and energy … all through the lens of black swan events. The virtually offered program will be held Oct. 26-30, with around four hours of keynotes, panels and student poster presentations each day. In addition, MRS 2020 will also host a USCG Strategic Evergreen analysis event Oct. 29-30, leveraging the unique perspectives of those attending MRS. The Evergreen Program is the Coast Guard's Strategic Foresight Initiative, tasked with looking over the horizon to inform current planning and better prepare the Coast Guard for an uncertain and unpredictable future.

Finally, this year's event will also feature expanded engagement for students. The annual poster contest is open to undergraduate, graduate and doctoral students. In addition, arrangements are being made for students to engage with some of the key participants in virtual Q&A sessions, offering access usually not available in international events like this.

For more information on the 2020 MRS agenda and student poster contests, please visit: **https://ciri.illinois.edu/events/11th-maritime-risk-symposium-2020**

Here is a link for the MRS registration can be found at the MRS webpage: **https://ciri.illinois.edu/events/11th-maritime-risk-symposium-2020**

The Author

Nicol & DiRenzo

Dr. David Nicol is the director of the Department of Homeland Security Center of Excellence at the University of Illinois – Critical Infrastructure Resilience Institute (CIRI) and a Franklin W. Woeltge Professor of Electrical and Computer Engineering. **Dr. Joe DiRenzo** is the director of research partnerships at the U.S. Coast Guard Research and Development Center. A retired Coast Guard officer, DiRenzo teaches for American Military University and Northcentral University.

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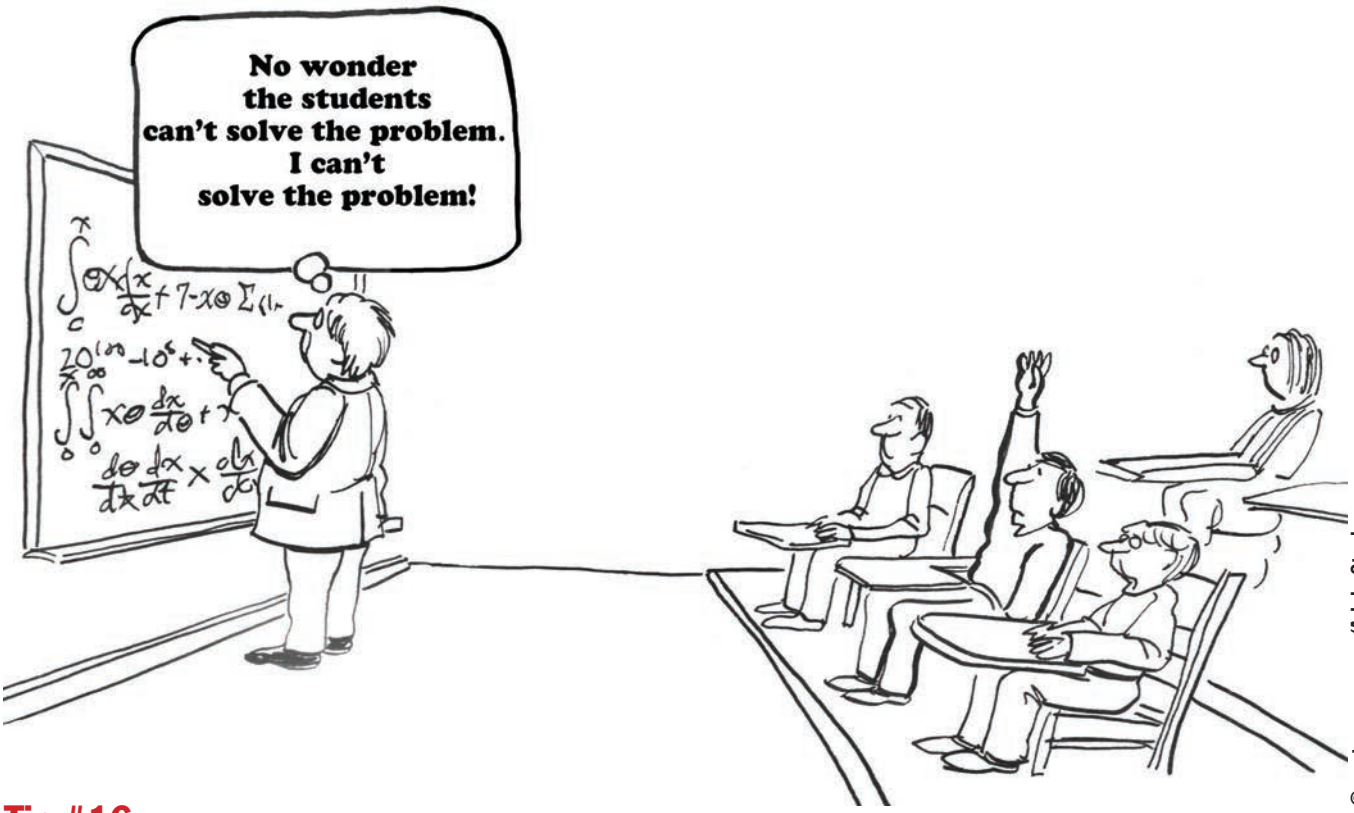

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Tip #16

Using Student Exam Results to Measure OUR Performance – Part II

In last month's Training Tips for Ships, we began the discussion of how we can look at our existing training data to measure our success as trainers and training organizations. The data in question are the results from the multiple-choice exams we deliver to our trainees. We deliver these exams all the time, and we gather a tremendous amount of data (answers) over the years. Yet typically we only use that data to determine whether our trainees have gathered the knowledge we are trying to impart. There is so much more we can do. It is time to look at this data from a different perspective: to evaluate OUR performance.

In practical terms, these analyses will be difficult if you deliver paper-based exams, but easy to do if you deliver exams online and can download the responses into a spreadsheet. It is even easier if your LMS automatically supports the generation of these metrics. Thus if you deliver paper-based exams it may be time to consider adopting an LMS or some other simple online exam delivery tool that allows you to download the responses.

In the previous article we looked at two simple, but remarkably useful ways to slice and dice the data to reveal hidden indicators of learning, performance and even safety. The first was to report on the performance of questions grouped by the competency they cover. The second was to use the data to identify common misconceptions and misunderstandings held by our employees. In this edition of Training Tips for Ships we will add some additional ways of looking at our data to help determine the health of our training program.

One of the simplest approaches to looking at multiple-choice exam responses is to determine, on average, how well each question is being answered. This is easy to do and the value is immediately apparent as it allows us to identify those questions which are being performed poorly across the organization. Once we have this data then the next step is to determine

whether there is an issue with the question or an issue with the training delivery that the question is related to.

Another metric to look at is how long trainees spend, on average, answering each question. This can be highly revealing; a question with a long dwell time may indicate that the question is difficult to understand (which requires attention) or that it simply requires deep consideration. Looking at this coupled with the performance of that question can help determine the difference between the two and guide any needed updates to the question or the learning materials.

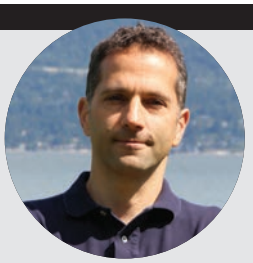
Finally, a similar metric is whether the trainee selected their final answer for a question as their first 'click', or first selected one or more previous choices before settling on their final answer. Some LMSs and exam delivery systems record and report on this information. This reveals information about how certain the trainee felt about their answer. If they were less certain they are more likely to have equivocated about their response. Like the previous metric, it may be that questions which exhibit more of this equivocation are difficult to understand or it could be that the associated learning materials are ineffective. Either way, it says something about our training and assessment and needs to be evaluated by a trainer.

In practice, an excellent approach is to gather these metrics along with those outlined in the previous edition of Training Tips for Ships as part of a continuous improvement program for training. Metrics can be gathered and evaluated once or twice per year, and corrections put in place to address those issues found. The next time they are gathered we can look at how the metrics have improved (or degraded), and another round of targeted improvements can be made. This regular, ongoing approach helps keep the training team focused on identifying training issues, early indicators of safety, and optimal training outcomes.

Thanks for reading, keep healthy, and sail safely!

The Author

Goldberg



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

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U.S. Cabotage Summary

The United States domestic maritime sector recently celebrated the 100th anniversary of the passage by Congress of the Jones Act. It is considered the most significant of various US cabotage laws. Few mariners though appreciate the long history of cabotage laws in this country.

Cabotage laws here are older than our nation. The British Navigation Acts and its predecessors were designed to develop, promote, and regulate British ships, shipping, trade, and commerce between other countries and with its colonies, including the restriction of foreign participation in its colonial trade. Later the goal of generating revenues from the colonies was added as a purpose of the Navigation Acts. This was done by prohibiting the colonies from exporting certain products to foreign nations and requiring the purchase of other products from Britain or British colonies. For example, molasses and later sugar could only be legally imported into the North American colonies from the British West Indies, even though these products could be purchased at a much lower price in the French West Indies. Such actions created dissention in the North American colonies, as well as increased smuggling, and were factors that led to the American Revolution.

Despite independence, the Navigation Acts found a permanent home in the new United States. The second law adopted by the First Congress imposed duties on numerous goods, wares, and merchandise imported into the new nation. The duty was lower if the imports were carried on vessels built in the United States and belonging to citizens thereof. The third law adopted imposed tonnage duties on ships in US waters, but again the duties were lower for vessels built in the United States and belonging to citizens thereof. The same Congress later adopted laws for registering vessels of the United States and for regulating the coastwise trade and for the government and regulation of seamen serving on vessels of the United States. Registered vessels were required to be wholly owned by citizens of the United States and the master was required to be a US citizen. The registry for vessels sold foreign was required to be surrendered. Another law imposed a significantly higher duty on foreign vessels trading between Customs districts than that imposed on vessels of the United States.

The Second Congress required ships of the United States to be commanded by US citizens. Foreign vessels captured in war and lawfully condemned as prize or adjudged to be forfeited for breach of laws of the United States and acquired wholly be US citizens were entitled to be registered as vessels of the United States. Another act provided for the enrollment of vessels of the United States and their entitlement to engage in the coasting trade or fisheries. Like registered vessels, enrolled vessels were required to be wholly owned by citizens of the United States and the master was required to be a US citizen. An enrolled vessel could not proceed on a foreign voyage until it had surrendered its enrollment and replaced it with a certificate of registry. Registered vessels could engage in the coasting trade, but if they carried goods, wares, or merchandise of foreign growth or manufacture, they were charged a higher duty.

In 1804, subsequent to the ratification of the Louisiana Purchase, foreign vessels coming up the Mississippi River were required to unlade in New Orleans. This effectively stopped all foreign vessels from operation on the Western Rivers upstream. In 1812, as an exception to prior law, steamboats owned wholly or in part by aliens resident in the United States were allowed to be enrolled and licensed, so long as they operated only in US bays and rivers and a bond of $1,000 was paid by the owner or owners. When the War of 1812 broke out, the duty on imported goods and merchandise was raised to 100%, with an addition 10% duty on goods and merchandise imported on foreign vessels. Also, the duty on foreign vessels calling in US ports was raised.

In 1813 a law was adopted, to enter into effect when war with the United Kingdom ended, making it unlawful to employ on any vessel of the United States persons other than citizens of the United States or persons of color or natives resident in the United States, except that masters in foreign ports were authorized to hire foreign seamen if there was a deficiency of US seamen in that port. This law, amended many times, remains in effect to date.

Commencing in 1817, the officers and at least three-fourths of the crews of vessels engaged in the fisheries were required to be citizens of the United States. The law also imposed a duty of fifty cents per ton for vessels of the United States, except for licensed vessels, engaged in transporting goods, wares, or merchandise from one state to a non-adjacent state. In 1819, the coasting trade law was amended to establish two ‘great districts’ – one on the east coast (and waters pertaining thereto) and the other on the south coast (and waters pertaining thereto). Vessels licensed for the coasting trade

were allowed to so trade within their particular 'great district'. Vessels could be separately licensed to trade between the 'great districts'.

In 1825, enrollments and licenses for steamboats owned by incorporated companies was allowed for the first time. The enrollment or license was to be issued in the name of the president or secretary of the incorporated company. The president or secretary was required to swear or affirm that no part of the steamboat had been or was then owned by any foreigners.

In 1830, tonnage duties were abolished as regards vessels of the United States and vessels of foreign nations that likewise exempted US vessels. This remains the current US practice.

In 1848, yachts used exclusively for pleasure purposes were authorized to be enrolled as American vessels and could operate between ports of the United States without making entry.

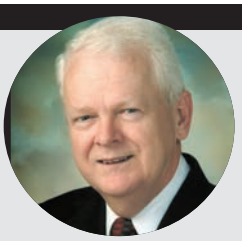
In 1886, foreign vessels transporting passengers from one US port to another became subject to a fine of $2 per passenger so landed. In 1898, this act was amended to increase the fine to $200 per passenger. The 1898 statute also explicitly prohibited foreign vessels from transporting merchandise laden in one US port to another US port either directly or via a foreign port under penalty of forfeiture.

The Shipping Act of 1916 provided that no corporation, partnership, or association could be deemed a citizen of the United States unless the controlling interest therein is owned by citizens of the United States and, with respect to corporations, the president and managing directors are citizens of the United States and the corporation is organized under the laws of the United States or a state thereof. In 1918, this law was amended to provide that the controlling interest of a corporation shall not be deemed to be owned by citizens of the United States: (a) if the title to a majority of the stock thereof is not vested in 'such citizens free from any trust or fiduciary obligation in favor of any person not a citizen of the United States ; or (b) if the majority of the voting power in such corporation is not vested in citizens of the United States; or (c) if through any contract or understanding it is so arranged that the majority of the voting power may be exercised, directly or indirectly, in behalf of any person who is not a citizen of the United States ; or (d) if by any other means whatsoever control of the corporation is conferred upon or permitted to be exercised by any person who is not a citizen of the United States.

The Merchant Marine Act, 1920 (popularly known as the Jones Act) was adopted consolidating and updating many of the statutes mentioned above. The Jones Act has been revised numerous times, expanding the cabotage laws to apply to such activities as dredging, salvage, and towing. In 2006, the Act to complete the codification of Title 46, United States Code repealed the uncodified portions of Title 46, including the Jones Act and the other cabotage laws and consolidated them into the United States Code. Judges, maritime lawyers, and members of the maritime community continue to refer to the cabotage laws as the 'Jones Act'.

In summary, cabotage laws have been part of the fabric of the United States from the beginning. Ironically, the British Navigation Acts, the progenitors of our cabotage laws, were repealed in 1849 under the influence of a free trade philosophy.

The Author



Bryant

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

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New Fuels, New (Propulsion System) Concerns

Lubrizol's Simon Tarrant discusses optimizing large marine engine lubrication.

As the marine industry seeks solutions to meet new and ever-tightening emission regulations in the run up to 2050 and the IMO plan to reduce Greenhouse Gas Emissions (GHG) 50% from marine engines, engine lubrication oils and additives take center stage in the quest to keep engines running smoothly, efficiently and effectively. New fuels mean new challenges, as the potential switch to LNG, Methane, Hydrogen, Ammonia, Biofuels – or some other yet-to-be-discovered derivative – stress the capabilities of modern engines and materials which have been designed to run for more than a century on fossil fuels, primarily liquid diesel.

Lubrizol has some interesting insights, having started an intensive R&D initiative nearly four years ago. "Our work began in 2017 when we embarked on research to understand the characteristics of the IMO 2020 compliant fuels, which we all know now are or very low sulfur fuel oil (VLSFO)," said Simon Tarrant, Global Business Manager on Large Engines, Lubrizol. "That research aimed to understand what effect VLSFOs would have on engine operation in conjunction with the cylinder lubricants. It looked at how existing lubricants in the market would perform, and whether any different performance would be required."

Specifically, at the start Lubrizol examined several new fuels that were available," said Tarrant. "We blended some specific in-house mimics, to determine what the blend variability would be, which helped us address what was widely reported across the industry on expected fuel variability."

Those lab and engine tests corroborated the greater degree of variability in the fuels, and their propensity to cause deposit formation from the combustion characteristics among those VLSFOs. The R&D effort led to adapting some existing testing and the creation of new proprietary protocols aimed at including VLSFOs in combo with the lubricant to ensure there was good additive lubricant and additive screening.

"The results indicated how existing lubes on the market would struggle to provide adequate performance when using VLSFOs," said Tarrant, "and where new additives designed for IMO 2020 can effectively reduce the impact of adverse fuel combustion deposit issues through rebalanced detergency, novel dispersancy chemistry delivering a robust solution to enhance deposit control and maintain engine durability."

'Maintaining engine durability' is tops on any shipowner's mind,. "There are multiple reports from ship owners and in-

Lubrizol

Watch Simon Tarrant on MR TV:
www.marinelink.com/videos/video/future-marine-fuels-and-large-engine-lubrication-challenges-100417

"There are multiple reports from ship owners and industry organizations of piston deposit issues as well as liner scuffing, with one of those reports pointing toward the legacy lubricants as being the issue."

Simon Tarrant
Global Business Manager on Large Engines, Lubrizol

dustry organizations of piston deposit issues as well as liner scuffing, with one of those reports pointing toward the legacy 40BN lubricants as being the issue," said Tarrant. "If I go back to the finding from (Lubrizol's) early studies, we were able to reaffirm that those existing legacy lubricants would not be adequate to provide protection required, and that more advanced solutions were needed to tackle those problems without returning to higher BN lubricants."

Tarrant said that using those higher BN lubricants does, in the short term, aid piston cleanliness, "but long-term use can and does lead to over-lubrication issues that manifest additional problems, such as turbocharger deposits and wear, as well as after-treatment deposit fouling."

That research clearly showed a link between piston cleanliness deposit and the lubricant's ability to cope with that combustion phenomena from the VLSFOs. "In the case of scuffing, there could be a number of factors involved, and investigation is required to understand the root cause," said Tarrant. "Once the root cause is fully understood, appropriate robust wear protection within additives, can and will be used to combat those (issues)."

Future Fuels

"The shipping industry is clearly looking toward new alternative fuels as a key solution in moving toward decarbonization," said Tarrant. "Each alternative fuel will likely have different inherent characteristics, and will likely manifest differently in the engine operation, particularly the combustion cycle." Lubrizol is not conducting its investigations in a vacuum – and is the first lubricant additive technology supplier to join the Getting to Zero Coalition, an international group composed of more than 100 organizations aiming to drive the development of commercially viable, zero-emissions deep-sea ships by 2030. As OEMs look to increase efficiency performance and/or accommodate alternative fuels, engine designs will change. New hardware modification, as well as new materials. "We must consider the impact this will have on the lubricant performance requirements," said Tarrant. "Lubrizol's R&D in understanding these various phenomena will allow us to formulate lubricant additives enabling necessary wear protection. This will be the case for whichever alternate fuels make up the palette of options being explored ultimately to replace fossil-based liquid diesel of today."

"It's my dream job"

One-on-one with Søren Andersen, CEO, StormGeo

When Søren Andersen took the helm at StormGeo in September 2019, it was the self-confessed "dream job" for the 23-year shipping industry veteran. Andersen came with leadership experience from the likes of A.P. Møller – Maersk, APL, and Rickmers, among others, bringing to StormGeo inside experience on how ship owners can modernize practices and procedures to quantifiably cut emissions and fuel costs. "What I saw in StormGeo was a company with the opportunity to enrich the shipping industry," said Andersen, at a time when maritime is ripe for the implementation of advanced analytics and digital transformation. "Today, we are behind the curve." Being 'behind the curve' is not entirely the fault of shipowners, rather the hard cyclical nature of the business itself: When business is great, companies don't necessarily have the time to stop, strategize and invest in the future; when the market is in the doldrums, companies have neither the appetite nor the funds to invest in the future.

"You don't have to be Maersk to reduce your emissions"

StormGeo is a Norwegian company, started in 1997 in Bergen and enjoying steady growth, today with 24 offices and more than 500 people globally, a leader in weather intelligence and advanced data science, powered by seven forecast centers globally available 24/7/365. Being Norwegian means maritime is tightly interwoven into its DNA, and today Andersen said it counts on the maritime industry for nearly 65% of its $80 million+ per year in turnover.

"For weather routing, we have seen savings ranging from 3-10 percent," said Andersen. "The IMO says there is approximately three percent efficiency savings to be gained through weather routing, but in our experience it is often higher."

While digital technologies have enjoyed a solid run in recent years in maritime, this (mostly) has been powered by the handful of corporate behemoths that have the funding and the ultra-long-range vision to invest in bespoke solutions. While being large and well-funded does not hurt, Andersen said that "You don't have to be Maersk to enjoy efficiency and fuel savings. StormGeo is that partner that can help small to mid-size companies enjoy the efficiency benefits of larger companies."

At StormGeo the core is weather routing, and StormGeo routes more than 65,000 voyages per year, "far more than any one shipping companies could do; we are the experts in routing," Andersen boasts. But while weather routing is the core, it is just one piece of the platform, one tool in the toolkit to help vessel owners better manage fleet emissions, fuel efficiency and safety, too.

StormGeo

Watch Søren Andersen on MR TV:
www.marinelink.com/videos/video/weather-routing-drives-maritime-efficiency-safety-100418

"Efficiency is all about human behavior ... Our platform helps to drive that efficient behavior."

Søren Andersen
CEO, StormGeo

Andersen said the key differentiator for StormGeo is its ability to build, maintain and extend a common shared platform, so that the chief engineer, the captain and lead navigator, the vessel operator and even the chartering department can see and share the same operational picture. "Efficiency is all about human behavior," said Andersen. "Our platform helps to drive that efficient behavior."

"For smaller companies, a system has to be easy to implement. Often getting hardware on board is a delaying factor, so a light touch is important. We are hardware agnostic, and we can cooperate with any other systems," said Andersen.

"This allows customers to apply advanced solutions in a simple manner. We offer a fully holistic approach. Customers can do all their route planning on one seamless system, from planning to execution. And the ship shares the same information with onshore personnel, so everyone experiences the same shared reality."

The challenge for companies looking to take the 'digital leap' is to realize that it is not really a leap at all, rather one step at a time. "You have the big companies, you've seen Maersk launch the Zero Carbon shipping foundation; but you don't have to be Maersk to reduce your emissions … you don't have to be Maersk to become more efficient," said Andersen. "That's why we exist; we offer smaller companies without the resources access those efficiencies. There is no hardware to install to access our services. We can download and 'switch on' (nearly) overnight."

The future is now

The maritime industry historically has been reactive, waiting for legislative mandate to demand change. While there is no sign that this will ever change, Andersen said that if it doesn't, regulations will become increasingly draconian.

To that end, he envisions an industry where disparate players will gravitate to a few select sources for information, and he's helping to build StormGeo to be one of the main players in the field. It all starts with data. "Secure data sharing platforms that facilitate convergence and cooperation between players are becoming more common," said Andersen. Creating the platform is not a small job, said Andersen, noting that StormGeo has a team of more than 50 developers continuously working on the platform.

The goal: achieving a shared platform in five years with ports, ships and shippers all sharing the same tools. It won't be easy, said Andersen, as the stakeholders still today are stuck in traditional roles, not always eager to share information liberally. "The challenge is to continue building that platform so that it is better and better. There is so much opportunity for change in the marine industry, and StormGeo can be a catalyst."

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Standalone Rmp System that has (4-20 ma output) to the bridge and or control room to our touchscreen. Total, revolutions, direction and instantaneous Rpm for Maneuvering, Shaft Stop (optional) specific fuel consumption. Local and remote touchscreen bridge and control room viewed by 3.5" or 7 in" typical.

Shaftmaster saved Data:

• Shaft Rpm • Shaft Torque • Shaft Horsepower • Shaft Kilowatts • Shaft Newton Meters
• Shaft Stop screen • Shaft Fwd and Rev • Shaft Manuvering to give immediate Rpm
• Total Shaft Revolutions • Total engine time • Instantaneous RPM and Horsepower
• Average Rpm and Horsepower • Instantaneous Kilowatts • Average Kilowatts
• Average NM • Data recording on Micro SD Chip is especially great for seatrials
• Specific Fuel Consumption (Optional)
• Shaftmaster displayed at local and remote touchscreen

Partnering on the Digital Ship

Inside Denmark's ShippingLab

Denmark's ShippingLab project is a three-year initiative that commenced its work in March 2019 with the aim of developing the first fully commercially operational, fully digital, autonomous and environmentally friendly ship. There are almost 30 partners working together within ShippingLab, which is coordinated by the Danish maritime cluster, Blue Denmark. A lead partner is The Automation and Control Group within the Technical University of Denmark's Department of Electrical Engineering which has researched autonomous systems for the past 25-30 years focusing on diverse application domains including marine craft. Around 2010-2011, in collaboration with the Royal Danish Navy, the group started a series of projects looking into the development of control and perception algorithms for achieving unmanned operation of a high-speed waterjet. Over a period of four to five years, this collaboration produced significant know-how on the challenges connected with object detection and classification during navigation, and it qualified the group to scientifically steer an investigation promoted by the Danish Maritime Authority, the Electronic Outlook project (2017-2019), to evaluate the potential of electro-optical sensing devices as complementary means to increase the awareness of the navigator. One year into this investigation additional funding was raised to perform research on methods and algorithms for developing solutions as part of the Autonomous Situation Awareness for Navigation (ASAN) project, which runs from 2018-2021.

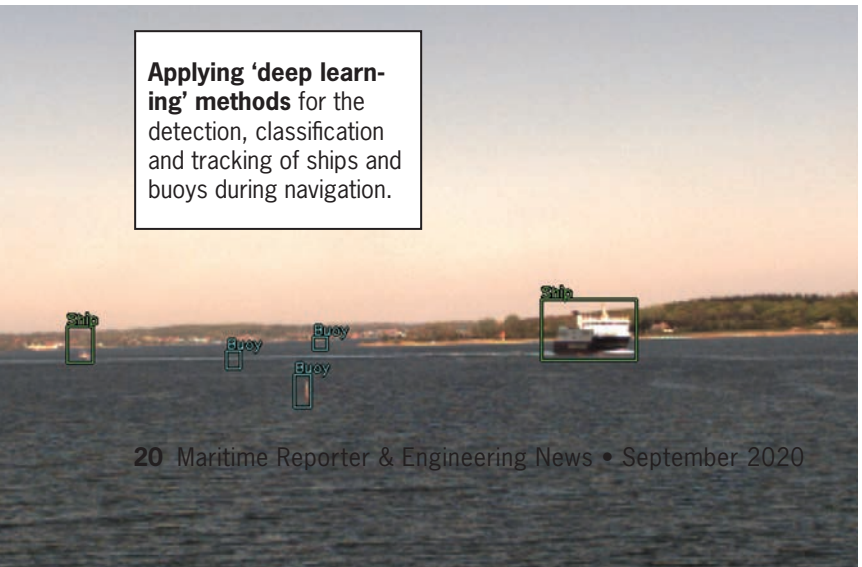
"ShippingLab was actually initially established in the fall 2017 as an innovation forum aiming at creating and developing R&D ideas with the ultimate purpose of making Denmark a global maritime power hub, as envisioned by the Plan for Growth in the Blue Denmark cluster launched by the Danish Government at the beginning of 2018," said Associate Professor Roberto Galeazzi of the DTU Automation and Control Group. "Three main research drives were the focus: digitalization, autonomy and decarbonization. The ShippingLab forum was set up thanks in a collaboration between Danish Maritime, Danish Shipping, Force Technology, Maritime Engineering DTU, CBS, the Danish Metalworkers Union and the Danish Maritime Authority."

Full-scale Autonomous Operation

Based on ongoing research efforts by Professor Mogens Blanke, Associate Professor Galeazzi and Associate Professor Søren Hansen, a proposal was made to set up an innovation project for the development and full-scale demonstration of functionalities/systems for the autonomous navigation and supervision of passenger ferries in Danish waters.

"In particular the core idea was to develop advanced tools for autonomous navigation and decision support by exploiting state-of-the-art electro-optical sensor technology and methods in sensor fusion, AI and control theory to enable vessels to operate with a partly unattended bridge," explained Galeazzi. "Based on this idea, DTU succeeded in gathering a strong network of industrial stakeholders from the Danish maritime cluster that shared the vision of demonstrating the autonomous ship in Denmark."

The focus on ferries was inspired by the geographical composition of Denmark, a country characterized by many small islands with rather limited connectivity with the mainland. It was envisioned that autonomous ferries could, in the short to medium term, improve transportation at sea since reduced manning on a single ferry could generate more passages by redistributing personnel. In the long term, it was anticipated



Applying 'deep learning' methods for the detection, classification and tracking of ships and buoys during navigation.

A TUCO Marine support vessel taking part in tracking systems testing in Faaborg, Denmark in December 2019.

that new business models could be enabled by autonomy, such as the 'ferry-on-demand'.

"Autonomy and digitalization will radically transform the maritime sector by improving vessel and fleet performance, increasing crew, cargo and vessel safety, supporting decarbonization, changing maintenance policies from periodic to predictive, and introducing new business models, to mention a few of the benefits," said Galeazzi.

Systems for autonomous situation awareness could have a large impact on the shipping industry in terms of increased safety during navigation in harsh weather conditions as well as at nighttime, when visibility is limited. Such systems could be widespread in the global fleet to help the officer on watch monitor the overall situation around a ship and significantly reduce the workload in challenging sailing scenarios with heavy weather and multiple vessel encounters.

"Systems for collision avoidance could also be developed and benefit the navigator," said Galeazzi. "The integration of these systems on board vessels do not imply unmanned operations, but they will give the crew improved actionable information enabling them to take decisions, and this will possibly help reduce workload, fatigue and stress."

Partly and fully autonomous solutions are likely to first find application in vessels for port, coastal and offshore operations, and here the potential market could be large: short-sea shipping, coastal ferries, small RoRo vessels, tugboats, supply vessels for offshore operations, and boats for firefighting.

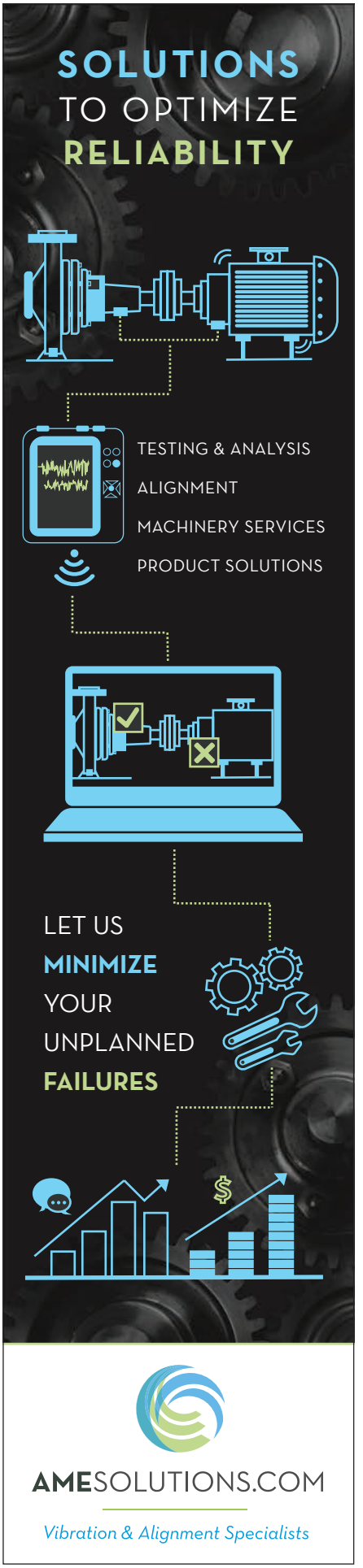
"Autonomy in these cases will once again increase safety by removing humans from dangerous environments, diminish energy consumption, and standardize operations. Digitalization in the form of, for example, advanced condition monitoring of vessel machinery systems can provide vessel owners with a large amount of information and give operation and maintenance companies information about how the vessel is operated, enabling more efficient and possibly cheaper maintenance," said Galeazzi.

"A more digitalized ship is potentially a more transparent ship in terms of, for example, emissions, and the public may have more powerful instruments to confirm compliance with environmental regulations," said Galeazzi. "Society can certainly benefit from the real creation of the autonomous ship."

A sensor platform acquiring data during navigation. The platform is equipped with two color cameras, two monochrome cameras, an infrared camera, FMCW radar, a GNSS receiver and an inertial measurement unit (IMU).

PhD students participating in the testing of sensing technologies in Faaborg, Denmark in December 2019.

All Photos Courtesy DTU



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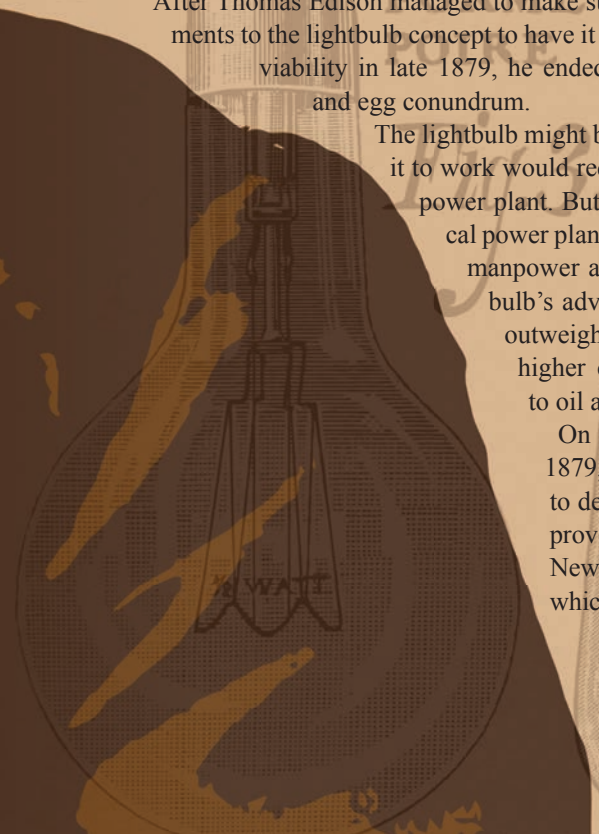
Columbia *Lighting* the World;

How Classification Can Make a Difference.

By Rik van Hemmen



I don't remember when I discovered that the first application of lightbulbs occurred at sea rather than ashore. But when I dug a little deeper into the subject recently, I came across an interesting set of coincidences that shows how innovation often relies on simply doing, rather than endlessly talking about it.

After Thomas Edison managed to make sufficient improvements to the lightbulb concept to have it show commercial viability in late 1879, he ended up in a chicken and egg conundrum.

The lightbulb might be great, but to get it to work would require an electrical power plant. But to run an electrical power plant takes money and manpower and then the lightbulb's advantages would be outweighed by its much higher cost as compared to oil and gas lamps.

On New Year's Eve 1879, Edison decided to demonstrate his improved lightbulb at his New Year's Eve party, which was attended by Henry Villard, President of the Oregon Railroad and Navigation Company. Mr. Villard saw the light (pun intended) right away, not for his house or some other land-based application, but, instead, for his new steamer, the SS Columbia that was under construction in Chester, Pennsylvania.

I have no record of Mr. Villard's thinking, but if he were familiar with passenger ship operation at all, he knew that lighting was a major nuisance, risk and manpower drain aboard ships. Every light in every cabin, passageway and workspace consisted of oil lamps. These lamps needed to be lit, wicked, refilled and doused by crew every night and they smoked, smelled and were a fire hazard. Aboard a ship the addition of an electrical power generator in the engine room would be an almost trivial investment and could be easily managed by the propulsion plant crew during normal watch standing. Villard had found the killer app for lightbulbs.

He very quickly ordered an Edison lighting system for installation on the new vessel. Thomas Edison accepted the order, but reportedly was not terribly enthusiastic about it. I have not been able to establish why, but these lightbulbs were quite delicate and, quite possibly, he was concerned that the ship movement would damage them and damage the reputation of the new system. Still, somehow, Edison agreed, but then the ship builder, John Roach, refused to install the system thinking it was a fire hazard for which he did not

want to take the risk.

It was also rumored that the vessel would not be able to obtain insurance, but this was being dealt with by building to class rules both to BV and the American Ship Master's Association rules, the forerunner for ABS. A big player at the American Ship Master's Association was Francis A. Martin who joined the Board of Captains in 1875 and was the Chief Examiner and New York City surveyor for underwriters. (He is the Martin in my company's name.)

In those days the rules did not have any discussion of electrical systems (or steam engines) at all, but somehow these classification societies, or at least ASA, went along since our 1888 record shows the Columbia as fully classed. Noting that risk assessment was always part of classification, the classification society might have taken a more rational approach than John Roach. It is reported the vessel would still carry oil lamps and if the system failed, oil lamps could take their place. (I still own a WWII era marine style emergency oil lamp, which was carried for that purpose) With regard to fire risk, it would not have been difficult to figure out that there is no strong increase in risk from electric light as compared to open flame.

The actual design consisted of four steam engine driven dynamos (DC generators). Three of the dynamos powered the lights and the fourth functioned as a field exciter for the other three. Each dynamo was later described as a 6 kW unit. Each dynamo could power 60 light bulbs (so these bulbs were about 100W each) and the vessel was fitted with 120 lightbulbs, mostly in the common rooms and the staterooms. (There also were lights in the engine room, which the engineers used to adjust the voltage to get the proper light output.) The system was fused with lead fuses and there were light switches for each light. However, the light switches were fitted in locked boxes and only the stewards could turn lights on and off at the request of passengers. (Just like when I was a young engineer, and only the copy machine operator was allowed to push the copy button on the copy machine)

Since Roach did not want to install the lighting system, the vessel had been shifted to the foot of Wall street in downtown Manhattan in late February 1880, where the system was installed by Edison men. The system was running by the end of April and became a shore side attraction for the next few days being the only electric lighting system outside of the Edison lab in Menlo Park. We have no record of it, but it is highly unlikely that Francis A. Martin did not stop by for a visit with his office only being a few hundred yards away.

The vessel departed on May 4, 1880 around the Horn to the West Coast where she arrived without any electrical (or other) problems and the system ran (with upgrades) until the vessel was sunk with loss of life in a collision in 1907. The most remarkable aspect of the whole system was that it simply ran without any problems. Based on this, electrical lighting was adopted on other vessels incredibly quickly, and was readily adopted into the larger maritime commercial context due to classification. This was all long before Edison felt he needed to electrocute elephants to make weird shore based electrical arguments about safety.

Since we have lived with this technology for almost a century and a half, this project may seem so simple today, but it really was a tremendous advance that came together in just a few months. It needs to be remembered that it only happened because the right people showed up at the right time. I

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can think of dozens of innovations that I have been personally involved in that simply never got past "go" due to a doubter or naysayer (or a worse, a cabal of naysayers), whether at the regulatory, the manufacturing, the insurance or the finance level, who could not be moved regardless of the technical evidence provided. Such innovation poison is difficult to deal with, and really only can be solved by finding ways to get around the doubters and naysayers, which happened with the SS Columbia lighting system.

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 National Maritime Historical Society https://seahistory.org/ .

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Will our Customers Redefine Design and the Science of Propulsion?

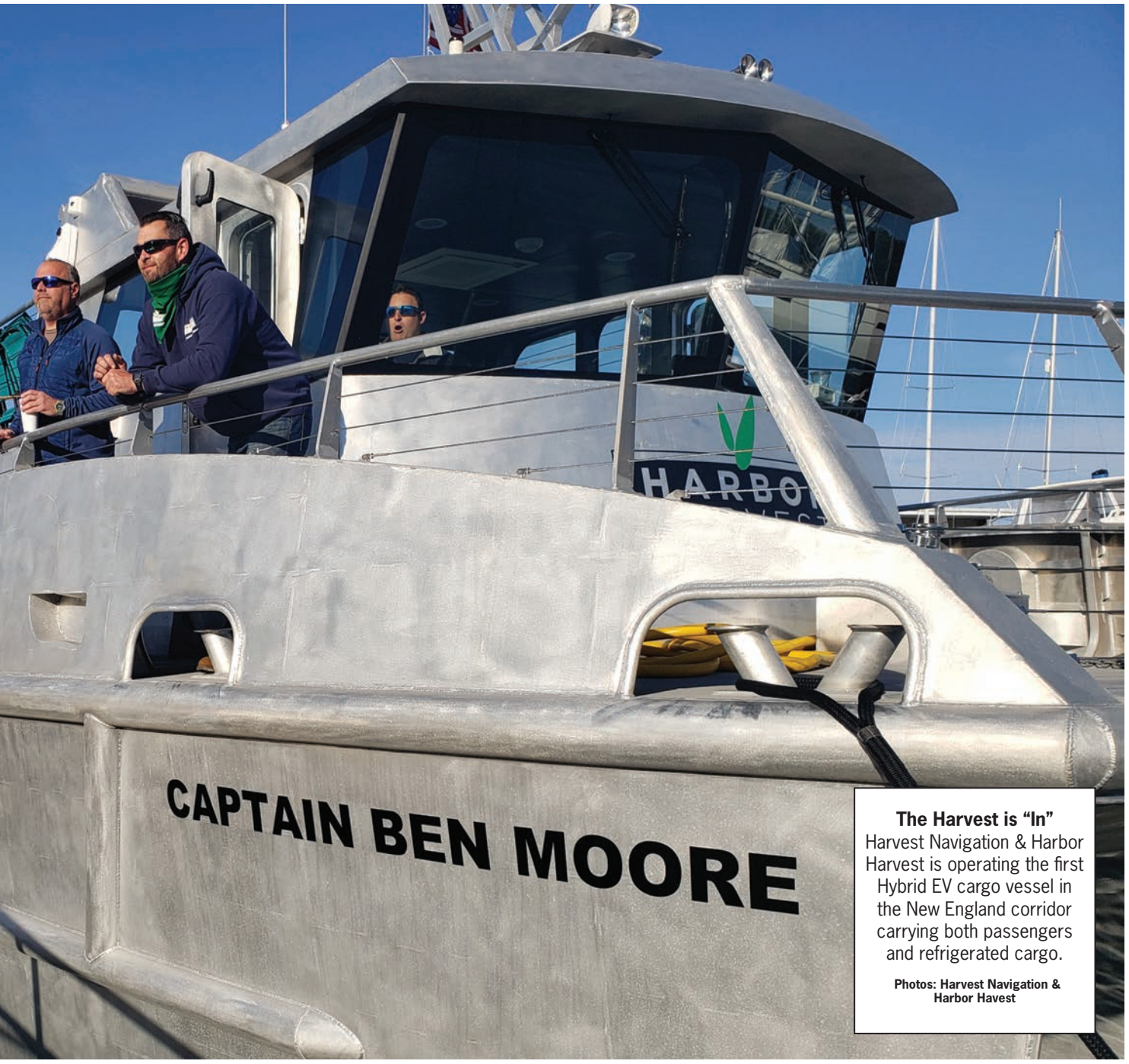
By Robert Kunkel

It is "Pre-Covid " April of 2018, and 174 member states of IMO adopt a new strategy to reduce greenhouse gases from shipping. The meetings are considered "urgent" and the target is to reduce carbon emissions in half by 2050. Prior to those "targets" shipping dealt with regulations to address SOx and NOx reductions. Most of which have resulted in limited success due to infrastructure problems and a consideration as a temporary fix.

The technical world has responded with low sulfur fuels, LNG, and Methanol to work towards the target. Not a surprise as shipping has been addicted to fossil fuels and large combustion engines for more than 100 years. Many of the new fuel changes have affected maintenance and new building costs, the owners bottom line and in turn global commerce. Beyond those issues many owners will find that their new construction EEDI calculation have been compromised by new regulations issued during MEPC 262(68) affecting their deadweight percentage and minimum power ratio. As a result new "reduced emissions" tonnage has a poor EEDI value as compared to tonnage built five years past. No surprise, we are past a " fuel reduction" strategy in ship design.

Here is where the future of shipping "propulsion" may be redefined. We transported cargo by sail and without emissions – carbon and climate was not a discussion or a concern. We moved to steam and coal, as transportation adjusted to the need for speed and distance. Propulsion was forced to address the change from local commerce to cross Atlantic or Pacific commerce. Advanced internal combustion engines and difficult coal logistics took us into the age of diesel oil, gasoline and heavy fuels. Those fuel and design changes were commercially based to allow us to move into globalization. Propulsion followed the dollars and we entered the age of Far East manufacturing supporting service orientated developed nations where manufacturing was no longer competitive.

No one knows shipping's circle of life better then a technical man – we have gone from designing and building small and fast to designing and building large and slow. We debate 100 year old cabotage laws in the United States, human rights, safety and trade problems in China, geopolitical issues across the globe and now a pandemic – all affect shipping & trans-

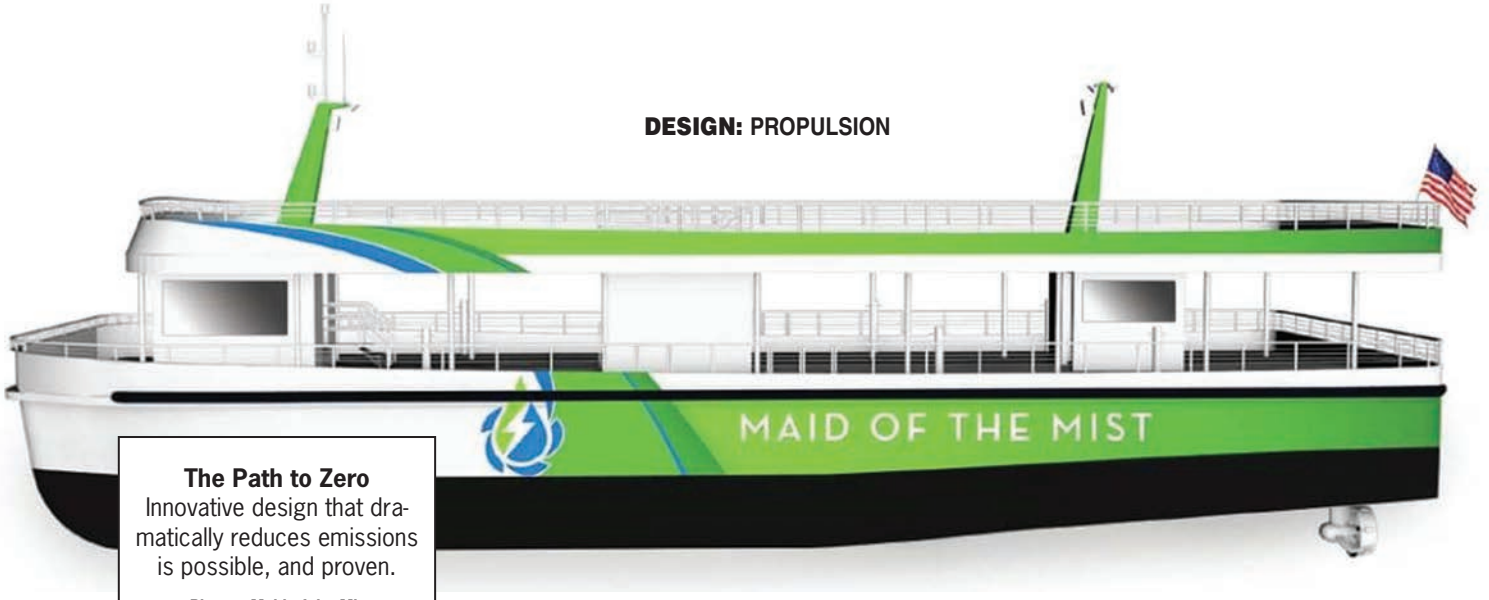


The Harvest is "In"
Harvest Navigation & Harbor Harvest is operating the first Hybrid EV cargo vessel in the New England corridor carrying both passengers and refrigerated cargo.

Photos: Harvest Navigation & Harbor Havest

portation and with that the ship propulsion we choose. Most of these debates leave technical men scratching their heads in confusion when asked what is the future of ship design. Fast, slow, large, small, clean or dirty - local, coastal or global?

The quest for decarburization may place us again in a period of transportation reinvention. The decision maker will simply be the consumer and his or her daily interaction with social media and the speed of information. That instant gratification tends to lead to faster deliveries as we locate the service or item on Amazon and expect it on your doorstep the next afternoon. With that expectation, farming, manufacturing and processing will need to be local or "near- coastal". Simply because distance transportation at speed will result in larger energy sources and increased GHG in a global economy – all the more difficult to meet an IMO 2050 regulation across the globe. All the more difficult to introduce



The Path to Zero
Innovative design that dramatically reduces emissions is possible, and proven.

Photos: Maid of the Mist

new zero emission technologies.

The effort to reach zero emissions and carbon neutrality in propulsion will upset current global businesses and trade. Manufacturing nations of current exporting countries will look to relocate their factories at importing nations and reduce global trade volumes. That change can push marine propulsion closer to EV technologies and a move away from large fossil fuel combustion engines. Simply put, battery technologies, Hybrid and EV marine propulsion is taking hold of ferry markets, coastal operations, offshore wind and small tank vessels operating in the ECA zones around the globe. Most if not all displaying near zero emissions and sustainability well before the 2050 IMO mandate.

Japanese chemical tanker operator Asahi Tanker has ordered two emissions-free 4,500-dwt tankers with the ship design work completed by e5 Lab Inc, a joint effort between Asahi Tanker, MOL, Mitsubishi Corp and Exeno Yamamizu Corp. The ships are powered by 3500 kWH Lithium – Ion batteries.

Asahi claimes the ships will be the world's first emissions-free tankers, eliminating all carbon, nitrogen/sulphur oxide and particulate matter. Zero emissions.

In the United States this needs to begin with the support of local business and near coastal hybrid transportation. First Harvest Navigation & Harbor Harvest is successfully operating the first Hybrid EV cargo vessel in the New England corridor carrying both passengers and refrigerated cargo. The company growth is reaching into autonomous operation with pilot programs under discussion with Sea Machine of Boston, Massachusetts. The construction of several larger vessels supporting New York City and northern Connecticut is part of this growth. Regional waterborne transportation completed with zero emissions well before 2050.

As EV begins to dominate these smaller markets and ship sizes, the question is simple; can energy storage technology move into longer distances, higher speeds, larger ships and global trade? From our recent experiences and discussions with the builders, BAE Hybridgen, ABB and Major Oil, we believe it can.

The new consumer is informed and aware of the environmental impact of products and services they purchase. The trend shows this customer base is more likely to trust a company or corporation that is actively supporting social or environmental issues. Many "talk the talk" and market their visions. However, the truth is those corporate goals are reached in manufacturing, farming, and service industries and then is lost once the company moves into transportation. Trucks, ships, and airlines moving those products do not meet the climate change goals.

We can work to make hulls more efficient, burn bio fuels and ammonia, reduce speed and in turn reduce fuel consumption. All that said, to reach the IMO target by 2050, zero-carbon vessels must be developed well before that date and the global infrastructure must be in place to support that EV technology.

Offshore wind powering charging stations, digital technol-

ogy to control the grid in an effort to support full digital electric operations and small autonomous vessels moving cargo along a waterborne highway. Science fiction? Hardly, as we have learned that the decision process and speed of which this technology change needs to take place is entrepreneurial and requires private support and action from ship owners, cargo source and finance. Government regulation and interaction will delay the process. We experienced that delay with First Harvest Navigation first hand at both Federal and State levels.

From a design perspective, a transition needs to take place beginning with a move to diesel electric propulsion in larger vessel construction. The DC grid and technology with that well established propulsion process can work to move into battery support and the replacement of generator(s) with the new battery energy source. A Hybrid path no different then the path the automotive industry has taken to move to full EV. The role of the financial sector is important in financing that transition. Owners and Cargo sources will need to show the change is investible. Look at Space X, Tesla, Virgin and their leadership into new technology and private investment. Shipping needs to follow that lead – from local to global and away from government interference that regulates the speed of change to support political agendas.

Being carbon neutral means that your net release of CO2e- into the atmosphere is zero. We need to work towards zero emission design not emission reduction. The establishment of the Emission Control Areas or "ECAs" was a good start of establishing control levels near the populations. Continue to develop those regions as local areas to introduce EV propulsion and transportation on both land and sea. We believe EV is the path forward and the future of propulsion design. Start small as we have seen in our projects and grow into the technology supporting larger commerce.

NYC Ferry fleet | 35 Catamaran Passenger Ferries and counting

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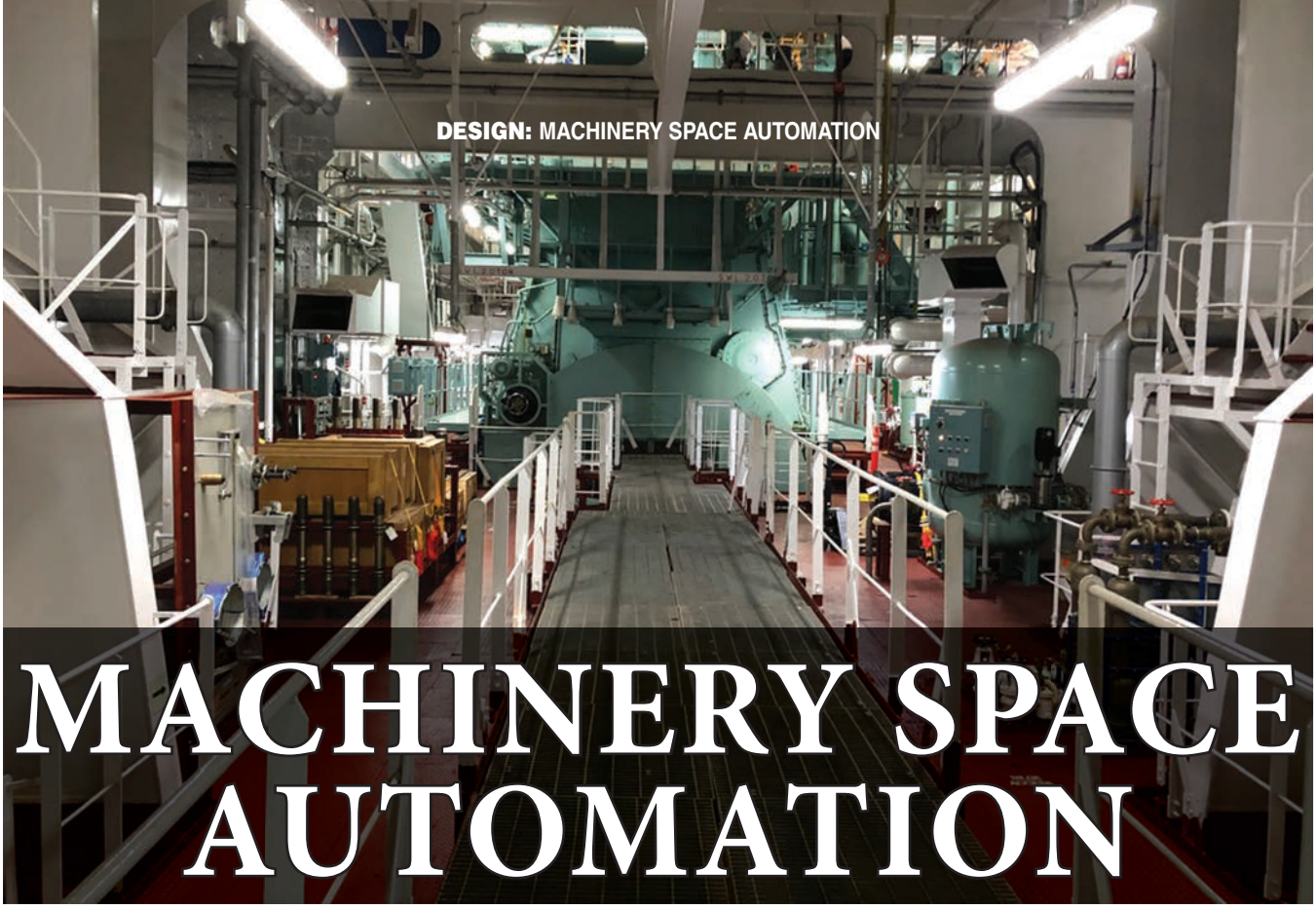

MACHINERY SPACE AUTOMATION

and the History of Coast Guard Testing Requirements

By LCDR Tony Guild and CDR Brian Peter, USCG Ret

You may have noticed some renewed emphasis in the way the United States Coast Guard (USCG) is overseeing the periodic testing of vital machinery on commercial vessels. Following the tragic loss of the El Faro, this emphasis on automation testing seems to have taken on additional significance. As we consider the implications of this new paradigm shift, understanding some of the history of shipboard automation and how that technology has advanced might help us when dealing with the Coast Guard on these issues.

The first automated vessels came into vogue back in the 1960's due to rising costs. Shrinking margins found ship owners looking for alternative ways to reduce overhead and while the cost of bunkers represented a large portion of those operating costs, vessel manning overhead was also increasing [1]. At the same time, automation technology in the stationary engineering industry was showing promise and naturally that technology started to pollinize the maritime industry. The first Coast Guard certificated steam ship to operate with reduced manning following automation upgrades was the Great Lakes Steamer William G. Mather. In 1964, the Mather's boiler was automated by the Bailey Meter Co. (later to be called Bailey Controls) and approval of the ship's request to reduce manning and watch keeping levels followed the installation of automated feedwater and combustion controls. At the time, the Mather was *"..the most automated steamer in the country " [2].*

As automation gained popularity and traditional crew sizes were reduced, reliability of the automated equipment became critically important and also one of the primary objectives of the Coast Guard's machinery oversight program. Automation continues to play an increasingly important role in machinery plant operations; however, the Coast Guard's mission has changed from ensuring the reliability of early automation components to including ensuring the International Safety Management (ISM) and Standards for Training Certification and Watchkeeping (STCW) Codes are being implemented and followed. Initially,

automation was unproven and considered unreliable. Today, advances in technology and years of demonstrated reliability, along with increasing complexity of vessel systems has firmly established the need and dependence on automation. The ISM and STCW Codes have also had a significant impact on how equipment is maintained and how work/rest requirements dovetail into the management of a ship's machinery system; from watchkeeping, to equipment maintenance.

HISTORY OF REGULATORY OVERSIGHT

In those early years, as the Maritime industry experimented with inventive ways to reduce operating costs and as automation technology advanced, the United States Flag State or Coast Guard focused on the need to ensure that those new technological breakthroughs would not compromise the safety of a vessel. This resulted in the publishing of a number of Navigation and Vessel Inspection Circulars (NVICs) starting with NVIC 1-69. Published in January of 1969, NVIC 1-69 was the Coast Guard's first official publication that addressed the automation of a ship's Main and Auxiliary machinery. For the first time the Coast Guard identified those systems necessary to reduce engineering watchstanding requirements and, in some cases, crew size without impacting the safe operation of the ship. Then and today, the Coast Guard strategy focused on three key areas to facilitate these reductions. They are: 1. Plant reliability, 2. Watchkeeping, and 3. Manning. These three areas overlap just enough so that when properly managed there are sufficient safeguards in place to ensure safe operations. In essence, the principles established in NVIC 1-69, were designed to outline the overall objectives for safe operations and to ensure uniformity when adding automation features that permit a reduction in the traditional number of engineering watch standers on a commercial vessel [3].

While NVIC 1-69 was the first published document where the Coast Guard discussed minimum equipment, performance standards, periodic testing of vital systems, and maintenance requirements for that equipment to ensure reliability, it was not the last. In all, the Coast Guard has published nine additional NVICs addressing automation to assist Coast Guard personnel and the maritime industry in managing expectations for this advancing technology. They include: NVIC 7-73, 1-78, 6-84, 8-84, 8-86, 10-81, 2-95, 4-05 and 01-13). Each of the above documents followed the same thematic key areas (Plant Reliability, Watchkeeping and Manning). In every case the goal was and is to ensure that vital systems are reliable and can operate as intended, support crew reductions and most importantly, carry out those machinery space watchkeeping functions traditionally performed by a live watch.

Even with the guidance from the numerous NVICs, the most important change impacting the implementation of automation for U.S. commercial vessel came on May 18, 1988. On that date, the USCG published the Interim Final Rule (in the US Federal Register Volume 53, No. 96) addressing control systems and machinery automation for USCG inspected vessels. This rule making was a shining example of regulatory / industry cooperation for achieving a common purpose: Safe Operation for a vessel while addressing automation and crew reductions. As noted in the preamble:

> ***"Coast Guard intends these rules to provide minimum performance and testing standards that do not restrict use of technological developments or alternative arrangements that provide an equivalent degree of safety".***

That 1988 rule created Parts 61 and 62, in Title 46 Code of Federal Regulations, which is the current rule set on machinery automation and was designed to ensure compliance of automated vessels with the Coast Guard goals and "..with the international standards of safety promulgated by the SOLAS convention and the applicable IMO resolutions" [4]. The rules were designed to be performance based due in no small part to the knowledge that technology was advancing at a rate that would quickly outpace even the current rule set, if flexibility was not rooted into the regulations.

The new regulations memorialized some of the previously mentioned NVIC's addressing automation and codified specific procedures to ensure that automation design and operational reliability did not comprise safety when reducing watchkeeping standards or when reducing crew size. Additionally, manning requirements and watchkeeping definitions were outlined for "Minimally Attended" and "Periodically Unattended" machinery plant operations as well as the minimum conditions needed to ensure Plant Reliability under all watchkeeping conditions.

PLANT RELIABILITY

The Coast Guard premise has always been that "the safety of vessels with automation should be at least equal to that of a vessel with its vital systems under direct manual supervision" meaning, that even though someone may not be physically present in the area where the vital machinery is operating, the crew or watchstander can rely on automation to perform part of the "watchkeeping" functions allowing them to focus on other watchstanding responsibilities. This is regardless if the machinery space is manned or unmanned. Therefore, redundancy and reliability of vital equipment becomes a critical part of the ship's safety net.

For the purpose of shipboard automation, reliability can be broken down into three key areas; Minimum Vital Equipment Requirements, Periodic Testing of Vital Equipment, and Maintenance of Machinery including Vital Equipment (See Figure 3).

In the early days, the industry was more focused on modifying existing ships to obtain approval for reduction in crew requirements. As newer ships replaced older tonnage, the emphasis shifted to ensuring that newer vessels were constructed

to meet the latest standards. Regardless, the minimum equipment requirements must be met before a reduction in crew size can be approved. Once approved and installed, proper maintenance and regular testing are essential to plant safety and reliability. Accordingly, the Coast Guard places great emphasis on periodic testing of automation through the use of the Periodic Safety Test Procedures (PSTP) in part, to help them conclude that maintenance is being performed.

It goes without saying that lack of maintenance can and does have a direct impact an automation systems intended function bringing into questions its reliability. If part, or all of that system is vital or being relied upon by the watchstander to perform part of his or her watchstanding functions, then there is an obvious deficiency in that watch. In the event of a casualty or emergency, especially while operating the machinery space unmanned, the result of that watchkeeping deficiency could potentially lead to more serious consequences. And as we know, as equipment ages, Maintenance becomes even more important. It is easy to conclude that reduced Plant Reliability can increase the risk of an accident or an incident. Either of these two issues can directly impact a company's bottom line. Therefore, lack of maintenance = less reliability = bad.

USCG PART 61 AND 62

The 1988 codified the functional requirements needed ensure Plant Reliability. They included;

1. *Identification of "vital" equipment is required;*
2. *Specific Alarms, for Monitoring and Control of vital equipment are required to be identified, tested and documented;*
3. *Fail Safe standards for the installation of vital equipment or systems are required to be identified, documented and tested;*
4. *Procedures on how to operate equipment following an emergency are to be documented and tested;*
5. *Periodic testing of all vital equipment, systems, alarms and control shall to be documented; and,*
6. *Development of a planned maintenance program*

The first five items noted above, require the automation system to meet minimum engineering design standards, which are validated in the Design Verification Test Procedures and then their reliability is validated annually through the approved Periodic Safety Test Procedures. Both of these procedures require U.S. Flag State approval, and require some level of oversight being completed by the Coast Guard or by Class on behalf of the Coast Guard, Follow-up verification that testing is being completed is then carried out by Coast Guard inspectors annually during the ships Flag State inspection.

These procedures include details on everything from primary and alternate controls, to alarms for vital systems and are in part, designed to demonstrate the adequacy of the vessel required planned maintenance program [5]. They describe in detail the specific steps necessary to accomplish testing and identify expected results. While the PSTP are required to be sufficiently detailed so that engineering personnel unfamiliar with the test procedure should be able to follow them. Importantly, there is no Coast Guard requirement for ship personnel to be capable or competent in completing the tests as they "are intended to evaluate the equipment not the capabilities of the crew" [6]. Meaning simply, that a third party can be used to demonstrate the performance of the vessel's automation system similar to annual servicing of a ship's fixed fire extinguishing system.

PLANNED MAINTENANCE AND MACHINERY SPACE TESTING REQUIREMENTS

As mentioned earlier, one of the foundational elements of maintaining a ships machinery system is a robust maintenance program. While periodic testing demonstrates that the equipment continues to perform as intended, planned maintenance helps management ensure their asset can reliable operate without disruptions in trade as well as complying with Coast Guard, Class and manufacture requirements. For vessels operating on international routes, the planned maintenance system is a required element of the International Safety Management Code (ISM). Specifically, Part A section 10, which states:

"The company should establish procedures to ensure that the ship is maintained in conformity with the provisions of the relevant rules and regulations and with any additional requirements which may be established by the company"

Section 10.3 of the ISM Code is also important as it requires a company to identify shipboard vital equipment and promote the reliability of that equipment through periodic testing. Notice the theme is consistent with Coast Guard requirements. The good news here is the approved PSTP demonstrates compliance with this portion of the ISM Code as long as the PSTP is implemented in the Vessel's Safety Management System. When developing or evaluating your maintenance program the following items should be considered:

- Manufacturer's recommendations for maintenance and testing
- Regulatory requirements
- Class requirements
- Company requirements
- Shore side support capabilities
- Length of voyages and frequency of port calls
- Labor contracts and other drivers

PROBLEMS ENCOUNTERED

The authors are regularly contracted by vessel managers to assist with Coast Guard PSTP development and inspections/testing. Some of the more common deficiencies we encounter are the PSTP is worded incorrectly, Portions of the PSTP were not completed, and the engineer conducting the testing does not follow the written and approved procedures. It is important to remember during any interaction with Coast Guard personnel that the Coast Guard "intends these rules [On testing] to

provide minimum performance and testing standards that do not restrict use of technological developments or alternative arrangements that provide an equivalent degree of safety" [7]. This mind set does not mean the engineer can deviate from the approved procedures even if the end result is the same e.g. the alarm functions from sensor to output. It means that if there is an alternate way to demonstrate the performance of the automation system (sensor to alarm) then the Coast Guard can consider that method. In all cases the procedures should reflect how each test is being performed because the CG inspector witnessing the testing uses the PSTP to help them confirm that the automation system works correctly regardless of their experience. In other words, If the procedures are correct, being followed, and the alarms function as intended then they serve to help a non-engineering Coast Guard inspector make the conclusion that the system is functioning properly.

For a company with a planned maintenance program similar to DNV's Ship Manager Technical PMS software, ABS's NSE, or some other maintenance software program a leading indicator that testing and maintenance is not being adequately addressed can sometimes be found in the anecdotal observation of the number of overdue jobs waiting to be completed. Overdue jobs required to be performed in support of reduced manning not only reduces Plant Reliability but can be an indication of shortfalls in crew or shoreside support. If the company is relying on the ship's crew to complete routine maintenance, then the crew must be sized to accommodate the number of required planned maintenance tasks associated with any reduction in watchkeeping or crew size, and at the same time ensure that STCW work rest hours are not violated. If shoreside support is provided, then managing scheduled maintenance plays a critical role in machinery reliability.

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This leads to us a brief discussion on manning. Within the last several years the U.S. Flag State manning requirements have undergone some significant changes. The USCG Marine Safety Manual (MSM) Vol III, Marine Industry Personnel is the policy document that the Coast Guard uses for manning requirements and watchstanding issues for all vessels including those with automation. These recent changes have been important in several ways, the most significant is the adoption of Principles of Safe Manning IMO resolution A.890(21) by the Coast Guard. For vessels operating domestically those same international principles apply with some subtle differences. This is especially important for those vessels operating with reduced watchkeeping or manning levels since failure to maintain plant reliability provides the Flag State (USCG) a reason to increase manning levels or add watchkeeping requirements (e.g. remove permissions to operate the machinery space periodically unattended). Therefore, while it can seem unreasonable and burdensome to complete 150 pages of test procedures for vital system machinery on an annual basis it is a critical part of maintaining plant reliability and ensuring the vessel's equipment is working and reliable.

Gimi, the "World's Second"
Following the delivery of the world's first converted FLNG in 2017, Keppel O&M is currently undertaking its second FLNG conversion, Gimi, for Golar LNG.
Photos: Keppel O&M

Keppel O&M's FLNG conversion solution helps to give

Old Ships *New Lives*

As the focus on carbon emissions comes to the fore across all industries, Keppel O&M, which supports the circular economy concept and is a ship conversion leader, is able to help companies reduce their indirect emissions. Proof of this was delivery of the world's first FLNG conversion solution that dramatically reduced the carbon footprint of the project as compared to new construction. There's a second conversion project currently underway, and by the way: *it's faster to market and billions of dollars cheaper than a newbuild.*

By Greg Trauthwein

Keppel Offshore & Marine's (Keppel O&M) conversion of a Liquefied Natural Gas Carrier (LNGC) into a Floating Liquefaction Vessel (FLNG) using a design and execution model jointly engineered by Keppel O&M and Golar LNG Limited (Golar), is estimated to save approximately 33% of greenhouse gas (GHG) emissions compared to an FLNG newbuild, according to a study conducted by environmental consultants, Environmental Resources Management (ERM).

The study, which assesses the converted FLNG Hilli Episeyo and a new build FLNG of a comparable design and specification, concluded that the converted FLNG saves a total of 63,343 tons of GHG emissions.

"Golar has long understood the merits of repurposing its fleet of high quality assets, having repurposed five vessels over the last 13 years with a further 2 currently in the process of being converted," said Iain Ross, CEO of Golar LNG in a press release statement on the project. "The company has never scrapped an asset. The advantages of cost and speed to market have always been well understood and easy to quantify. Golar has consistently believed in the sustainability of this approach too and Keppel's study now quantifies the environmental advantages of this part of our FLNG business model."

"Keppel O&M has been the leader in conversions in various solutions since the first FPSO that it converted in 1981 and has amassed strong engineering and conversion know-how in this space over the decades," said Chor How Jat, Managing Director (Conversions & Repairs) of Keppel O&M. "The push towards energy transition and cleaner fuels has also made our customers including the oil majors and field operators explore more sustainable solutions that can quantifiably reduce their carbon footprint. Companies are reviewing not only their own emissions, but also emissions throughout their value chain. They are relooking their business models and making commitments to their shareholders to reduce emissions."

Keppel O&M supports the circular economy concept and the role conversions have played in providing sustainable solutions. "While the savings in GHG emissions from a conversion solution were intuitively clear, we wanted an objective study to quantify the significant savings after having completed a full scope FLNG conversion like the Hilli Episeyo which was the world's first," said Chor How Jat. "As steam-propelled LNG carriers are phased out by the industry, owners can also leverage this solution to repurpose their vessel for other uses, adding decades to the life of the vessel and reducing their carbon footprint. This study would also help shipowners make informed decisions as they think about what to do with some of their older assets."

The repurposing of LNGCs into FLNGs adds decades to the life of the vessel, recapturing value that would have been lost through disposal. It also reduces the consumption of materials that would have been needed for a new build. For example, the use of virgin steel was reduced by 39% in the converted FLNG Hilli Episyeo, contributing significantly to the reduction in GHG emissions.

"Jointly developed by Golar and Keppel O&M, the concept of using sponsons was an innovative game changer, creating new acreage to house additional equipment on the vessel and segregating the hydrocarbon and non-hydrocarbon systems to meet safe design requirements."

Mr. Chor How Jat,
Managing Director
(Conversions & Repairs),
Keppel O&M

While there are an increasing pool of candidate vessels coming online for conversion, no two conversion projects are the same, and for Keppel O&M the key challenges were space constraint on the vessel as well as ensuring safety and efficiency in the integration and organization of the systems, said Chor How Jat. "We were able to draw on our experience to develop with our client an innovative method to create more space on the vessel while outfitting it with the latest technology. Jointly developed by Golar and Keppel O&M, the concept of using sponsons was an innovative game changer, creating new acreage to house additional equipment on the vessel and segregating the hydrocarbon and non-hydrocarbon systems to meet safe design requirements."

As with any major conversion project, cost-efficiency is gained, or lost, in the intital design phase, as changes to plan raise costs exponentially as the project progresses. "We first conducted a robust one-year FEED study jointly undertaken by the key partners to identify upfront the critical issues concerning design as well as constructability," said Chor How Jat. "That helped to define the product and project plans more

accurately and enabled an efficient 39-month shipyard execution and six-month site commissioning on arrival at the Sanaga field, both of which are exceptional for a prototype."

At the end of the day, as is the case in nearly every shipbuilding and conversion endeavor, experience goes a long way toward ensuring an effective, efficient conclusion. "Generally, LNG carriers can be converted into production and storage vessels - FLNGs, FSRUs and FSUs," said said Chor How Jat. "Each conversion is different – it requires an experienced team with a specific and technical set of capabilities to meet the design and specification requirements of the project. For example, the type of containment system and storage capacity will impact the engineering considerations and technical feasibility of the project."

To date Hilli Episeyo has performed consistently, providing proof of concept and attesting to the solution put forth by Keppel O&M and Golar. The FLNG has maintained 100% commercial uptime since its delivery in 2017, and recently surpassed its 42nd cargo dispatch. Keppel O&M is currently undertaking its second FLNG conversion, Gimi, for Golar which is being repurposed for the 20-year BP Greater Tortue Ahmeyim contract offshore West Africa. Keppel O&M has an extensive track record in the conversion of vessels. In addition to converting the world's first FLNG in 2017, Keppel O&M converted the world's first Floating Production Storage and Offloading vessel (FPSO) in 1981 and the world's first Floating Storage Regasification Unit (FSRU) in 2008. It has converted 134 production vessels including FPSOs, FLNGs and FSRUs.

While the environmental savings are commendable, it's another type of green savings, U.S. dollars, that provides real impact in comparing newbuild versus conversion. According to numerous analyst and media reports, the Hilli Episeyo – which was the world's first converted FLNG completed by Keppel O&M – cost a reported $1.2 billion for a total production capacity of 2.4MTPA, or $500 per ton production capacity installed. Comparing the costs to the world's biggest FLNG newbuild, Prelude, the price advantage is clear. According to numerous analyst and media reports, Prelude cost an estimated $10 to $13 billion to build. At the time, Shell estimated the project would cost up to $3.5 billion per million tons of production capacity (or an estimated $2800 to $3700 per ton production capacity installed).

Taming of the Engine Killers

Effectively Mitigating Heat & Vibration in the Engine Room

While the size, shape and purpose of maritime vessels varies widely, a common concern for every shipowner is ensuring the long-life, efficient and safe operation of a vessel's biggest capital expenditure: the propulsion machinery. Heat and vibration are the two main culprits in cutting machinery life short and raising maintenance cost. *Maritime Reporter & Engineering News* was in Mannheim, Germany late last year to visit Thermamax, a specialist in the design and manufacture of thermal and acoustic insulation solutions for diesel engines, spark ignited engines, exhaust aftertreatment systems and electric storage systems.

By Greg Trauthwein

Steffen Cronauer, an 18-year Thermamax veteran, believe in the axiom that 'you get what you pay for' is particularly true in machinery insulation: "In some parts of the world, insulation mattings are used, and while they are cheaper from the beginning and can pass tests on the bench, they are not as effective in the long haul."

Thermal and acoustic insulation is the business of tmax Holding GmbH, a holding of six companies in Europe, USA and China with headquarters in Mannheim, Germany, a company of about 500 people working to provide engineered solutions to the automotive, on- and off-highway sectors, power sports vehicles, stationary power generation, ships, and oil platforms, both on land and at sea. For the marine industry, Thermamax is a solution provider for SOLAS-compliant insulation solutions for engine rooms. The company engineers and supplies insulation claddings for most of the leading engine and turbocharger OEMs. In addition, Thermamax is able to design, manufacture and install SOLAS-compliant retrofitting insulations also for engines that are already in service for a longer period of time and that eventually do not meet latest safety standards.

Something Old, Something New ...

According to Cronauer, the number one driver for Thermamax products in the maritime and offshore sectors is safety, and in fact it was the Deepwater Horizon accident that served as an inflection point with potential customers understanding that "sheet metal insulation cladding is the better product when it comes to safety onboard, whether it is a rig or a propulsion engine for a vessel." According to IMO SOLAS the surface temperature of modern marine engines must not exceed 220°C. In addition, engine builders are striving for better fuel efficiency, mainly by increasing the engine`s power density what typically leads to higher exhaust gas temperatures. Due to higher charge air pressures even the area of the compressor outlet of the turbocharger becomes a concern in terms of surface temperatures. Consequently, every new engine has to be equipped with a highly efficient insulation system. "We also have to look at and consider the aftertreatment devices, as large SCR systems become more common on ships," he said. "For example the aftertreamtment system is almost as big as the engine itself. They too are hot, they too must meet SOLAS requirements."

While new engines are a central focus, the larger market opportunity comes in the retrofit sector, as there are many engines 20 years or older that could

Keeping Machinery Heat & Vibration in Check
Thermal and acoustic insulation is the business of tmax Holding GmbH. Left: An engine with old, worn-out cladding; Right: An engine with new tmax cladding.
Photos: Thermamax

utilize an insulation retrofit, which spurred Thermamax to develop its Tmax-Retrofit.

Thermamax Engineered Solutions

While many may not put 'insulation' in the category of engineered solution, a stroll through the modern manufacting complex of Thermamax dispels that notion. It starts with the realization that the plant workers go about their business without masks, courtesy of a state-of-the-art air quality vaccum system which was installed and monitored regularly (Note: this visit was conducted pre-COVID-19).

There are many key factors to producing the bespoke engineered insulation solutions – from the latest laser cutting equipment to metal handling/bending machines, and, of course, the quality of the insulation materials themselves.

"The most important aspect is the grade of the material," said Cronauer. "You can buy a 20 mm material for 10 Euros or for 7 Euros, but the fact is, this highest technical requirement for our material is not temperature, it's vibration. Even the cheap stuff that you can use for the roof of your house can give you high temperature protection, but it's the vibration that is a killer with a very bad influence on the lifetime of the insulation and the machinery."

In this regard, for the marine sector Thermamax uses stain-

less steel and a stitched and woven insulation fabric that is designed to better withstand the pressures of heat, vibration and time.

Over the years Thermamax has continued to invest in new machinery, for example laser cutting machines that today are five times more efficient than machines were 20 years ago, but at the same price point. And the advent of CFD simulation has allowed it to ensure that not only are its insulation solutions optimized for heat and vibration characteristics, but that they are engineered for ease of assembly and maintenance by unskilled workers; to maximize material use, "so maybe we don't neet 2 mm thickness, maybe 1 mm is enough. And do we need 215 screws, or maybe only 120?"

Thermamax continually invests in R&D to test new materials, but to date stainless steel and fiber materials are still the go-to. "There is some movement (at the R&D departments that manufacture insulation material), but there hasn't been a real breakthrough. For example, a cladding design without any fibre material. From a physics perspecitve, it is possible and it works perfectly on the test bench but the question is ... who will be the pioneer for this new design?"

But manufacturing in the marine sector is a low-volume affair for all, and Cronauer stress the importance of a skilled workforce to deliver consistent quality.

"Blue-collar workers in Germany go through an apprenticeship program that is three years long, certificate-based and teaches them how to work skillfully with metal (and other materials)."

As the maritime market moves increasingly to news fuels, hybrids and batteries, Thermamax evolves too, engineering unique solutions to address the need to manage heat and vibration. Recently Thermamax developed housings for battery modules to support electrification, beside others, for marine application. Also, on board ships electrification is becoming more and more important. Thermamax battery housings can be used for on-board energy storage systems,. Thermamax battery housings ensure effective fire protection and extend the battery range by balanced thermal management. But in regard to market guidance, Cronauer it was still too soon to tell how fast and how far these newer applications would move.

At the end of the day, the company is able to lean on the multiple markets it serves. "From the automotive side you can learn a lot of cost-efficiency, cost-engineering, secure processing," said Cronauer. "From marine we learned a lot about combining multiple materials into a single function. This is a key factor in making Thermamax a leader in providing complex solutions."

The Tmax-Retrofit

In the engine room temperatures are highest and reliable fire prevention is vital. As 3D details are often not available for older engines, retrofitting with SOLAS-compliant high-performance insulation systems has only been possible to a limited extent until now. With Tmax-Retrofit, older marine engines can now also be upgraded with high-temperature insulation systems which exceed SOLAS guidelines. The all-in-one package provides all services – from the preparation of the engine's 3D profile to the thermography of the developed and installed insulation system – all from one source.

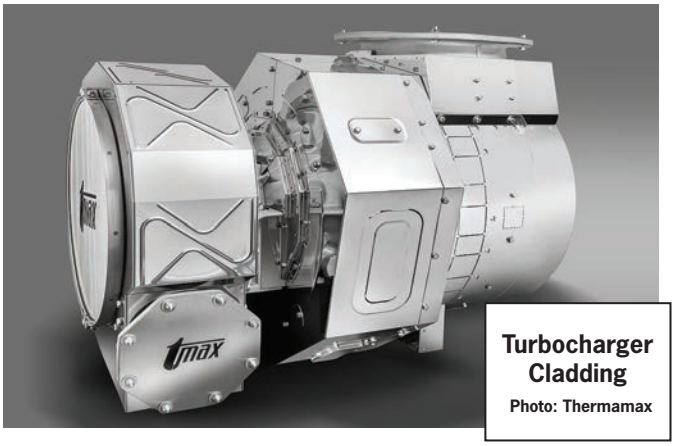
"We see retrofit opportunities, as there are many old ships

A 3D Scan
The Thermamax retrofit solution starts with a 3D scan of the engine.
Photo: Thermamax

with old engines with old insulation systems which are rotten and do not have any fire protection properties anymore," said Steffen Cronauer. He noted that many engine manufacturers – Thermamax's main customers – are not inspired to release a retrofit system for an engine released 25 years or older, and the decision to retrofit an insulation system requires conversation between the ship owner and the engine makers. "This is the biggest opportunity for us in the maritime sector. The offshore sector is interesting, too, dependent on the price of oil and their willingness to invest."

1. A 3D-Scan of the engine to ensure the best fit of the exhaust gas and turbocharger cladding. Results of the scan are used as the basis for preparing digital 3D models.
2. Reverse Engineering: Based on the scanned 3D profile, Thermamax develops a CAD model of the engine. For this it first generates a polygon network in STL format from the available data. This is converted into standard geometries and free-form surfaces. From these attributed surface models and own on-site photos, we can then create a CAD model in the STEP or IGES format.
3. Design and Simulation: Now starts the classic design process. On the basis of a 0D/1D thermal calculation Thermamax defines material and thickness of the insulation. The detailled constrution is made in Creo, a specialized software. The result is a durable exhaust gas/turbocharger cladding which reliably lowers the maximum surface temperature below 220°C and even below 100 °C, depending on requirements.
4. Manufacture: First, Thermamax produces a prototype. Which will be test-installed on a mock-up in order to guaranty best fit later on the engine. The individual Tmax-Insulation Cladding is now ready to use and can be installed.
5. Installation: Thermamax installs the exhaust gas/turbocharger cladding – first the prototype – on your engine.
6. Thermography: To ensure that the new insulation system performs as required, Thermamax performs a thermography test.

Tmax offers a SOLAS-check in order to provide a profound assessment to the vessel responsible. Regardless of whether the customer buys the insulation, if necessary, at Thermamax or renews it on his own. And for Tmax-Insulation cladding, the company offers a regular maintenance service during which the insulation is checked against SOLAS requirements and takes care of the production and replacement of the installation if hotspots are detected.



Turbocharger Cladding
Photo: Thermamax

Precision Manufacture
The Thermamax plant in Mannheim, Germany.
Photo: Thermamax

Quiet by Design

Environmental concerns drive ship noise mitigation efforts

Noise Control Engineering (NCE) recently completed an underwater noise study for Washington State Ferries. **Jesse Spence**, President, NCE, discusses the growing mandate to mitigate noise from commercial vessels.

By Greg Trauthwein

Noise Control Engineering, LLC (NCE) recently completed an underwater radiated noise study for Washington State Ferries (WSF), a study which entailed measurement of nine vessels representing all seven operating classes of WSF vessels, quantifying noise, potential impacts to orcas and other marine life, and methods of reducing noise.

"With the increasing awareness of underwater noise impacts on marine life, both globally and locally in the Northwest, WSF is interested in learning more about how their operations may impact marine life," said Jesse Spence, President, NCE. "They are also interested in learning what aspects of their vessel designs cause underwater noise, and if they can reduce their impacts through procedural changes as well potential improvements to the design and engineering of their vessels."

"This work provides the information that WSF needs to take the next steps towards operational and engineered mitigation measures to reduce the impact of underwater radiated noise from our vessels on marine life, particularly the critically endangered Southern Resident Killer Whale," said Kevin Bartoy, Environmental Stewardship & Sustainability Program Manager, Washington State Ferries.

NCE used its Buoy Acoustic Measurement System (BAMS) to perform vessel noise measurements in general accordance with ANSI S12.64 while allowing the vessels to maintain their normal operating schedule. Simultaneously, vessel operational and environmental data was collected allowing for assessments of noise at varying propeller RPMs, operating powers, and speeds. This information was compiled into a database which was used to calculate 'source levels' and identify impacts to marine life using NMFS guidelines. The measurement data was also used to identify causes of noise ranging from propeller cavitation to specific machinery items.

Cutting Ship Noise

While emissions from ship exhaust has been the main target of regulators to reduce shipping's impact on the environment, the matter of noise mitigation with a focus on its impact to wildlife has been a long-running concern, growing in stature in recent years as the overall health and well-being of the ocean and ocean issues have risen in the public conscience.

"Early in 2019 there was a meeting held at the IMO offices in London, organized by Transport Canada, to attempt to quantify what we should do regarding underwater noise limits and quantifiable approaches to noise mitigation. These meetings have all been in response to the rising recognition of our impacts to marine life, with respect to noise," said Spence. "Looking forward, I believe there will be greater acceptance of established noise criteria as independent operators design vessels that meet these criteria and modify existing vessels to reduce underwater noise. This issue has been discussed for nearly (or possibly more than) 20 years, and the momentum is building."

Drivers and Solutions

According to Spence, there are ef-

> "'Environmental' limits are available which are aimed at reducing underwater noise emissions without imposing onerous design limitations and the need to put damping on every panel, stiffener & dinner plate."
>
> **Jesse Spence**, President, NCE

forts to put more regulations in place, particularly for newbuilds, as a focus on shipborne noise continues to grow. "The marine vessel operator community is generally aware of the issue, and some are concerned that if the community does not take action to reduce noise emissions on their own, then tough limits will be set for them.

One of my main takeaways from the 2019 IMO/Transport Canada meeting is the technology is available to reduce noise on commercial vessels. However, the desire and need to have reduced noise must be stated clearly in the vessel specification or it will not get implemented."

With the wide variety of private, commercial and government vessels plying the world's waterways, there is no single 'silver bullet' solution used to mitigate noise from boats and ships. "Every vessel is different, and there is no 'one size fits all' solution for underwater noise," said Spence.

"However, propeller cavitation is a prominent feature of underwater noise for most commercial vessels. Machinery noise will also play an important role, particularly propulsion engines, gensets, gearboxes, and other large equipment."

When asked define 'top tips' to mitigate underwater noise, Spence admitted "Really, I have one. Put a limit in your vessel specification and require the vessel to be designed to meet it. There currently are a variety of underwater noise classifications from ABS, Lloyds, DNV GL, and others. Environmental' limits are available which are aimed at reducing underwater noise emissions without imposing onerous design limitations and the need to put damping on every panel, stiffener, dinner plate, etc. The more these limits are used the more we will learn about what it takes to meet them (with the associated confidence that they can be met), and what this all means to marine life. The limits will likely change over time, as we learn more and refine our understanding of quiet ship design and impacts to marine life. But without the first step of stating "I want lower noise," no progress will be made."

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Fit for Fight

Navies challenged by COVID at sea, ashore

By Edward Lundquist

Despite the COVID-19 pandemic, navies adjusted how they operate at home and while deployed, to keep their forces ready for any missions as they keep their Sailors, families, communities, as well as allies and partners safe from the coronavirus.

Navies have taken a number of prudent preventative measures to limit outbreaks, mitigate cases of infection and reduce the community spread of the virus.

Speaking during his May 29 "On The Horizon: Navigating the European and African Theaters" podcast, Admiral James G. Foggo III, Commander of U.S. Naval Forces Europe and Africa, said The U.S. Navy is "open for business. "Basically, it means that our Navy, no matter what the circumstances, will provide maritime security where and when it's needed. No matter how tough this thing, the coronavirus, gets, we just can't let our guard down."

The global COVID-19 pandemic has had a major impact on navies--from how they manage maintenance and sustainment; to how they train, educate, exercise and operate; to how they have contained the pandemic and treated personnel; to how they have helped respond to people in need.

For Assistant Secretary of the Navy for Research, Development and Acquisition James Guerts, his top priority during the COVID crisis has been keeping a healthy workforce. "We have not closed a single shipyard or FRC (fleet readiness center) through the crisis. We've maintained a strong industrial base, and we've made sure we've got the worked queued up. We have been able to keep new and existing programs on track with high confidence, increasing current readiness and driving costs down. Now we need to focus on the future, so when we get out past COVID we're not where we were, but where we need to be."

Later he admitted that the pandemic has caused disruptions that have led to some inefficiencies, which have added to cost, but that the Navy is committed to keep work funded and on track.

"The fleet's operating tempo has not slowed down, so we can't slow down," Guerts said.

Shipboard infections

COVID cases have occurred on naval vessels around the world, and in some instances ship operations have been curtailed by a Coronavirus outbreak. About one out of every three Sailors aboard the USS Theodore Roosevelt (CVN 71), and aircraft carrier with a ship's company of about 3,000, became infected, and one sailor died. Most of the crew was moved ashore in Guam until they could be free of the virus.

In the case of the USS Kidd (DDG 100), the guided missile destroyer left Pearl Harbor in late March to support counter-drug operations in the eastern Pacific, with apparently no cases of COVID 19, yet nearly a quarter of the crew of 330 were infected when she arrived at San Diego more than a month later. Two of the crew had to be evacuated during the transit. Most of the crew was removed for treatment in San Diego while a skeleton crew remained on board. The ship was able to resume operations on June 10.

During a Mediterranean deployment this spring, the virus infected more than 1,000 crewmembers—nearly half of the crew-- aboard the French aircraft carrier Charles de Gaulle. Several sailors were hospitalized. The ship underwent a cleaning and disinfecting process when it returned to port, and all crew members were tested and monitored.

On Mar. 30, the Dutch Ministry of Defense announced that the country's Walrus class attack submarine HNLMS Dolfijn, had to return to port two weeks early after eight members of its 58-person crew tested positive for COVID-19, and others displayed symptoms. The crew was placed in quarantine after returning to the Netherlands. The crew was tested, those infected were treated and the sub subsequently cleaned. The Dolfijn was back to sea with the same crew three days later.

Exercising caution

While some at-sea exercises were postponed, cancelled or curtailed, other went ahead with prudent precautions in place.

The biennial Rim of the Pacific (RIMPAC) maritime exercise is being conducted as an at-sea-only event in light of COVID-19 concerns. The exercise was planned to conduct a

Fit for the COVID Fight
Sailors stand in ranks before manning the rails of Nimitz-class nuclear aircraft carrier USS Carl Vinson (CVN 70).

Photos: U.S. Navy Photo by Petty Officer 3rd Class Christian Huntington

meaningful exercise with maximum training value but minimum risk to the force, allies and partners, and the people of Hawaii. "In these challenging times, it is more important than ever that our maritime forces work together to protect vital shipping lanes and ensure freedom of navigation through international waters," said Commander, U.S. Pacific Fleet Adm. John Aquilino. "And we will operate safely, using prudent mitigation measures."

As the U.S. Navy continues to limit the spread of COVID-19, RIMPAC 2020 is not scheduled to include social events ashore. Joint Base Pearl Harbor-Hickam will be accessible for logistics support, with a minimal footprint of staff ashore for command and control, logistics, and other support functions.

According to a NATO statement from Allied Maritime Command regarding the recent Dynamic Mongoose multinational ASW exercise, just one sailor with COVID-19 could mean the entire ship becomes infected. "All our missions have robust procedures in place to protect our people and prevent the spread of the virus. The particular action of each ship is dictated by the ship's national policies. In general, it's limiting contact between ships, hand washing, disinfecting of supplies transferred, routine ship dis-infecting and, when in port for resupply, crews are not allowed to leave their ships. Our ships are essentially self-quarantined in place as units," the statement read.

"It is vital that we are able to conduct our operations and tasks regardless of the threat from COVID-19. Reducing the risk of getting the virus on board our ships in the task group is therefore one of my top priorities", said Commodore Yngve Skoglund of the Royal Norwegian Navy, Commander of Standing NATO Maritime Group One (SNMG1), and who led the ships participating in the Dynamic Mongoose exercise.

Ships from Standing NATO Mine Countermeasures Group Two (SNMCMG2) that were participating in the Dynamic Manta ASW exercise in the Mediterranean started implementing protective measures starting as early as Feb 27, including a wet chloramine carpet at the flagship entrance, antibacterial gel cans, masks and gloves.

Around 30 ships from 19 NATO Allied and partner nations participated in the annual BALTOPS maritime exercise in the

Baltic in June, although the amphibious component of the exercise was cancelled along with ships visits and personnel exchanges because of COVID concerns.

Royal Danish Navy Commander s.g. Henning Knudsen-Hauge, Commander of Standing NATO Mine Countermeasures Group One, said his ships disinfected provisions and spare parts taken on board, and eliminated physical contact with personnel outside the group. Port visits were replaced by short logistical stops without shore leave, and all official calls were either cancelled or digitalized.

People, training and education

Tens of thousands of Sailors as well as family members, who were scheduled to move to a new duty station were affected by a "stop movement order" in mid-march that lasted about five months and temporarily halted all travel. This took place right in the middle of the busy summer months when families typically execute permanent change of station moves between school years. Many Sailors couldn't depart for their next assignment until their relief had reported aboard.

Training and education have been affected by the pandemic. In the U.K., Cadets from Royal Navy university units are volunteering to drive ambulances, treat coronavirus patients, look after the vulnerable in lockdown and even advise political leaders – at the same time as they continue their studies.

As the pandemic spread, service academy students were sent home and completed their coursework online. The U.S. service academies created online workouts and exercise sessions for students to keep up their physical training.

The U.S. Naval Academy and Coast Guard Academies held virtual graduation and commissioning ceremonies. The usual commissioning ceremonies for the Naval Reserve Officers Training Corps and universities around the country were cancelled and replaced with virtual events. The Marquette University NROTC unit commissioned its midshipmen as ensigns and second lieutenants administering the oath of office during in a ceremony carried on YouTube. The new officers were in uniform at their homes, and had their families and friends put on their new insignia as officers.

New recruits attending the Navy's enlisted boot camp at Recruit Training Command in Great Lakes in Illinois, are sequestered for a 14-day ROM as a COVID mitigation measures. Incoming freshmen at the U.S. Naval Academy in Annapolis, Md., underwent a 14-day ROM in Bancroft Hall, the academy's huge dormitory.

The Naval War College in Newport R.I., is using tools like Zoom, Blackboard and Microsoft Teams for orientation and instruction. The summer quarter education at Naval Postgraduate School in Monterey, Calif, will be delivered via distance learning, although a small number of students will be allowed to perform lab work and research and take part in classified classes. For ships at sea, the number of safe ports to visit has been dramatically reduced. Guam in the Pacific and Rota, Spain in the Mediterranean are two examples of ports where the Navy already has a presence and can ensure compliance with COVID protocols.

The crew of USS Nimitz (CVN-68) was sequestered inside the skin of the carrier for nine days of a 14-day ROM period before heading to sea for pre-deployment training.

The USS Dwight D. Eisenhower (CVN 69) and USS San Jacinto (CG 56) returned to their homeport of Norfolk, Virginia, on Aug 9th. Due to the COVID 19 pandemic, the ships

Safe Navigation
Sailors navigate the ship in the bridge of the Nimitz-class aircraft carrier USS Dwight D. Eisenhower (CVN 69). Dwight D. Eisenhower Carrier Strike Group has remained underway as a ready strike group during the COVID-19 global pandemic.

U.S. Navy Photo by Mass Comms Specialist 3rd Class Sawyer Haskins

remained continuously at sea for 200 days. with no port visits.

Caribbean Cooperation

France, the Netherlands and the United Kingdom are working together to provide a coordinated humanitarian response in the Caribbean, where all three nations have a presence. The French amphibious assault ship Dixmude, British primary casualty receiving ship RFA Argus and Dutch multi-function support ship for amphibious operations HNLMS Karel Doorman are now in the region to help with the COVID-19 crisis currently affecting their overseas territories.

RFA Argus and her 100-bed medical facility, was already scheduled to sail for the Caribbean, a region that contends with severe hurricanes and tropical storms each year, and Argus is prepared to respond if needed, but she is well equipped to assist British Overseas Territories dealing with the COVID-19 outbreak. In addition to Dixmude, the French navy mobilized its other two its Mistral-class amphibious assault ships in response to the coronavirus pandemic. Mistral was dispatched to support the French territory of Reunion in the Indian Ocean, and Tonnerre was sent to Corsica. The Karel Doorman carries a medical support unit and can also supply the other with fuel. A coordination cell has been set up on the French island of Martinique to manage cooperative efforts when necessary. Looking to the not-too-distant future, normality won't return until the virus can be prevented. Russia already claims to have a vaccine. A number of promising multi-national efforts are underway. The U.S. Department of Defense claims that the public-private partnership "Operation Warp Speed," is on track to meet its goal of delivering 300 hundred million doses of safe and effective COVID-19 vaccines by the end of the year. In any event, navies will likely play a role in testing and administration of new vaccines to combat COVID 19.

Global impact

Even in February navies were becoming aware of the virus. When the Royal Malaysian Navy (RMN) ship KD Lekiu was assigned to escort a floating superstructure owned by Malaysian oil company Petronas from South Korea to Malaysia, everyone on board was given a clean bill of health prior to leaving home port, and again when they arrived at Geoje-do, an island off the port city of Busan.

According to RMN Lt. Norzuhaira Ruhanie, a new normal started to creep into the ship's operation and routine when the global pandemic was declared, including a greater focus on good hygiene.

"In port, masks were procured for the crew and hand sanitisers in the sick bay were put to good use," Ruhanie said. "Social distancing was practices as much possible. The medical officer on board, Lt (Dr) Amirul Arzahar, was kept busy with regular screening of the crew throughout the return journey. The commanding officer, Captain Shaiful Nizam, realised the journey home was a form of self-quarantine for him and the crew. No crew members became infected during the mission."

The RMN is working closely with the Malaysian Armed Forces' Health Service Division and the Army's Royal Medical and Dental Corps, in preparing a standard operating procedure," she said. "Regular screening and health checks are now required of all navy personnel involved in routine operations."

In Thailand, the Navy and other services had to cut their budgets by a third to enable the government to fight the pandemic. Among the cost-cutting measures being implemented, the Navy is postponing procurement of its second and third submarines as a result.

The Bangladesh Navy assisted the civil administration in implementing the government's directives to fight coronavirus. Navy personnel distributed food, water, masks and disinfectant soap to local communities, and conducted an awareness campaign about social distancing and sanitation to prevent the virus transmission. The Navy had ships visiting ports and fishing villages to raise awareness among local communities about the coronavirus outbreak.

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Necessity: the Mother of Invention

Nothing inspires change quite like being told to do something, in the case of maritime this means new legislation mandating increasingly strict emissions reduction limits. Profiled here are some innovative new and emerging designs.

Stena Bulk's IMOFlexMAX

Stena Bulk continues its IMOIIMAX design with a prototype for a new chemical tanker, the IMOFlexMAX, which will be designed to reduce greenhouse gas emissions by more than 25% compared to modern product tankers. IMOFlexMAX has been designed by naval architects at Stena Teknik. From hull design to vessel propulsion, these ships will incorporate the latest technology, including Flettner rotors and solar panels to harvest energy from wind and sunlight. They will be powered by dual-fuel engines that can run on LNG as well as conventional low-sulfur fuels, but will be flexible to consider alternative fuels based on client and regional demand.

Ammonia-Fueled Tugboat

A trio of marine powers in Japan seeks to develop the world's first ammonia-fueled tugboat. A joint R&D agreement was signed by NYK, IHI Power Systems, and ClassNK recently to put the world's first ammonia-fueled tugboat into practical use. To start, in fiscal 2020 the companies will tackle themes such as technological development of the hull, engine, and fuel supply system, and development of safety navigation methods. After evaluating the practicality of the R&D results, the JV will begin study of the construction of the ammonia-fueled tugboat and the plan for construction. NYK Line will focus on R&D of the hull and fuel supply system; IHI Power Systems will address R&D of engine and exhaust gas aftertreatment devices; and ClassNK will focus on safety assessment of ammonia-fueled tugboat

Battery-Powered HS Ferry

A Washington State team was selected for funding from the U.S. Department of Transportation's Federal Transit Administration. Kitsap Transit is a public-private partnership team is being led by Washington Maritime Blue to advance the fast foil ferry design and the business case for sustainable operations. The funding from FTA, which will provide $372,910 as part of the Accelerating Innovative Mobility initiative, and other funding will help to complete the

Ammonia-Fueled Tugboat

Image Courtesy NYK, IHI Power, ClassNK

Battery-Powered HS Ferry

Image Courtesy Glosten

Stena Bulk's IMOFlexMAX

Image Courtesy Stena Bulk

preliminary design for a high-speed passenger ferry powered by battery-electric, low-emission technology. The hydrofoil design will use lightweight carbon fiber construction and batteries to speed up travel between urban centers and suburban and rural communities, reducing and perhaps eliminating fuel use compared to conventional fast ferries.

Program partners include: naval architecture and marine engineering firm Glosten; Anacortes-based Bieker Boats; DNV GL; as well as public sector stakeholders.

AiP for CTV

BAR Technologies and Chartwell Marine earned Approval in Principle (AiP) from the American Bureau of Shipping (ABS) for the design and construction of the new BAR 30m crew transfer vessel (CTV). Vessels servicing the expanding U.S. East Coast offshore wind development areas will increasingly need to travel further for longer, while navigating deeper waters and greater wave heights. To meet this challenge, BAR, with the support of Chartwell, developed a 30m CTV, making use of FOSS technology (foil optimized stability system) to enhance seakeeping and maneuverability, while reducing vertical acceleration by up to 70% in 2.5m wave heights. While offering greater levels of availability in rough seas, the BAR 30m CTV also demonstrates up to 50% fuel efficiency savings at 15 knots, keeping emissions at bay in line with stringent EPA Tier 4 guidelines.

Monomaran Crewtender

Coastwise Offshore Services and Next Generation Shipyards signed a contract for the building of a new type of vessel, an aluminum vessel for the offshore wind-industry, with an option for three additional vessels.

The new boat aims to combine the stability of a catamaran with the speed and fuel efficiency of a monohull, and the building of the vessel was at the initiative of Coastwise Offshore Services, the new shipping enterprise owned by Eelko Wijdieks, Douwe van den Berg and Onno Nienhuis. Harlingen-based SeaZip Offshore Service will be responsible for the commercial management of the vessel.

The combination of monohull and catamaran is reflected in the new vessel type name: the 30 Pax Monomaran Crewtender- Endurance class NG2727. The 27-m, 27-knot vessel is scheduled to be delivered to Coastwise December 2021.

New Fishery Inspection Vessel

Danish naval architects OSK-ShipTech A/S designed, and Hvide Sande Shipyard will build a new $27m fishery inspection vessel for Danish Fisheries Agency. Ny Vestkysten will replace the existing MV Vestkysten from 1987. In addition to its main purpose as fishery inspection vessel for the North Sea and Skagerrak area, the new vessel is designed to fit future inspection challenges, e.g. by the use of large drones, and cover service functions such as emergency towing assistance, salvage, and surveys.

AiP for CTV

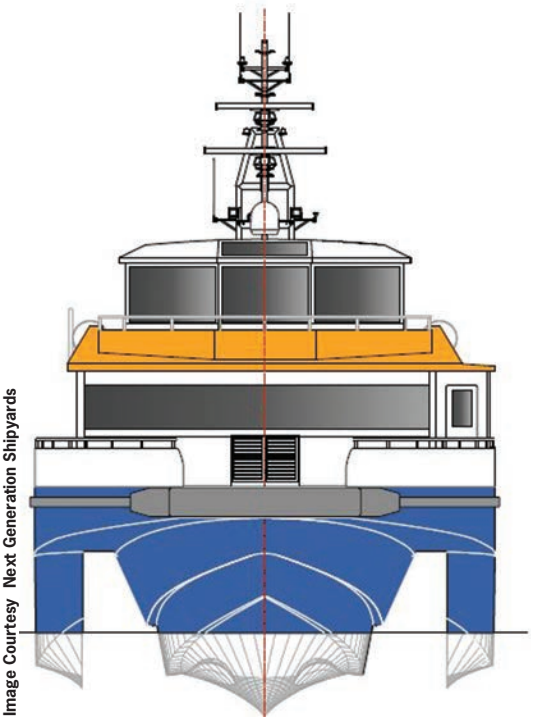


Image Courtesy Next Generation Shipyards

Monomaran Crewtender

Image Courtesy Next Generation Shipyards

New Fishery Inspection Vessel

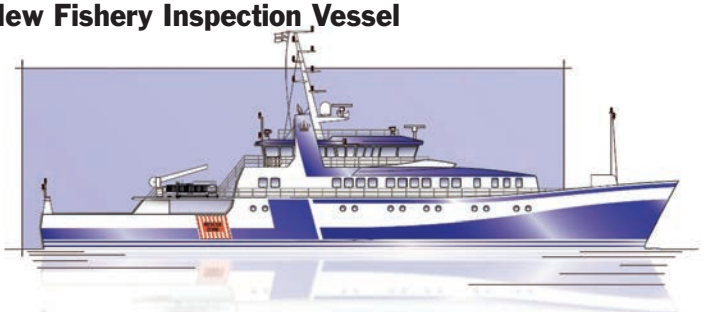


Image: © OSK-ShipTech A/S

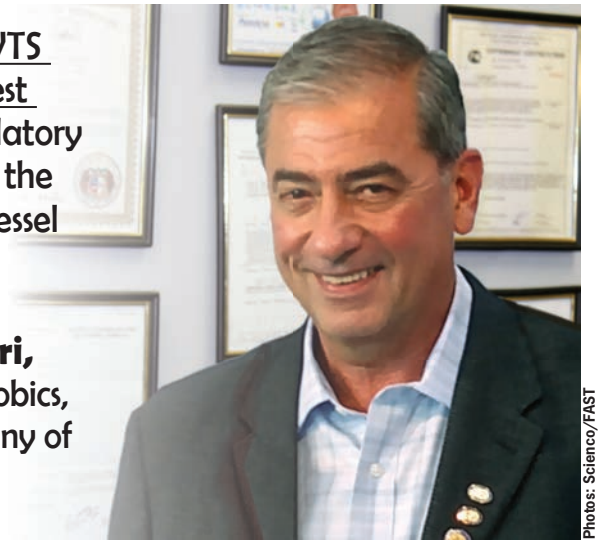
Scienco/FAST Acquires InTank BWTS

Last month Scienco/FAST, a subsidiary of BioMicrobics, Inc. and specialists in water and wastewater treatment, added an important capability with its acquisition of the InTank BWTS from Envirocleanse, a division of Charter Brokerage, LLC, a Berkshire Hathaway Company. Robert J Rebori, President, BioMicrobics, Inc., discusses the deal and its importance to his company's business.Scienco/FAST's business is centered on providing water and wastewater treatment systems, and last month it completed the deal to acquire the InTank Ballast Water Treatment System (BWTS), a system tailor-fit for the company's business plan an manufacturing capabilities.

"We acquired the InTank BWTS technology and all IP assets," said Rebori, who said that the benefits of the InTank system are easy to see, pointing out that it is the only BWTS that can treat InVoyage, as opposed to InLine systems with filters that need to work in port.

"The InTank BWTS provides the best confidence of regulatory compliance with the least impact to vessel operations."

Robert J Rebori,
President, BioMicrobics, Inc., parent company of Scienco/FAST



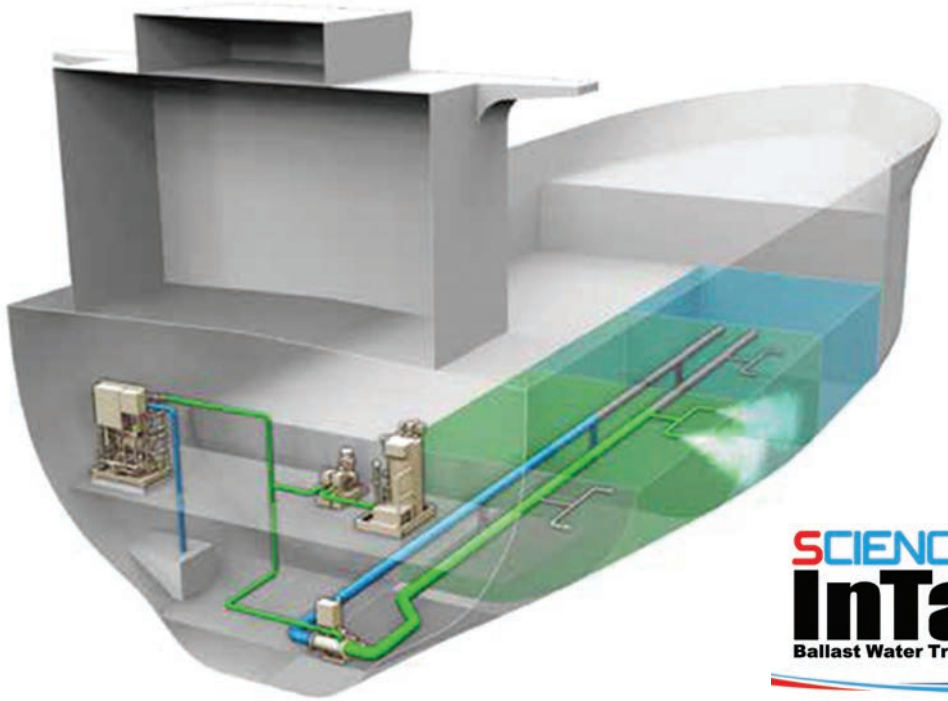
Photos: Scienco/FAST

With patented nozzles inside the ballast tanks and a hypochlorite generator, the InTank BWTS is an "InVoyage" and unique, ballast water management system, which – thanks to its lack of filtration and complete independence of ballast pumps or lines – is immune to many of the problems associated with ballast including pump flow rates, pressure losses and power shortages, according to SciencoFast.

According to Rebori, a key factor in the technology acquisition was familiarity with the process. "We have our own knowledge of our own sodium hypochlorite generators, so we understood their approach to ballast water treatment and the advantages."

"The InTank BWTS provides the best confidence of regulatory compliance with the least impact to vessel operations. It is an important and unique addition to the current offerings in the marketplace. Add all of these advantages to the fact that we are the most life-cycle, cost-competitive system on the market."

According to Rebori, the market for this system is worldwide for large vessels for bulkers, heavy lifters, semi submersibles, and large tankers that use large amounts of ballast water and often long voyages



SCIENCO® InTank™ BWTS
Ballast Water Treatment System

FPSO Digital Twin

Image: Akselos SA

Akselos SA (Akselos) deployed a structural Digital Twin for Shell's Bonga Main FPSO, located 120km Southwest of the Niger Delta in Nigeria. The structural Digital Twin, which is based on Akselos' patented RB-FEA technology, selected by Shell Nigeria Exploration and Production Company (SNEPCo), Shell's deepwater company in Nigeria and operator of the 225,000 oil barrel capacity FPSO. The Bonga Main FPSO, which became operational in 2004, has a capacity of 225,000 barrels per day and weighs more than 300,000 tonnes, making it the largest asset in the world to be protected by a structural Digital Twin.

Shaftmaster Torsionmeter

Hillhouse Industrial & Marine, Inc's ShaftMaster torsionmeter systems will help maintain the vessel's performance by having historical data such as shaft horsepower, shaft RPM, shaft torque, total shaft revolutions, and engine hours, triggered by a RPM setpoint. It is available to compare on a monthly, daily, or even hourly basis.

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Image: Hillhouse

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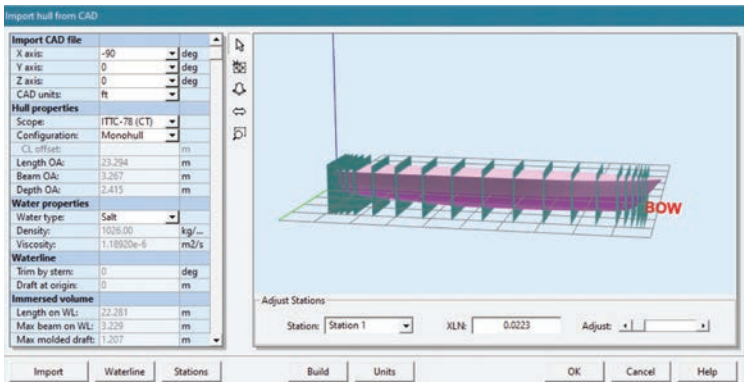


Image: HydroComp

Vessel-Propulsor-Drive Simulation

Development in 2020 for HydroComp NavCad offers new features for all three parts of NavCad's Vessel-Propulsor-Drive system simulation, as well as an improved user experience.The Hull CAD Import feature introduced in 2019 has been further developed for improved user feedback and process efficiency. It also is a key piece to a more efficient design workflow when coupled with hull CAD tools, such as with the new NavCad links from Orca3D and PROLINES.

Vessel resistance and hull-propulsor predictions have been enhanced, including a new hull loading parameter for evaluation of and appropriate planing hull method, updates to the Analytical Distributed Volume Method (ADVM), and prediction of form factor estimates. Data definition for Submarine/SWATH prediction in NavCad has been updated for easier definition from CAD models and early-stage conceptual parametric geometries. New prediction capabilities include updated resistance and hull-propulsor prediction, as well as a "nose flat" pressure drag model developed from an in-house R&D project. A major update coming in late 2020 is a new module for electric motors as the prime mover of NavCad's Drive component. Development includes consideration of AC and DC motors, with particular development for easy user definition of standard motor types.

New Tier 4 Mitsubishi Marine Propulsion Engine

Mitsubishi debuts the new mechanical controlled, EPA Tier 4, 1,260-hp heavy-duty marine propulsion engine. The Tier 4, Mitsubishi S12R Tier 4 is a 49-liter, V-12, 1,260-horsepower marine propulsion engine operating at 1,600 rpm. While the engine offers simple mechanical controls and big displacement, it uses SCR technology in meeting the NOx Tier 4 emission requirements. The S12R-Y4 engine has met Tier 4 certification requirements and is available for order now. According to Mitsubishi Marine Engine Manager Takeshi Yoshida, bucking the industry trend of moving to to complex electronic engines in 2007, Mitsubishi chose another approach: a series of mechanical engines that met the Tier 2 EPA emission regulations. "It was remarkable that Mitsubishi met Tier 2 with a simple mechanical engine," said Yoshida. But then the company was able to introduce a series of Tier 3 EPA certified engines, also without the introduction of electronic controls." Yoshida added that the new Mitsubishi S12R-Y4MP-TAW-3 EPA certified Tier 4 engine will also have mechanical controls.

Image: Mitsubishi

Aussie Sea Skipper Joins the Korean Navy

Aussie Pumps won a contract to supply 3-in. engine drive salvage pumps for the Republic Of Korea Navy. "The original requirement was for a lightweight portable diesel drive salvage pump, capable of handling saltwater," said Chief Engineer John Hales. "We'd already developed high pressure firefighting pumps for seawater applications in the form of both the Seamaster and Sea Skipper diesel drive machines." Those pumps are already in use by the Royal Australian Navy, the Indian, French, Sri Lankan and Bangladesh navies as well. "We found that we could configure as self priming salvage pump that would deliver in excess of 1,000 liters per minute and handle solids in suspension where required," said Hales. "The solid handling issue was a big one, as well as the ability to self prime through a vertical lift of 7 meters or more." The pumps are powered by Yanmar air cooled 10hp diesel engines with electric start and/recoil backup. The complete pumps are fitted into a stainless steel frame with an 18 liter, 10 hour fuel tank.

Quantum Dyna-Foil: Next Gen in Marine Stabilizer Systems

Marine stabilization technology has advanced rapidly in recent years. Quantum, the inventor of Zero Speed stabilization and a player in the stabilizer space for more than 35 years has launched the latest, patented system, Dyna-Foil.

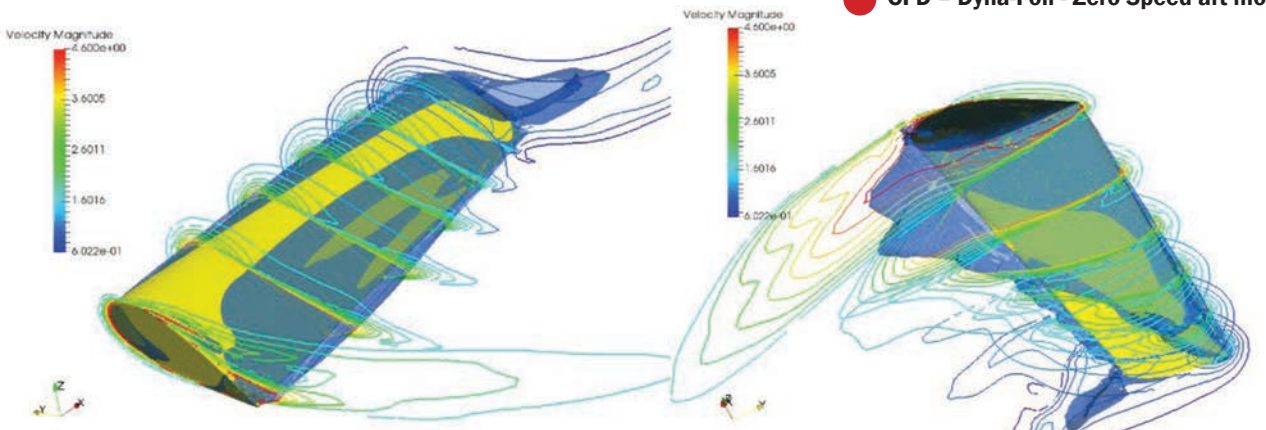
Dyna-Foil, was inspired by the 80-year-old airfoil design, developed by the National Advisory Committee for Aeronautics (NACA), the precursor to NASA. Through the use of complex Computation Fluid Dynamics (CFD) calculations, the shape of the Dyna-Foil was refined several times, including adjusting the thickness, aspect ratio, trailing edge profile, fairing shape and more. The Coefficient of Lift generated in the latest design, is 0.78 swinging aft and a 1.1 Coefficient of Lift swinging forward, while operating in Zero Speed mode. Basically, the unit has a larger lever arm than a standard stabilizer fin which increases the stabilizing moment or torque for better roll reduction. In addition, the force exerted by the foil, happens over a greater range of motion, smoothing out the stabilizing action.

The system features a high aspect, articulating foil that maximizes roll reduction, accommodating all speeds. Dyna-Foil represents the only system with a "dedicated" design for Zero Speed and underway performance with a retractable feature.

Another objective in the development phase was to satisfy stabilizer requirements for zero, slow, medium and higher speeds while offering solutions for various install configurations. In Zero Speed mode, the swinging motion creates flow over the foil and therefore lift for optimal stabilization. While underway, the foil can be fully extended with minimal drag or retracted. Dyna-Foil is suitable for vessels with space limitations for a fixed fin to fit within the hull's envelope and Ice Class applications. Dyna-Foil can be installed with or without a pocket and is fully functional up to 25 knots, while delivering lift that directly impacts performance. The higher lift-to-drag ratio versus a standard fin means that there is less impact to vessel speed and reduced fuel consumption, achieving a higher lift force with a smaller angle of attack.

A Dyna-Foil prototype was recently installed on a 70m refit. The initial results from the first two sea trials, surpasses the predictions and calculations recorded from the CFD calculations and model testing.

CFD – Dyna-Foil - Zero Speed aft motion.



CFD - Dyna-Foil - Zero Speed forward motion.

Image: Quantum

Images: Quantum

Retractable with pocketed option.

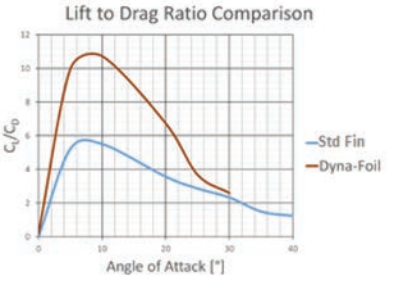


Photo: Aytug/Askin/AdobeStock

MarTID 2020

The 3rd Annual Survey of Global Maritime Training Practices

By Greg Trauthwein

Training budgets for seafarers continue to rise around the world, and seafarers themselves increasingly are paying the price, according to the MarTID 2020 Training Practices Report.

Responses (278) to the 2020 MarTID report, the third in the series, rose 60% versus 2019, and again included insights from seafarers (accounting for 53% of the response), vessel operators (24%) and METIs (23%).

The survey for MarTID 2020 was concluding just as COVID-19 was starting to spread rapidly, so the full scope of the pandemic's impact on the global economy did not have a significant impact on this year's report results. But it would be remiss to not look at maritime training through a COVID-19 lens, as every industry and walk of life is viewed today through this same lens, particularly with the serious impact the pandemic has had, and continues to have, on the world's seafarers.

"Seafarers continue to serve the global community as facilitators of a key link in the global logistics chain, particularly when the challenging events of the 2020 COVID pandemic are considered," wrote Cleopatra Doumbia-Henry, President, World Maritime University, in the Preface for the MarTID 2020 Training Practices Report. "In all the chaos, and sadly also with the alarming absence of proper and appropriate treatment of seafarers in many jurisdictions, the technical work of seafarers, by and large, keeps the global economy moving. Their competence, development, knowledge and skill retention and transfer to actual work settings is as critical as ever. Training needs to be kept in focus.

According to the International Chamber of Shipping (ICS), as of July 23, 2020, there were more than a half a million seafarers (out of nearly 1.7 million seafarers globally) impacted by the ongoing crew change crisis, with "over 250,000 seafarers trapped at sea." The Black Swan event undoubtedly will color the results of the 2021 MarTID report: "With challenge, comes opportunity. With many traditional places of learning closed so as to minimize human interaction and the need for travel, the drive for innovation has never been stronger," wrote Captain John Lloyd, RD MBA FNI CMMar, Chief Executive Officer, The Nautical Institute, in the Foreward to the MarTID 2020 report. "Those organizations with a solid foundation in flexible and remote learning found themselves well placed to address the market need in these circumstances. Others had to respond quickly with new

training solutions."

The full effects of COVID-19 on maritime training will not be realized for but until then, here are some of the significant findings from the 2020 report.

Maritime Training Budgets Rise … (again)

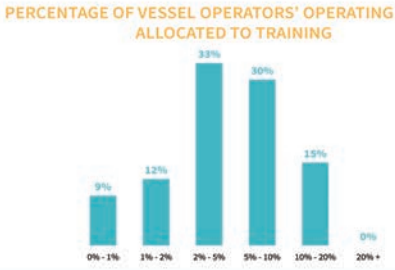
Training budgets have been rising for vessel operators and the trend is expected to continue into the future. 84% of vessel operators spent under 10% of their operating budget on training, with roughly two-thirds spending between 2% and 10%. Compared to the previous surveys, the reported training budgets are trending upwards. Nearly 60% of operators have seen an increase in their training budget over the previous year. Looking at METIs, an average of two thirds of a METIs' overall operating budget is spent on training activities and equipment, an increase of 14.5% over the 2019 MarTID survey, where the average was a little over half at 53.3%.

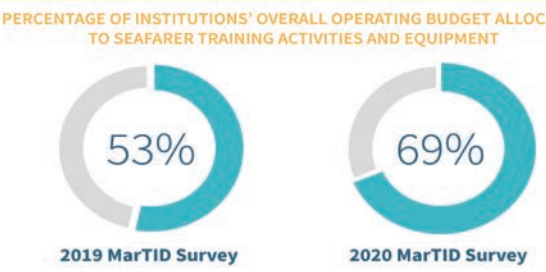
In-Person vs. Online

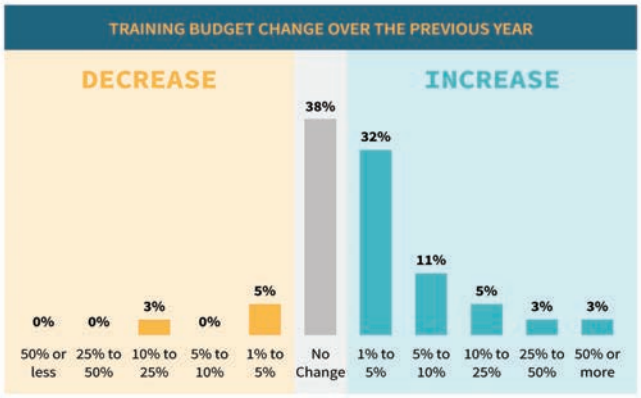
Taking deeper dive into how training budgets are spent, vessel operators report that face-to-face classroom training remains the most heavily used training method. At 84%, face-to-face classroom training is used more than internet-based e-learning, the second most used training method, which 76% of operators indicate is used to a high or medium degree.

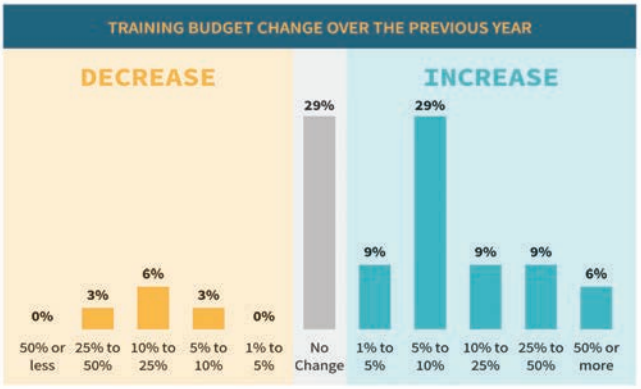
But the tide is changing, as this year's report found that 16% have reduced face-to-face training over the last year; and 23% expect to use less of it in the coming year. In contrast, in regards to internet-based e-learning, 65% of respondents indicated increased usage over the last 12 months, and 84% antici-

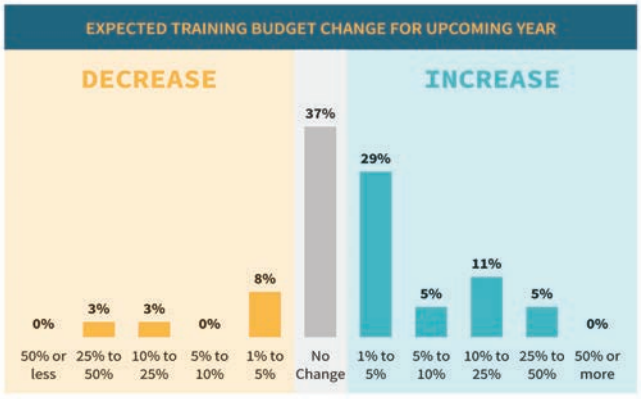
Where are Training Budgets Heading? Up!

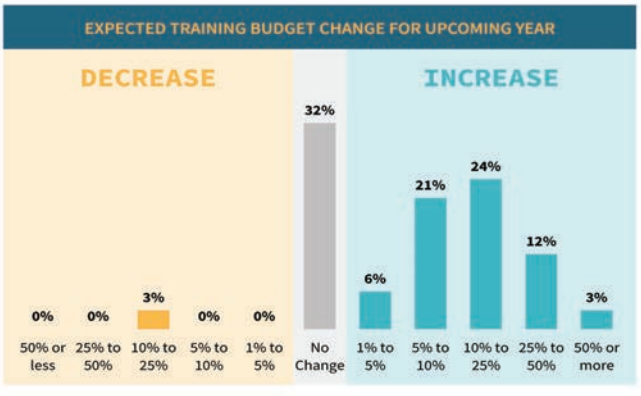












All Charts Courtesy MarTID

pate increased usage over the coming 12 months.

While the balance between face-to-face instruction and internet-based e-learning is more weighted toward in-person training at METIs than at operators, the trend toward increased use of internet-based e-learning appears almost as large, as the MarTID 2020 report show that 56% of responding METIs indicate an increased use of internet-based e-learning in the past 12 months and 69% anticipate an increase in the coming 12 months.

Though it is not reflected statistically in the 2020 report, the evolution of face-to-face training versus e-Learning will be a fascinating one to watch in the coming years as the full effects of COVID-19 are realized. One consistent throughout: primary training drivers remain increased safety and accident reduction.

MarTID 2020 also surveys operators on the use of tools and systems in training operations. For some, a single system manages all three (training, assessment and competency), while for others, a combination of software, forms and online tools are used. Technology, as is clearly illustrated, will increasingly play a role in the future.

Seafarers Increasingly Pay for their Own Training

In step with operators and METIs rising budgets, the cost for training to seafarers continues to rise as well. Similar to the 2019 MarTID survey results, more seafarers rely on self-funding for their seafarer training than those who rely on their employer (roughly 43% self-funded in 2019). Most seafarers spent under 20% of their annual income on seafarer training, with roughly 17% spending anywhere from one-tenth to one-fifth of their income on training.

Nearly half of responding seafarers have seen an increase in personal training expenditures over the last five years, and more than 60% believe that they will spend even more for the upcoming year.

And what is all of this increased expenditure delivering? The answer to that is perhaps fuzzy at best, as 78% of seafarer respondents report that they work for an organization that does not assess the impact of their training on their work performance.

The most common training method experienced by seafarers is the traditional, in-person classroom, as only 14% of seafarers indicate they no longer experience this method. Not far behind are e-learning and simulation, as roughly 45% - 50% of responding seafarers encounter either a high or medium amount of simulation or e-learning in their training. Job shadowing, mentoring and coaching were the least encountered training methods.

"Many participants in this survey have noticed an increase in on-line training and expect this increase to continue," wrote Captain Lloyd, CEO, The Nautical Institute, in the Foreward to the MarTID 2020 report. "There is a high level of confidence this methodology meets the industry needs and provides cost-effective solutions. For those paying their own way – the saving benefit is especially important."

The MarTID 2020 survey also asked seafarers to list training they would like to freely engage in, with relation to their career. The most common response was simulation, with more than 18% of re-

What's Changing? Vessel Operator's Expected Change in Training Methods

All Charts Courtesy MarTID

spondents citing increased simulator training. Following that, ship handling and practical on-the-job training were the next most commonly mentioned training initiative, with 8% of respondents mentioning them.

Quantifying Quality in Training

This year's focus theme is Quality in Training. Growing training budgets and state-of-the-art training methods and technologies are useless if training needs are not correctly identified and if outcomes are not properly assessed. The 2020 reports found that a majority of operators follow some sort of mechanism or process for training quality assurance, while every responding METI has a process or standard in place for training quality. Among respondents, about 50% of the operators and 80% of the METIs indicated that they follow an externally defined quality standard in their training operations. At the same time, seafarers perceive the quality of their company-originated training onboard to be significantly less than optimal.

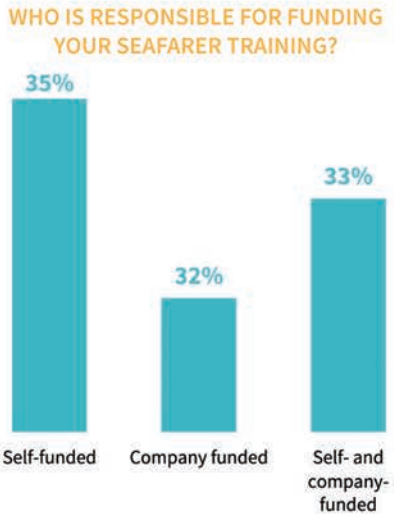
Ensuring quality in training often comes down to individuals in the organization tasked in this regard. For operator respondents, 85% have a someone in charge of ensuring training quality, and the chart here indicates their level of direct report.

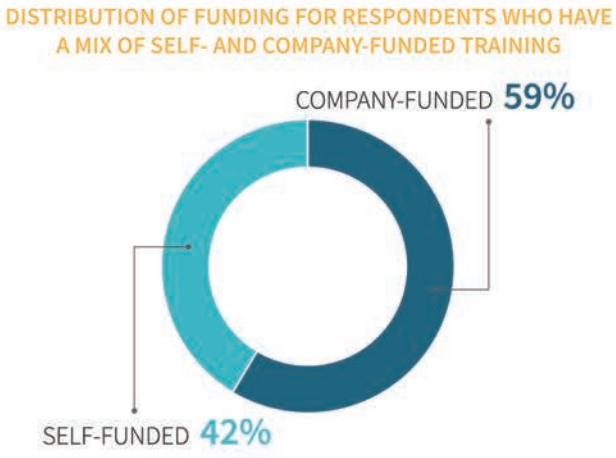
Continuous Improvement is at the heart of any quality processes, and training is no exception. Here the MarTID 2020 report found a stark contrast between vessel operators and METIs, with only 55 percent of vessel operators and nearly 90% of METIs following a continuous improvement program for training quality.

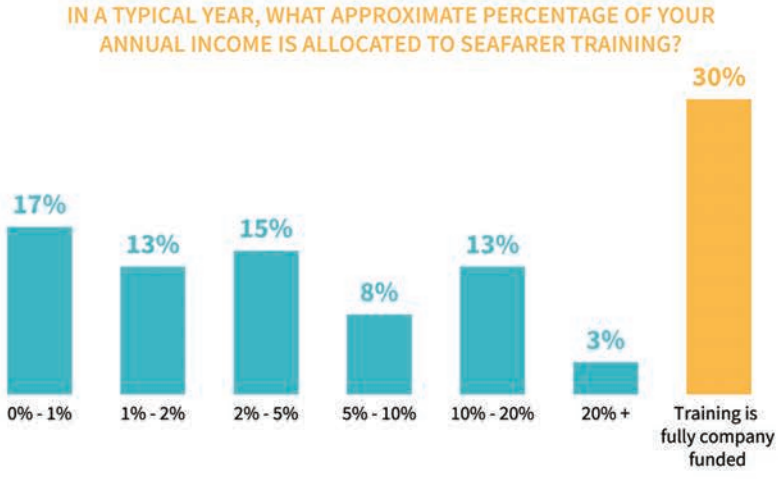
More than half of both METIs and operators indicated that these processes covered a wide variety of training components including instructor performance, curriculum design, assessments, outcomes and facilities.

In terms of actual metrics which were used as data to inform continuous train-

Who Pays? Increasingly, Seafarers







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ing improvement, the most common ones used by operators included safety records, job performance, and overall crew performance.

A smaller but still significant number looked at trainee feedback, trainee assessment results, and fine-grained analysis of individual questions on assessments. For METIs, the three most-cited metrics were customer feedback, student assessment results and trainee feedback.

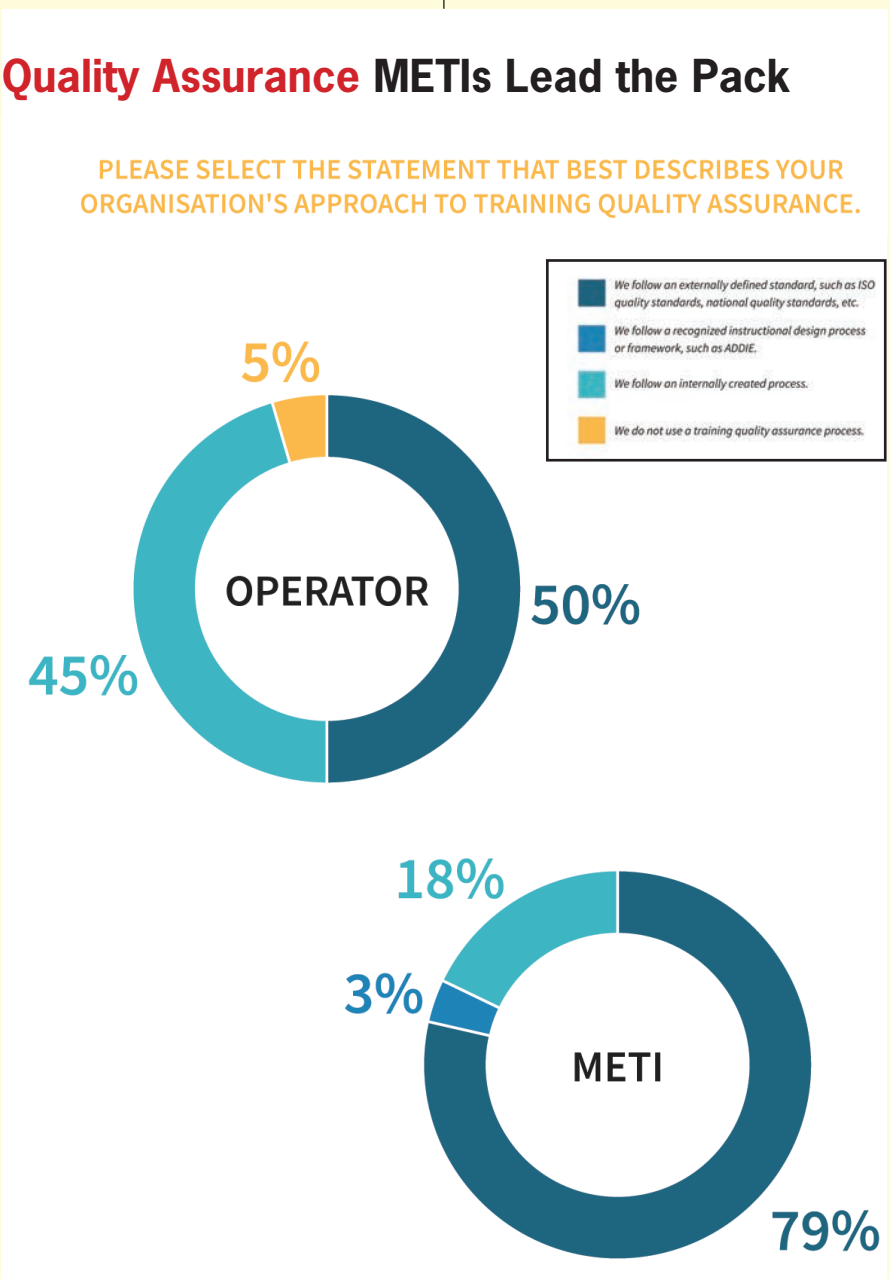
The Future of Maritime Training

The future for many industries today is unclear, and while the health, welfare and plight of the seafarer has been the mantra for many years, the importance of the seafarer as a vital cog in the wheels of global commerce has never been so apparent, particularly when nearly one-third of the world's seafarers and their families are impacted by COVID-19.

As the MarTID Training Practices Report has confirmed for the past three years, both operators and METIs consider "reducing accidents" and "improving safety performance" to be two key drivers to maritime training. In this regard, it appears that the focus has been a success. According to the Allianz Safety & Shipping Review 20202, there were 41 total losses in 2019 – a record low – representing a 70% decline in 10 years. While total losses were down, the cumulative number of "shipping incidents" rose 5% to 2,815, with machinery damage/failure (1,044 incidents) as the top cause. Looking again at the connection between the seafarer, training and ship safety, the Allianz report stated:

"One of the biggest issues has been the inability to change crews easily because of pandemic restrictions. Relief of crew is essential in ensuring the safety, health and welfare of seafarers. Extended periods on board vessels can result in mentally and physically fatigued crew, which is known to be one of the underlying causes of human error, estimated to be a contributing factor in 75% to 96% of marine incidents."

Quality Assurance METIs Lead the Pack



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Read the Report:

For free access to the full MarTID 2020 report, please visit: http://scholar.wmu.se/martid

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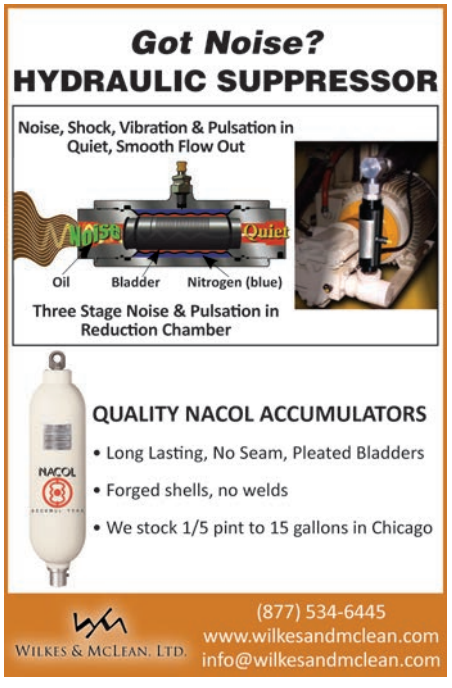
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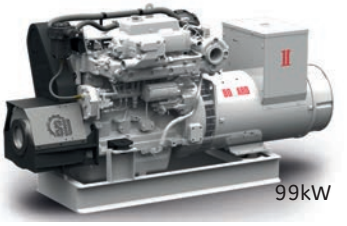

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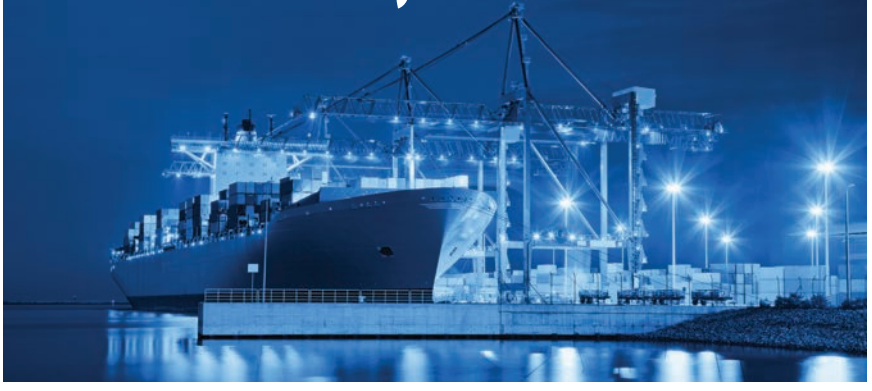

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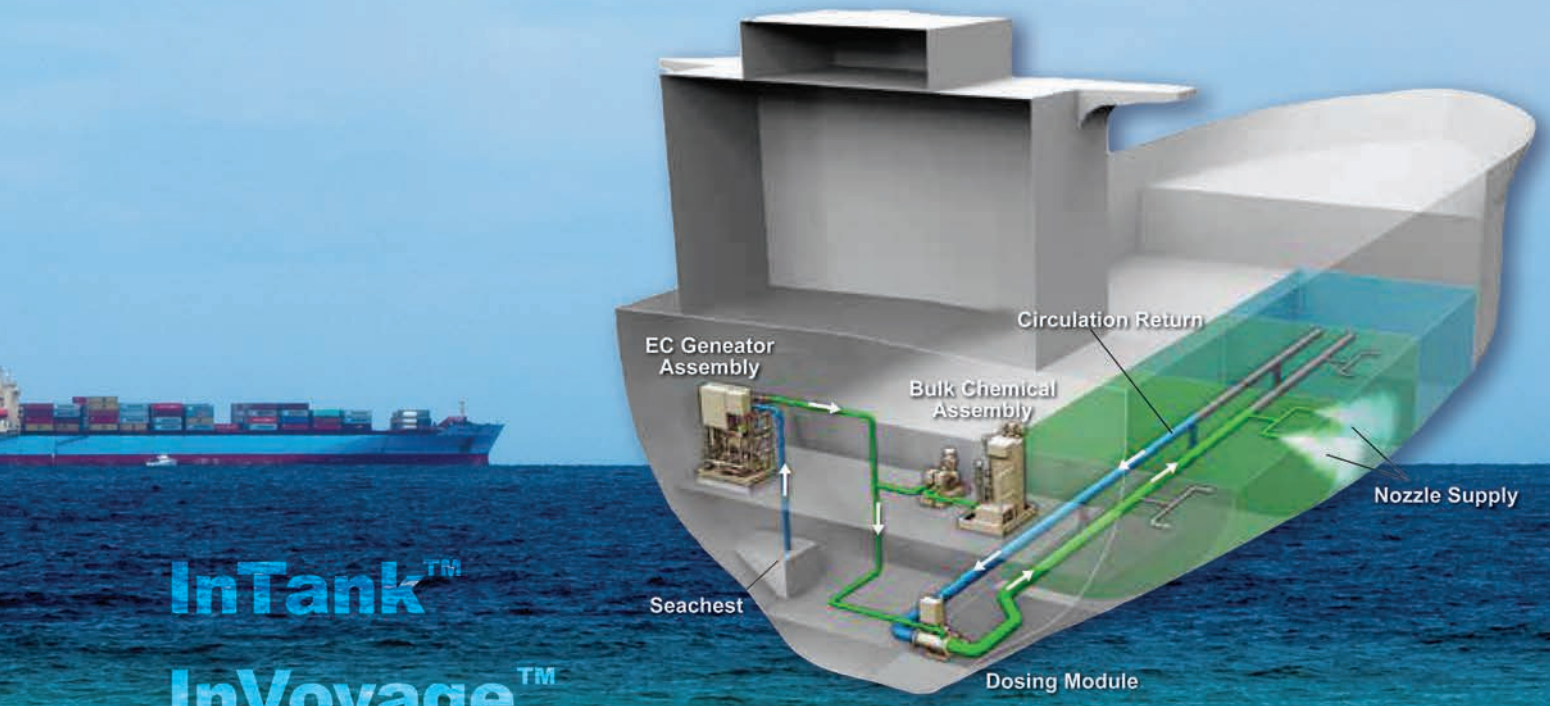

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