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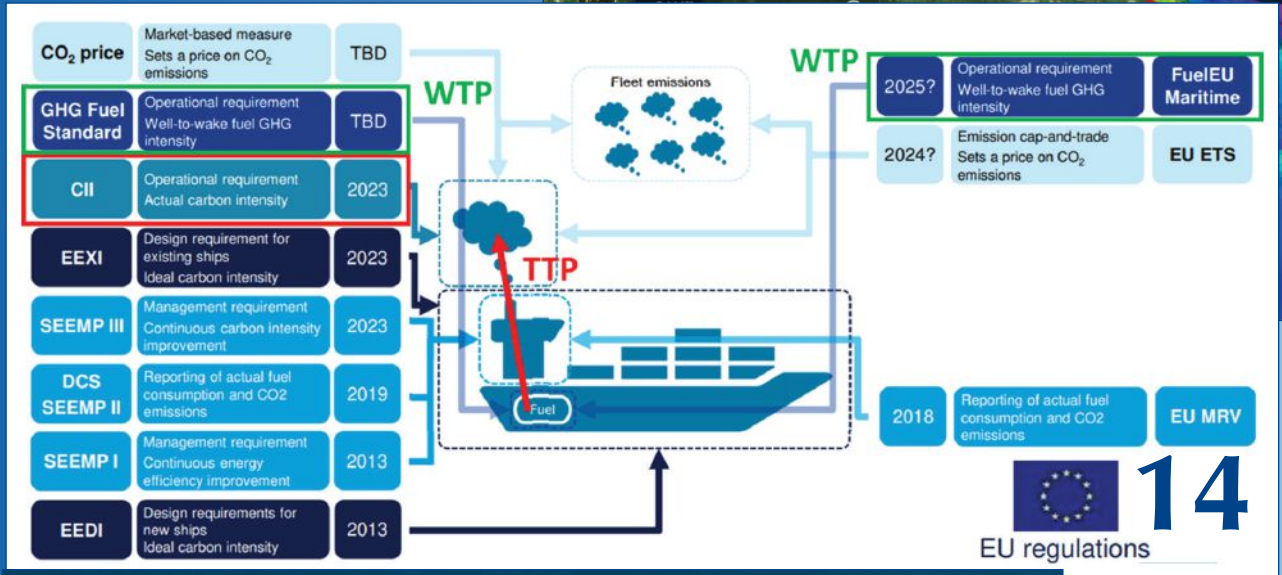
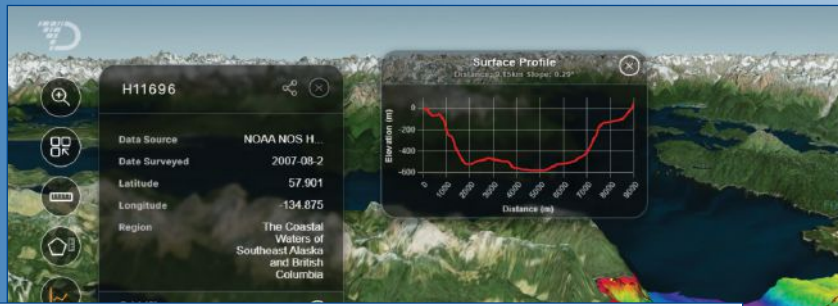
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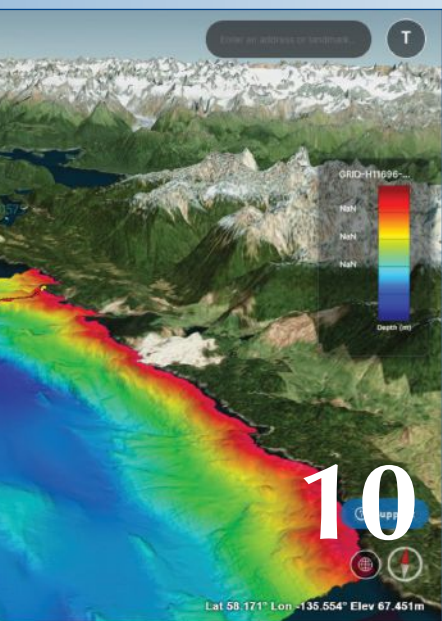
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Investigating complex channel bathymetry with the profiling tool in Absolute Ocean, Terradepth's cloud-native data management solution. See story on p. 10.

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)) Slow Progress on Maritime Digital Transformation. Despite 78 percent of industry professionals agreeing that change and technological innovation is a positive thing for the maritime industry, almost half (45 percent) admit to having a volatile attitude toward technology, and over a third (36 percent) say they are actively resistant to change, according to Wärtsilä's "Debunking the Mythical Beasts of Maritime Digital Transformation" report. As many as 18 percent do not think that the industry is unified in its understanding of digitalization and why it is needed. The research shines a light on these fears and misunderstandings, with 68 percent of industry professionals believing that the ability to digitalize existing infrastructure and retrofit vessels is challenging, 56 percent agreeing that the time and cost implications involved with digital transformation projects are too high, and 63 percent thinking there is a lack of skills and knowledge among seafarers to fulfill the requirements of new technologies. But on the positive side, the research revealed that 70 percent of industry professionals have a clear understanding of why digitalization is needed and its benefits, but 69 percent believe greater collaboration between industry players could be improved, with 88 percent agreeing that this will be key to making digital transformation a reality. Significantly, 64 percent of respondents recognize that people are more crucial to digital transformation than technology, therefore, without buy-in from a larger proportion of maritime industry professionals from the outset, successful digital transformation will not be possible. Wärtsilä's "Debunking Maritime Myths of Digital Transformation" report explores attitudes to digital transformation among maritime professionals across Europe, the Middle East, the U.S. and Asia-Pacific. It uncovers the surprising misconceptions thwarting progress and outlines a vision for a connected maritime ecosystem from ship to shore and beyond: www.wartsila.com/voyage/digital-myths.

)) Hydrogen Fuel Cell Adoption Accelerates. The maritime sector, which accounts for approximately 2.9 percent of global carbon emissions, seeks to meet broader climate goals, such as the Paris Agreement and "Fit for 55" in Europe (the EU's target of reducing net greenhouse gas emissions by at least 55 percent by 2030). Since it is the largest vessels, such as sea-going cargo vessels, which tend to contribute the most to maritime emissions, this presents a huge challenge. IDTechEx sees green fuels, such as green hydrogen and ammonia, as some of the most promising solutions, with the new IDTechEx report "Fuel Cell Boats & Ships 2023-2033: PEMFC, SOFC, Hydrogen, Ammonia, LNG" predicting that green hydrogen PEMFC (proton exchange membrane fuel cell) and LNG/green ammonia SOFC (solid-oxide fuel cell) markets will grow rapidly at 35 percent CAGR over a 10-year period. IDTechEx expects that most orders in the mid-term will use PEMFC technology and remain in inland and coastal sectors, due to the volumetric limits of hydrogen. Nevertheless, the market today is just getting started. Since most deliveries are pilot projects for fleet operators, each with fleet sizes of hundreds to thousands of similar vessels, repeat orders are poised to drive rapid market growth.

)) Subsea Wireless Optical Comms Standard. Hydromea is leading the development of the global underwater wireless optical communication standard for bandwidths up to 10 Mbps within the Subsea Wireless Group (SWiG), an international industry network of manufacturers and users of subsea wireless communication equipment (radio frequency, acoustic, free-space optic, inductive power, hybrid) that promotes their interoperability. Wireless optical communication systems are being developed to send data through water at speeds of up to 10 Mbps using dispersed LED light. This assures wide-angle communication coverage, as opposed to laser systems that require fine alignment. Hydromea's technology enables wireless, high-speed, low-latency communication between two or more communication nodes at depths down to 6,000 m. Currently, there is no industry standard, which makes the deployment of such systems less attractive for end-users.

)) Funding for FOCUS Project on Climate Change and Sustainable Ocean Use. The Future states Of the global Coastal ocean: Understanding for Solutions (FOCUS) project has been approved for funding by the U.K. Natural Environment Research Council (NERC). Designed to provide heightened understanding of the impacts of climate change and direct human activities on the global coastal ocean, this new project being delivered by scientists at Plymouth Marine Laboratory (PML) and the National Oceanography Centre (NOC) has been awarded £6 million for multidisciplinary research that will support the UN Decade of Ocean Science for Sustainable Development (2021 to 2030). FOCUS will encourage a more global perspective on coastal ocean science and advance the understanding of measures that can be taken to improve the resilience, adaptation and mitigation of global changes in the coastal ocean environment. The project will explore: the risks and impacts of climate change on the coastal ocean; the interactions of multiple human pressures on coastal habitats and ecosystem services, and the consequences for coastal communities around the world; how nature-based and engineering-based marine solutions can contribute toward a net-zero carbon society; and how the concept of the Global Coastal Ocean can be developed by synthesizing regional scale understanding to global scale assessments of change. The FOCUS project will run until 2026 and involves engagement with multiple international research networks to help ensure the research focuses on solutions and delivers genuine societal benefit. **ST**

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A Monument to Honor International Oilfield Divers

As the energy transition advances, we would be remiss if we didn't acknowledge that the oil and gas industry has been a foundational force in society.

Among the fundamental components of the industry are oilfield divers, who have worked decades underwater to contribute to powering the world. It is time to acknowledge them. We stand on their shoulders.

In honor of these pioneers, a monument will be built in Morgan City, Louisiana: a life-size bronze statue to commemorate the profession.

The first over-water oil wells were drilled in the late 1800s in the ocean, from piers extending off the beach at Summerland, California. In 1947, a consortium of companies led by Kerr-McGee and Phillips Petroleum completed the first out-of-sight-of-land well off Morgan City, Louisiana, marking a new phase in the evolution of the global oil and gas industry.

In the mid-1940s, oilfield diving developed into a profession, and by the late 1950s, oilfield diving had become an essential function of offshore petroleum operations. Divers assisted in constructing, installing, repairing and salvaging offshore platforms and pipelines. Those divers and the companies they started made incredible discoveries, breakthroughs and steady improvement in their career space, including in the field of safety. These efforts have been incorporated into many other industries, from robotics to the medical field and space exploration, just to name a few. The Space Shuttle astronauts working on the Hubble telescope even mentioned divers—where are they when you need them?—as they struggled with installing new mirrors.

To demonstrate the oilfield divers can-do spirit, I'd like to tell a tale of just one of my many adventures offshore. One time, I was tasked to inspect a platform that had been damaged by a passing barge that had hit the northwest leg. There was a ladder on the leg, so I thought I could use it to climb out of the water after inspection. I donned my scuba gear with my brand-new weight belt and jumped in. I inspected the leg down to 40-ft. It only took 15 min., but when I ascended, the waves had accumulated 6 to 8 ft. high. I couldn't get a hold of the ladder. As the waves were tossing me around, I knew I had to get rid of my gear. I hesitated releasing my weight belt because it was expensive, but I ended up letting it—and my tank—go. I had already lost my mask in the waves. Fortunately, I was able to grab hold of a rope for a lifeline, and, with a tender's help, I climbed out of the water.

I am but one of many. The offshore industry's development would not have been possible without the guys who jumped into the water to retrieve a lost tool, stab a drill pipe or tighten a flange.

The Oilfield Divers Monument will honor them. It will feature a diver wearing an early DESCO helmet, showcasing the old-style heavy gear (instead of today's advanced lightweight technical gear). The diver will carry a burning torch, jet nozzle and a hammer wrench with umbilical hoses on the deck. The monument will include the early history of (and improvements in) safety, equipment and procedures made by those working in the industry.

We hope this monument will inspire young people to follow their dreams. We also intend for the monument to pay tribute to those who have lost their lives while working in the field.

We invite you to visit www.oilfielddiversmonument.org to discover the history of oilfield diving. We also welcome donations there.

Morgan City, Louisiana, is supporting the monument by providing the location in its memorial park and installing the base for the statue.

We hope to see you at the unveiling on April 29, 2023. **ST**

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JANUARY

Annual Review & Forecast

****** *Oceanology International Americas*, February 14-16, San Diego, CA

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

****** *US Hydro*, March 13-19, Mobile, AL

MARCH

Electronic Charting/Vessel Management/ Ports & Harbors/Dredging/Homeland Security

****** *Ocean Business 23*, April 18-20, Southampton, U.K.

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

****** *Offshore Technology Conference*, May 1-4, Houston, TX

****** *XPONENTIAL 2023*, May 8-11, Denver, CO

****** *UDT 2023*, May 9-11, Rostock, Germany

MAY

Communications, Telemetry, Data Processing

****** *OCEANS 2023 Limerick*, June 5-8, Limerick, Ireland

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Absolute Ocean Combines Data Sets to Increase Accessibility

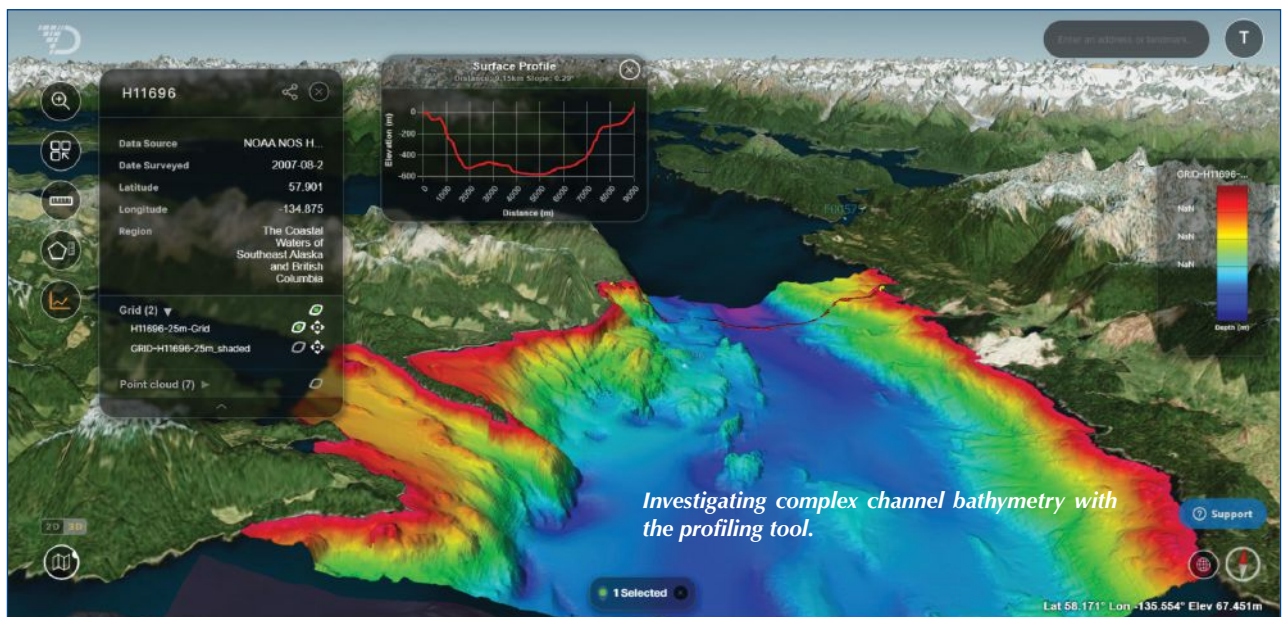
By Ken Childress

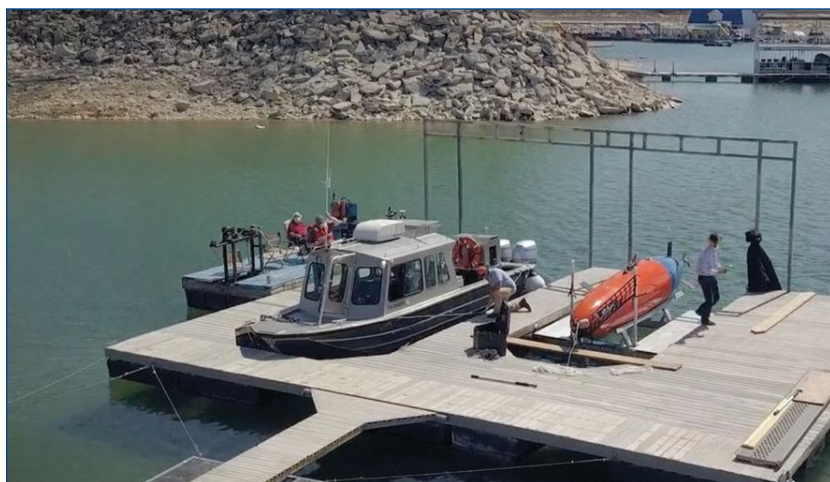
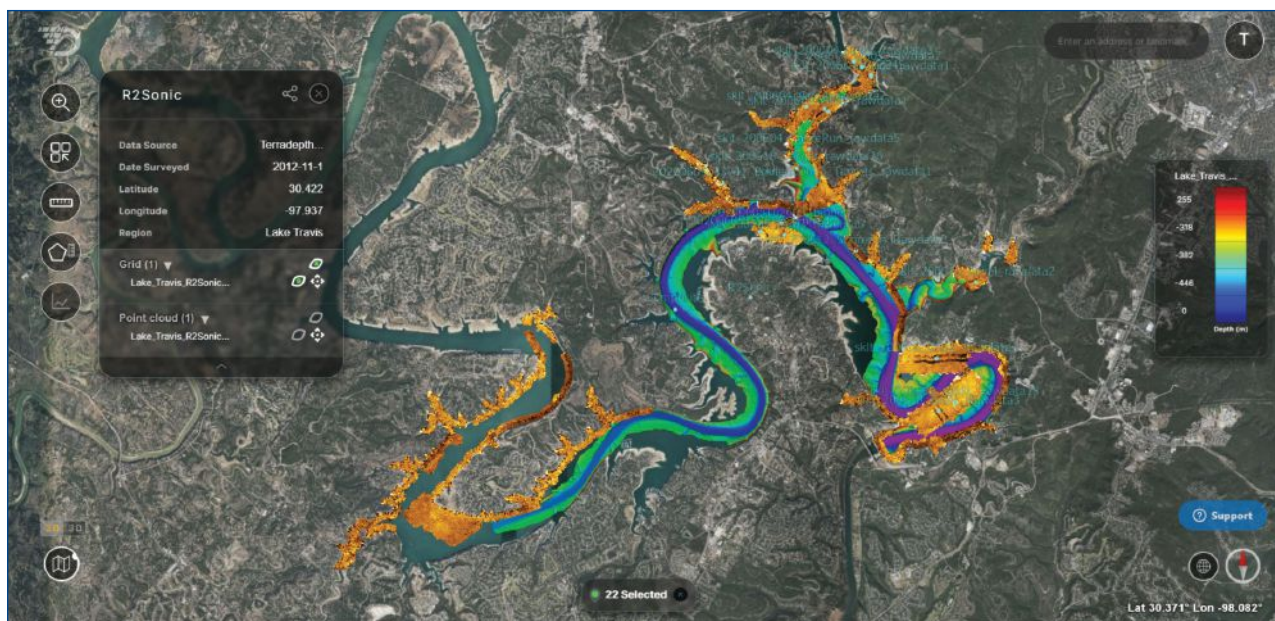
The ocean is the world's largest and richest under-represented data source. Both public and private ocean technology developers, driven by the general global movement toward sustainability, are revolutionizing the collection of massive ocean geospatial data previously only accessible to a relatively small community of hydrographic professionals, researchers and government entities. The high costs of sonar sensors and vessel operations, as well as the human risks involved with offshore operations, are providing incentives for these developers to deliver lower cost, more autonomous systems that can both increase the amount of mapping data collected and decrease the need for large vessels, large crews, and high-touch processing and delivery workflows.

Adding to the challenge of access to usable ocean mapping data is the propensity for collected data to be stored away, or "siloed," in inaccessible proprietary sys-

tems, used once or infrequently or never used again. If made available and more easily accessible, such stores of ocean bathymetric and image data could significantly contribute to the growing effort to create a highly accurate, more accessible global ocean mapping system.

Terradepth is an ocean-data-as-a-service company focused on scaling ocean data collection and dissemination to enable unprecedented exploration of the underwater environment. This is accomplished by an environmentally friendly, high resolution and cost-effective survey solution that reduces personnel at sea while receiving data within hours or days of collection. The survey capability is combined with an easy-to-use, cloud-native geospatial data management solution providing visualization, analysis and collaboration to internal and external stakeholders. This combination enables better and faster ocean decisions.





(Above) Exploring multibeam and side scan data simultaneously in Lake Travis, Texas. (Left) Testing site at Lake Travis, where Terradepth's boat, Terra, is based.

data sets that are stored by both government and commercial operators.

Multilayered Visualization Platform

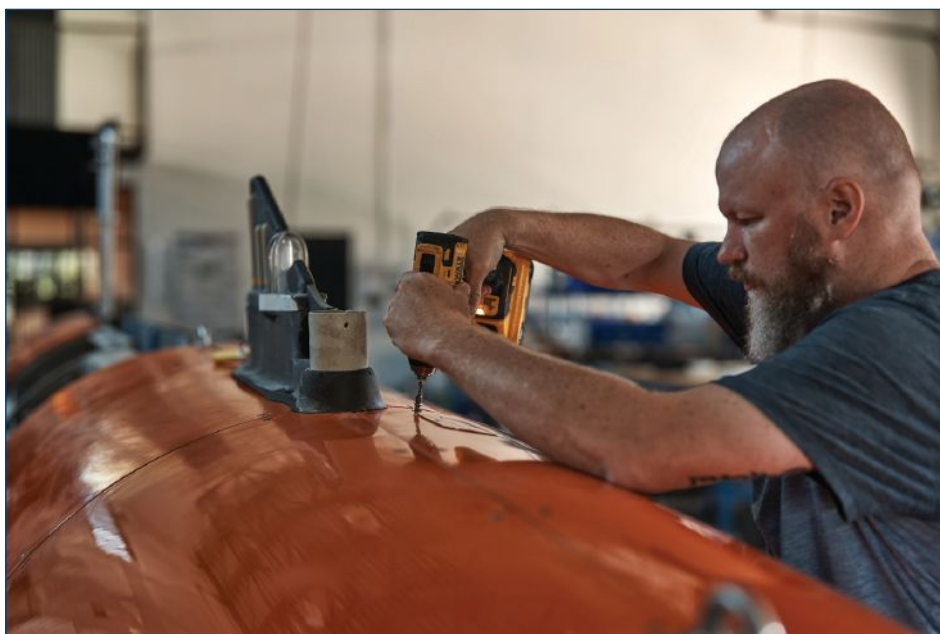
From its inception, Absolute Ocean was developed to make the movement of and access to vast quantities of ocean geospatial data quick and intuitive. The system is built on top of a powerful geospatial engine. It supports a broad spectrum of bathymetric, side scan and other images, which are geolocated when uploaded and visualized with a click of the mouse.

Within the system, you have access to public data sets, in addition to your private data. Public data sets include satellite-derived bathymetry for the majority of the Earth's coastlines from TCarta; data from the European marine observation data network (EMODnet); and last, but not least, NOAA's National Ocean Service hydrographic data and raster nautical charts.

There are direct connections to third-party data systems, including NOAA's ENC vector nautical chart data. This NOAA system was initially designed as a way for large vessels to implement electronic chart display and information systems (ECDIS) as a navigational aid, as well as to help avoid collision with and grounding on known underwater obstacles and in shallow-water areas. The charts are now widely deployed on all types of computer systems on many types of ships and recreational boats.

Terradepth is a full-cycle provider, from data acquisition to finished ocean survey delivery. The process begins with low-logistics operations of 1,000-m-capable AUVs that include multibeam, side scan, magnetometer and sub-bottom survey systems. The AUVs are coupled with quick-turnaround post-processing of the raw data into formats that can be directly uploaded into Terradepth's cloud-native data management solution, Absolute Ocean. Once in Absolute Ocean, rich visualizations, as well as all of the supporting survey data, can be easily accessed by stakeholders to share, collaborate and analyze. The data can be made available to suppliers, project managers, engineers, regulators, analysts and/or the general public.

Absolute Ocean provides an intuitive, immersive interface for the efficient visualization of vast, high-resolution geospatial and bathymetric data sets. The platform greatly simplifies access to these data for both technical and nontechnical users over an internet connection using standard browser technology (at the moment, the platform is not yet optimized for smartphones). Absolute Ocean can be leveraged to manage and visualize survey project files and large, previously collected bathymetric



(Above) Visualizing NOAA nautical charts layered over Absolute Ocean bathymetry. (Left) Terradepth offers 1,000-m-capable AUVs that include multi-beam, side scan, magnetometer and sub-bottom survey systems. The data from AUV surveys are post-processed for upload into Absolute Ocean for storage, display and analysis.

The power of Absolute Ocean as a multilayered visualization platform becomes evident with several data sources. Although bathymetric and other maps provide a rich visualization of the topology of the ocean floor, ENC's add details such as depth notations and contour lines. Additionally, the specific locations of surface infrastructure such as buoys, rigs and wind turbines, as well as subsurface power cables, pipelines and telecommunication lines, are clearly marked and frequently updated.

In Absolute Ocean, the ENC files appear as a layer over the base maps. The files can be presented on top of or underneath a bathymetric map file in either 2D or 3D visualizations, depending on the bathymetric file type. Once the map and ENC image layers are combined, the visual effect is that of a colorful map with all of the pertinent chart data embedded. These visualized layers add to the image by showing the existing depth, contour and known infrastructure information contained in the nau-

tical chart, thereby enhancing the visual context of the bathymetry. The ENC charts can be applied to multibeam, side scan, magnetometer and other Absolute Ocean visual files.

Recent examples of the usefulness of layering survey data with the ENC data include a survey over existing power cable runs from a wind turbine installation, which revealed pieces of a potentially damaging metallic object. Once the object was recognized in Absolute Ocean, an ENC image was combined with both the available multibeam and side scan images, revealing that the object was lying over the cable run and may need to be addressed. Similarly, surveys of abandoned pipelines in the Gulf of Mexico were overlaid with the nautical chart of the area, confirming that while some of the pipeline was indeed in the expected position, much of it was not even shown on the chart. The power of the Absolute Ocean platform is that all stakeholders in each case could have immediate access to the project files and have the ability to view the images from every angle and distance, giving

“Absolute Ocean provides an intuitive, immersive interface for the efficient visualization of vast, high-resolution geospatial and bathymetric data sets.”

a full picture of the surveys and surrounding areas to enhance their decision making.

Conclusion

The overall impact of easily combining, or layering, these various ocean data sets can be measured to some degree, akin to the impact of systems such as Google Maps or Bing. These systems derived from efforts to make geospatial land mapping data more available to all stakeholders and spawned a universe of useful location-driven applications with multiple layers and references.

In many areas of the blue economy, the impacts of easy access to ocean geospatial data will be immediate and measurable. For example, we have discussed the impact on the offshore industry's ability to store and manage survey and other information in an easy-to-access format. We estimate that tools such as Absolute Ocean will reduce the cost of managing, sharing and documenting project data by as much as 50 percent, and interaction with other ocean data sets via API will dramatically increase the value of the platform.

Easy access to high-resolution bathymetry combined with other images, data and chart references can help ocean industry target highly productive areas instead of concentrating on less productive zones. Additionally, near-real-time access via the web to mapping data generated by research projects can be provided to stakeholders who typically wait weeks or longer for initial visual results.

We envision the day when all ocean data stakeholders will have immediate access to high-quality data sets, significantly increasing productivity and overall maritime awareness. **ST**

Ken Childress is the chief strategy officer of Teradepth. He has over 25 years of experience in technology, unmanned systems and financial business development. Childress has worked for several technology firms, including Cisco Systems, Redback Networks and Force10 Networks. He founded Ocean Aero Inc., a startup developing unique, environmentally efficient, ocean-going robotic platforms for maritime data gathering services.



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Carbon Intensity Indicator

Solutions for Improving CII Ratings, Compliance

By Dr. Hinrich Mohr • Serafeim Katsikas • Hannah Ohorn

Starting January 1, 2023, International Maritime Organization (IMO) regulations are in effect regarding the Carbon Intensity Indicator (CII). All sea-going vessels greater than 5,000 GT have to report annual CO₂ emissions from actual operations. Based on these values, the vessels will be ranked in classes from A to E, which will be combined with an annual statement of compliance.

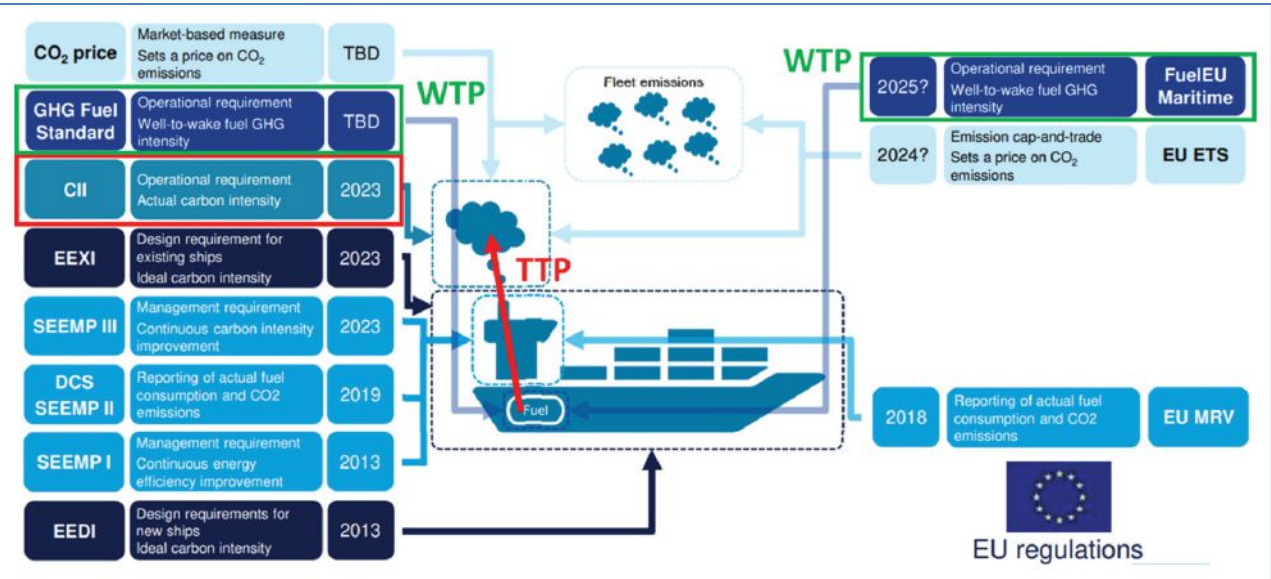
For every year following 2023, the mean value baseline for the class definition will be reduced by given percentage values, which will lead to a continuously deteriorating rank if no countermeasures for CO₂ emission reduction are applied to a vessel. When a vessel is ranked in class D or worse, the owner has to implement improvement measures to reach class C minimum within three years. Otherwise, the vessel will lose its emission certificate.

This article takes a look at container vessels and bulk carriers in relation to CII.

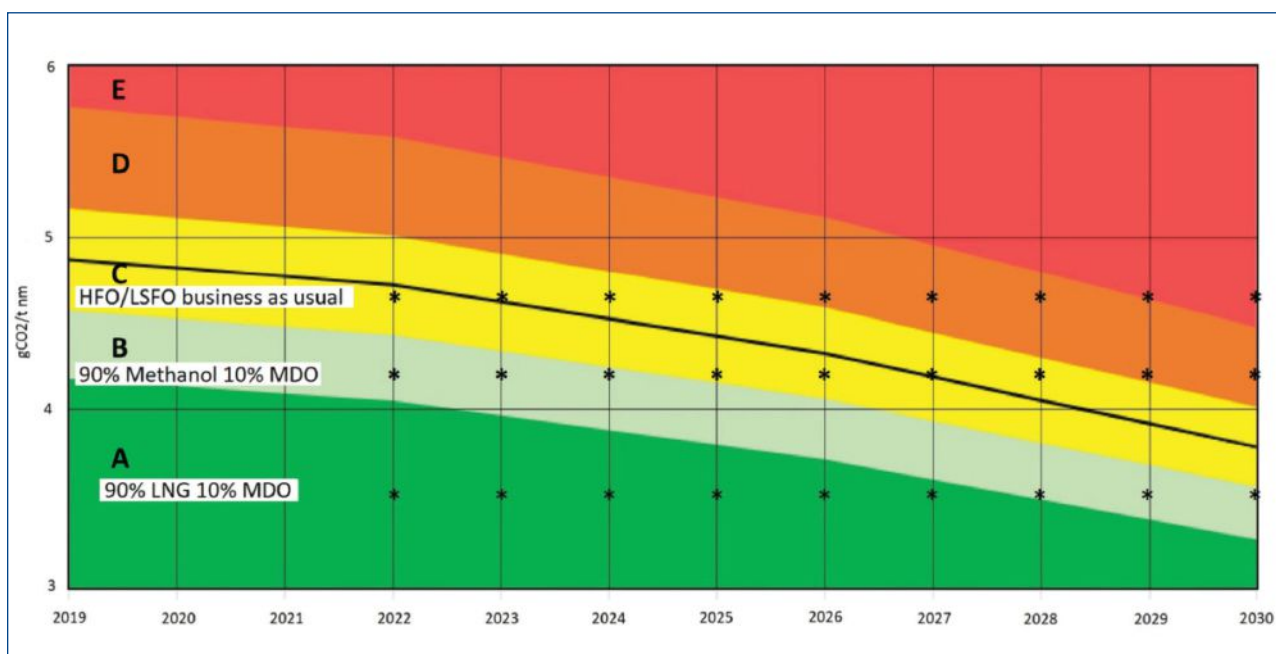
Green Fuels

The IMO currently considers only a tank-to-propeller (TTP) approach. This means that the CO₂ emissions considered for the CII calculation are generated from the fuel in the bunker storage of a vessel. The source of the fuel, fossil or renewable, is not yet considered. Based on this approach, the use of so-called “green fuels” does not bring benefit to the owners with regard to the CII ranking.

The EU is already ahead of this concept and is going to apply in 2025 the FuelEU Maritime regulation that considers a well-to-propeller (WTP) approach. This means that the production and transport of the fuel are factored into the CO₂ emission calculation, thus support-



IMO and EU frameworks for greenhouse gas (GHG) emissions reduction. (Credit: DNV)



Impact of methanol and LNG use on CII rating.

ing the use of green fuels. The IMO is discussing a similar approach, and a review of the regulations is expected in 2026.

Improving CII

Which measures can be applied to a vessel to improve the CII value? There are several options: optimization of ship operation, including auxiliary operation and hotel load, to minimize fuel consumption; a limitation of the main engine output (EPL), which results in a reduction of the maximum vessel speed; an optimization of hull resistance by hydrodynamic measures, e.g., new bulbous bow, low-friction paint, air lubrication; installation of carbon capture technologies to withdraw CO₂ from the exhaust gases into storage on board (the captured CO₂ can be discharged during berthing and utilized in the CO₂ circular economy to produce green fuels, or stored in underground reservoirs); and switching main and auxiliary engine operation to renewable fuel sources (this will be meaningful when the WTP approach is in place).

One typical improvement measure to decrease ship speeds is to switch to a propeller optimized for lower speeds. But this can have impacts on the powertrain behavior. The changed torsional vibrations can lead to accelerated aging and wear of the powertrain components. Installing a new torsional vibration damper is recommended. Other factors to consider include: will the maximum load of the engine support bearing be exceeded; would an additional support bearing be required; and is there enough space available in the front of the engine?

Further challenges with a limitation of the engine output to below 50 percent maximum continuous rating (MCR) are caused by the low boost pressure of the turbocharger. This leads to bad combustion quality and high temperature levels. A solution could be modification of the turbocharger specification. To achieve MCR output for emergency operation after modification, a controlla-

ble turbine bypass (so-called “wastegate”) has to be installed. This avoids exceeding cylinder pressure due to too high boost pressure at high engine loads.

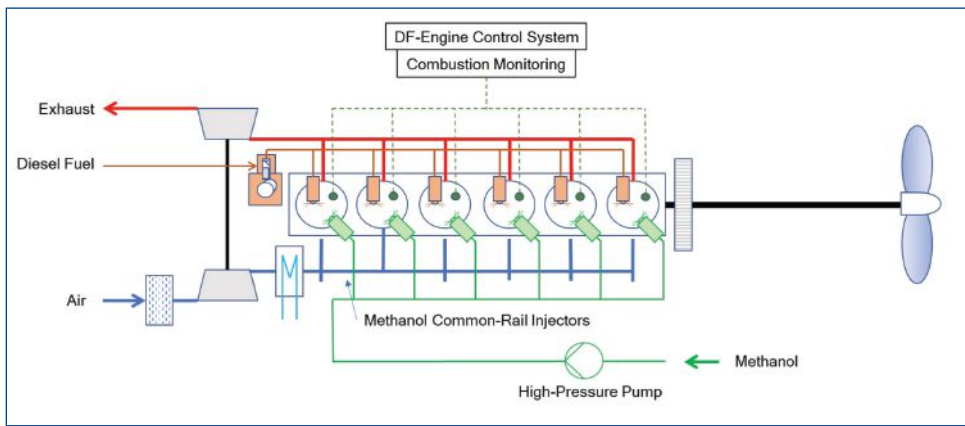
Another option to reduce the CO₂ emissions of a vessel is to use alternative fuels. For bulk carriers, green methanol seems to be an interesting option because existing bunker storages can be used after applying an appropriate coating. Of course, the total operation range of the vessel will be reduced due to the lower heating value of methanol. This has to be considered in the route planning.

Fossil LNG is currently better rated by IMO regulations than green methanol due to the TTP approach. The combustion of methane (CH₄), which is the main component of LNG, produces less CO₂ than methanol (CH₃OH). So, the use of methanol would keep the vessel only for three additional years in the C rating under the current boundaries. A retrofit of the vessel to methanol operation will make sense when the IMO changes to the WTP approach, considering the fuel is renewable. The technical concept for such a retrofit is already available and can be applied today. An engine concept with direct methanol injection in addition to an existing diesel fuel injection system would allow a methanol combustion ignited by a diesel pilot injection, or a standard diesel operation as backup mode. The concept can be applied to slow-speed, two-stroke engines and medium-speed, four-stroke engines as well.

It must be mentioned that LNG is not a preferable fuel for a bulk carrier because of the space requirements of the cryogenic storage tank. The installation could lead to the loss of one cargo hold, decreasing the vessel's economics.

Operational Optimization

The impact of optimized vessel operation was investigated for a capsize bulk carrier by comparing its results



Retrofit concept with direct methanol injection system. (Credit: Gaskraft Engineering)

in 2021 and the first half of 2022. The task was to define the optimum speed profile and the proper instruction speed based on the 2021 data in order to reduce the CII factors for 2022. By using the METIS IoT platform, high-frequency data were taken with a sampling period of 15 sec. The data included GPS position, speed, rudder angle, gyrocompass, anemometer, shaft torque meter, fuel flowmeters and draft gages. Mathematical and machine learning models of the METIS analysis platform were created for this vessel for the evaluation.

The analysis of the vessel's operation in 2021 resulted in the following main findings: The vessel traveled in laden condition in a variety of speeds between 10 to 13.3 kt., and the vessel was at anchorage almost 20 percent of the time in 2021. A statistical analysis of several speed-over-ground ranges of the main engine's fuel oil consumption per hour and per nautical mile revealed the problem with judging the instructed speed per voyage. Based on findings from 2021, the vessel's operational profile was changed, resulting in the following: The speed profile when laden was narrowed to around 10.6 kt.; the anchorage time was reduced by half; and the trim was adjusted to the new instructed speed.

This case study shows that the CII value was reduced by nearly 20 percent in the first half of 2022. The traveled distance increased by 25 percent, comparing similar time periods in 2021 and 2022, due to improved operational planning. For the first half of 2022, the vessel saved 930 metric tons of fuel oil.

Conclusion

The IMO's CII regulations took effect January 2023 in order to limit the CO₂ emissions of actual ship operations. Limitations become stricter with each passing year.

There are several main takeaways to highlight from this article. One is that limiting the main engine output can keep the vessel CII compliant for some years, but this can lead to operational restrictions, e.g., by barred speed ranges, or result in increased powertrain component wear, e.g., due to increased torsional vibrations.

Another takeaway is that alternative fuel usage can provide CII benefits due to reduced CO₂ emissions, but the IMO currently considers only TTP emissions, so fossil LNG is better rated than green methanol. Hopefully, from 2026 onward, the IMO will consider WTP emissions. The EU will start using the WTP approach in 2025.

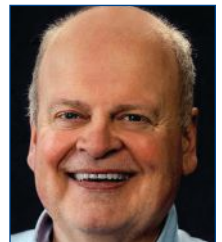
An additional finding is that optimization of vessel operation, including auxiliaries and hotel load, can support CII compliance but will not be sufficient as a single solution. Further measures for improvement, e.g., reducing hull resistance, can be meaningful.

CII compliance requires close operational planning between charterers, owners and operators. A detailed analysis of operational data with the involvement of component suppliers and service providers at the earliest possible stage will help prevent compliance issues.

Acknowledgments

The authors would like to thank those at Carl Baguhn Hamburg, CPO Containerschiffreederei, Gaskraft Engineering, Geislinger and METIS Cyberspace Technology who contributed to this article, and all partners for their input and fruitful discussions. This cooperation shows the value of such an experienced consortium. **ST**

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Improved Onboard Visibility

AI-Based Visual Analytics for Ship, Cargo Management

By Osher Perry

Visual analytics, one of the latest AI-based technology developments to reach the shipping industry, is already proving its value and having a tangible impact on ship and cargo management. By streamlining routine tasks, AI is expected to contribute \$15 trillion to the global economy by 2030, according to McKinsey, and the unique challenges associated with having remote assets at sea means shipping is well-suited to benefit from this developing technology.

Shipping companies often face challenges in effectively managing their fleets due to lack of onboard visibility and the subsequent need to work with late, sometimes inconsistent and nonactionable data. At sea, crews face increased workloads due to larger vessels, reduced crew sizes, and time-consuming regulatory commitments.

Both ship and shore management teams frequently struggle to accurately assess safety practices while ships are underway and often attribute human error to a high percentage of incidents at sea. However, the incidents are rarely intentional and often the result of the crews being overstretched. With more comprehensive data and insight, mistakes can be pinpointed to conditions, system designs, protocols and processes.

Forward-looking shipping companies are already identifying the underlying causes of issues at sea and proving the value of Shipln's FleetVision platform, the shipping industry's first visual analytics fleet management solution, which is powered by AI and machine learning. Headquartered in Boston, Massachusetts, Shipln is dedicated to improving the safety, productivity and sustainability of the maritime industry. Shipln's deep technology is led by Dr. David Michael, chief scientist at Shipln, who brings a wealth of experience to Shipln, including a Ph.D. in computer vision from MIT and over 80 patents in the field.

Shipln continues to actively develop and patent advanced solutions for specific maritime applications. Meanwhile, the company's FleetVision platform has al-

ready delivered tangible results to clients, reducing losses by 40 percent and increasing productivity by 8 percent for some clients. The platform's onboard cameras detect, analyze, and monitor discrete and routine events, including maintenance tasks and bridge team activity. Unlike traditional maritime CCTV, Shipln's AI-powered analytics system provides immediate, real-time visual data. This eradicates the need to sit through 10,000 hr. of footage for every vessel each month in the hope of determining retroactively what happened on board following an incident.

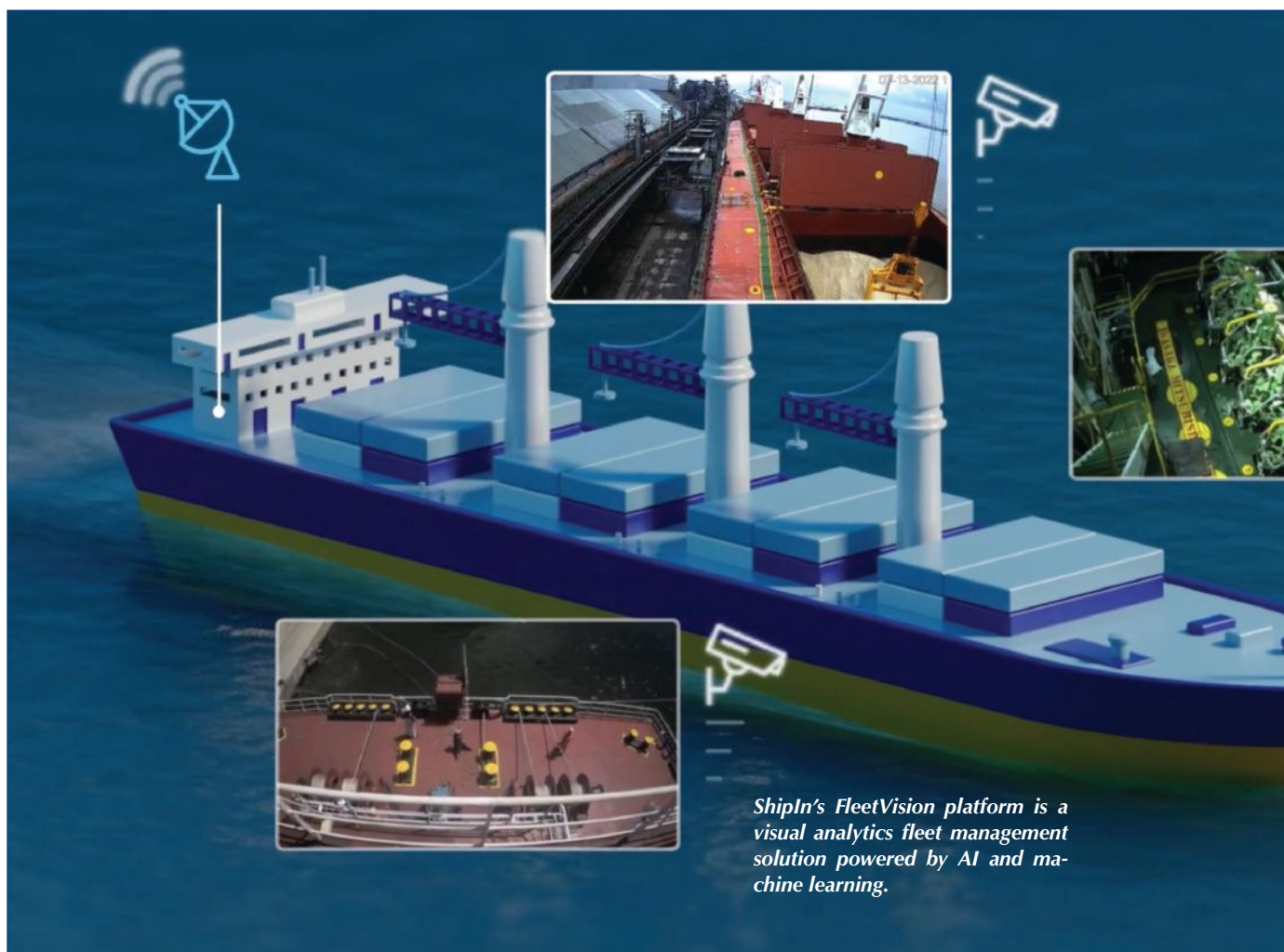
Instead, the FleetVision platform creates intelligence that teams can use immediately to shape safety protocols and onboard behavior. It automatically alerts stakeholders on board and onshore to potentially hazardous events in real time to prevent incidents and further provides analytics that can help identify and reduce risks and inefficiencies across a fleet.

The platform also helps to mitigate external risks, such as piracy, malpractice by surveyors and drug smuggling. In the event of an incident on board, the platform serves as a source of proof with live, immediately recallable video evidence, allowing for quick and efficient claims management. A further advantage of Shipln's solution is the lack of capital expenditure required for deployment. The system can be installed at any time, with the vessel operating commercially within weeks of subscribing to the platform.

Safety First

Shipln recently partnered with a tanker company that had experienced significant losses due to recurring navigation incidents across its fleet. By implementing FleetVision on its vessels, the tanker company was able to leverage the system's AI-powered CCTV technology to detect various instances of poor bridge watchkeeping practices, such as an "unattended bridge."

The system alerted the master, who then briefed the



Shipln's FleetVision platform is a visual analytics fleet management solution powered by AI and machine learning.

bridge team on the importance of maintaining proper lookout. As a result, no further anomalies were detected, leading to an improvement in navigational practices and an increase in vessel safety. The tanker company has since shared these lessons learned with the rest of the fleet to prevent similar incidents in the future and is working with Shipln Systems to implement FleetVision fleet-wide.

The S and G in ESG

Shipln places a strong emphasis on social and governance issues, the S and G in ESG (the E stands for environmental), and offers advanced tools and systems that aim to reduce the manual workload and safety risks faced by seafarers while also streamlining processes to save time.

The FleetVision platform has been well received by crewmembers, who have even advocated for increased use of the platform after experiencing its benefits. The platform, which was developed by seafarers for seafarers, is designed to make their job easier, safer, and more productive by providing advanced digital tools and automatically documenting events on board the ship. This leads to fewer accidents, less manual data entry and visibility into low-traffic areas of the ship, as well as remote guidance and support.

In addition, FleetVision can assist with the decriminalization of seafarers by protecting crewmembers from false blame and supporting them in disputes.

Surveys conducted by one of Shipln's customers showed that 39 out of 40 ships in its fleet believed that the platform was valuable and wanted it on their vessels.

Industry-Wide Benefits

The expectation is that inflation, geopolitical tensions, conflict, and the application of new fuels and technologies will drive risk and uncertainty around the world and place additional stress on crew. In one worst-case loss scenario, specifically, the collision and grounding of two large container vessels, management failures could result in a \$4 billion loss when accounting for the cost of salvage, wreck removal and environmental claims. Further, investigating the cause of incidents can take years and often relies on notoriously faulty human memory of crewmembers or eyewitnesses. For example, the results of the loss of the *Golden Ray*, which capsized off the coast of Georgia in the U.S., took two years to complete.

Establishing why a navigational incident happened is often difficult because many ships have limited contact with shoreside teams once they leave port. With limited visibility into ship operations, it's impossible to know what occurred on board when a vessel is involved in a



major incident such as a fire, piracy attack or sinking. By using a visual fleet management system, footage of such incidents can be retrieved in near real time to identify the cause, negating the reliance on witness testimonies.

Indisputable Evidence

Sharing data insights is a win-win for insurers and shipowners, but it requires a level of transparency that is still uncomfortable. To really tap the advantages, ship operators and their crew need to build confidence in the merits of sharing “warts and all” evidence. In response, insurers should support this by rewarding companies who take preventative measures to prevent losses and incidents.

An example of ShipIn’s value for shipowners and insurers in preventing operational incidents associated with cargo can be seen with an incident involving 1,677 MT of contaminated chemical cargo with a total value of around \$800,000. ShipIn Systems’ technology was able to help a shipowner avoid significant financial loss. Upon completion of loading the first foot

portion, samples drawn from a chemical tanker’s cargo tank were declared off-spec. The vessel was initially held responsible for the contamination, but with ShipIn’s platform installed, the sampling operation was captured and digitally logged. The indisputable digital evidence, which was accessible in real time on the ShipIn platform, ultimately led to the terminal admitting fault.

Real-time collaboration between the ship and shore and the availability of undisputed visual information also prevented further losses due to potential delays caused by the incident. The captain and crew on board were spared the frustration of the dispute and were able to reprioritize their time to more impactful projects, rather than allocating it toward root cause analysis, corrective actions and claim negotiation.

Optimization and Visibility

ShipIn’s systems can unlock increased productivity in cargo operations by solving potential bottlenecks in ports, preventing damage to vessels, streamlining demurrage claims and monitoring planned versus actual time spent in port. With its cargo operations interface, users can track KPIs in real time—including monitoring planned versus actual port time and stevedore’s activities, for example—wherever the vessels are located globally.

ShipIn conducted a case study in partnership with a

leading chemical tanker company that struggled with conducting cargo operations, including unplanned stoppages, reduced turnaround time and routine tank cleaning. The length of operations between like-build sister vessels carrying similar cargo varied significantly, and the company would routinely fly cargo superintendents from its shore office to oversee operations or verify proper completion prior to third-party inspection.

Several inconsistencies in port operations that were previously unreported and could not be deduced by ship logs or statements of facts alone were identified. Routine activities including crew briefings, line handling and pre-staging equipment for cargo operations added up. The best performing vessels turned around cargo 1.5 hr. faster than their sister vessels with similar vessel and cargo configurations, and with previously unnoticed best practices replicated across the fleet, the results was three extra days at sea per vessel every year.

“With more comprehensive data and insight, mistakes can be pinpointed to conditions, system designs, protocols and processes.”

The study identified several areas for improvement, including inconsistent port operations, insufficient voyage planning and a lack of real-time visibility into onboard operations. Implementing a visual fleet management platform allowed for improved collaboration between ship and shore, leading to better voyage planning and the ability to identify and address issues in real time. It also enabled the company to reduce unplanned costs and improve asset utilization.

The company assessed that, when extrapolated across the number of cargo operations conducted per vessel each year, implementing a visual fleet management platform could lead to significant financial improvements. Using the ShipIn platform could reduce the financial impact of incidents by 40 percent. This would result in an annual economic benefit of \$400,000 per vessel, or a total of \$12 million for a 30-vessel fleet, and an additional 13 days of sea time per vessel.

During its annual insurance review, the company was able to demonstrate to its P&I club industry-leading advanced methods to identify hazards, remove obstacles and collaborate with its vessels in real time. The insurer agreed that this would reduce the overall loss ratio and granted a reduction in the company’s premium as a result.

Performance Management

With data on navigation, security and cargo operations all rolling up to fleet-wide analytics, the ShipIn platform enables closer collaboration and greater integrated

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***“Performance management has been,
and will continue to be,
a perennial differentiator for
shipowners and operators.”***

operational insights. Visibility is crucial for optimizing fleet performance and strengthening safety and legal compliance protocols. By providing onshore teams, superintendents, and fleet directors with the ability to identify hazards, remove obstacles, and gather information, ShipIn's system enables them to work closely with crewmembers and develop processes to prevent future issues from occurring.

Through the advancement of technological innovation by using onboard camera footage powered by AI, the risk of incident is significantly reduced, and cargo operations can be improved across a global international shipping fleet. With data shared seamlessly between ship and shore, ShipIn's patented technology surfaces valuable insights across fleet operations that can be shared in real time without any increased data bandwidth through the use of logical summarization.

Performance management has been, and will continue to be, a perennial differentiator for shipowners and operators. In both up and down years, shipping companies stand to significantly increase margins, offer higher quality service to their charterers, and improve the working environment for their seafarers by employing visual fleet management practices. Overall, the use of visual fleet management tools can help shipping companies overcome the key challenges they face in the performance management of their fleets. By providing real-time visibility, actionable insights and seamless collaboration, the integration of AI technology on board vessels supports continuous process improvement and leads to significant financial gain. **ST**

Osher Perry is the CEO and co-founder of ShipIn Systems, a Boston-based fleet vision platform. Perry holds an MBA from Tel Aviv University and has studied with Harvard Business School Executive Education. He is a former naval officer (lieutenant commander) who brings significant experience in establishing strategic partnerships and fostering innovation to deliver value creation in operations. He is a commercial ocean yachtmaster who has sailed around the world.



AR for Arctic Navigation

Augmented Reality Concepts to Facilitate Arctic Operations

By Vittorio Lippay

Projections made using the latest global climate models show that open-water periods in the Arctic will increase significantly during this century. In 2022, Yunfeng Cao of the Forestry University in Peking and Shunlin Liang of the University of Maryland led research analyzing the changes of the trans-Arctic routes in the period 1979 to 2019. The conclusions of their high-quality harmonized satellite and observationally calibrated reanalysis of daily sea ice products were that, in the recent past, the navigability in the Arctic expanded faster than in the projections.

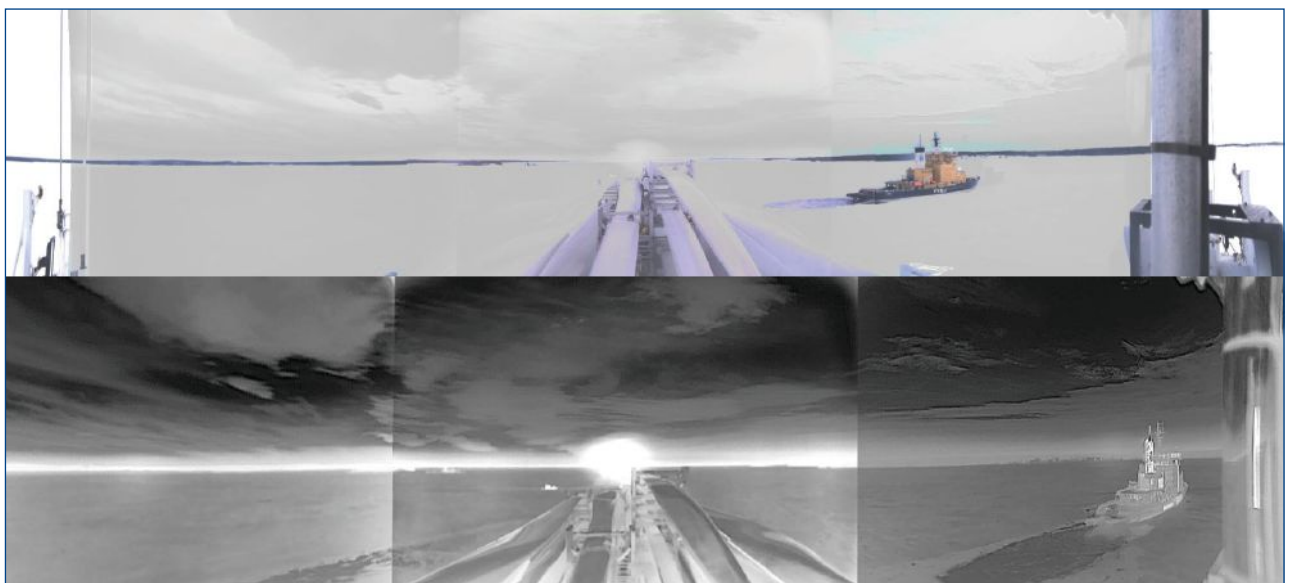
Commercial shipping will soon get more chances for shorter passages between the Atlantic and the Pacific Oceans. Navigation systems designed to increase sea

awareness in the Arctic may facilitate stakeholders' decisions on the new routes.

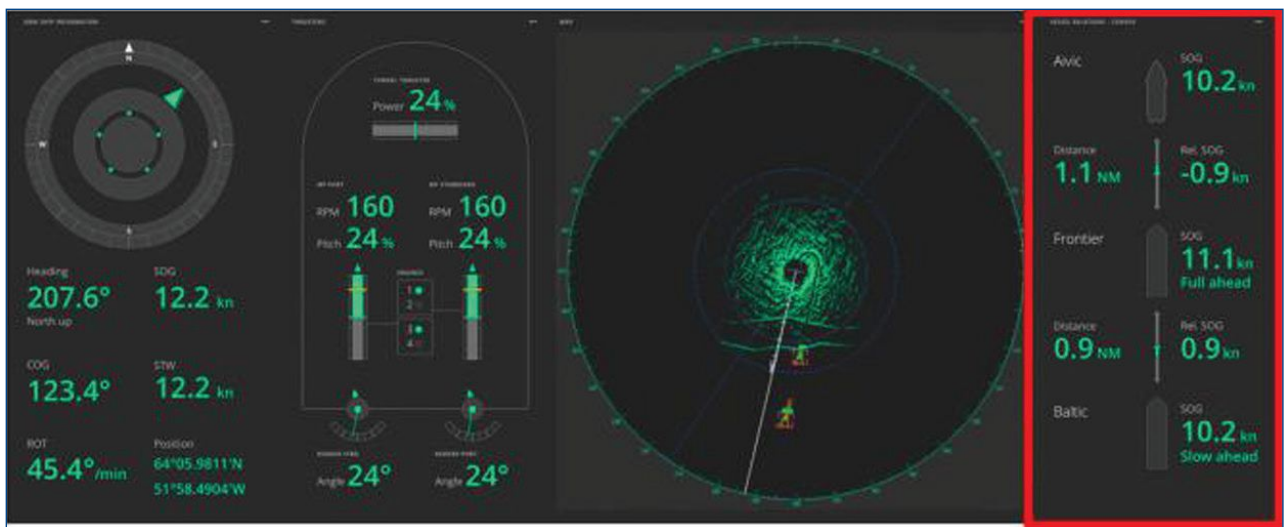
Sea Awareness and Augmented Reality

Sea situational awareness is defined as the knowledge of the relevant entities in a ship's environment, the understanding of their meaning, and their evolution in the immediate future. Errors ending in accidents mainly depend on a failure in one or more of the mental processes above that cause a low, or even vanished, awareness.

Paradoxically, the many electronic devices now found on bridge and designed to increase the level of information do not necessarily improve situational awareness. Conceived as standalone systems, some are not fully er-



Trials in ice of Polaris VG with the icebreaker Frej on starboard with blended images concept: thermal + visible. Side views show no blending. Below: thermal image only. (Credit: Groke Technologies)



Icebreaker assistance application with pane in the convoy mode and names and data of convoy ships on the right side. (Credit: Synne Frydenberg et al, Mar. Sci. Eng. 2021, 9, 996)

gonomic at sea, or, in many cases, the different sensors provide a flow of details that humans cannot process and associate quickly enough to the advantage of their decision making. When targets are dissociated from the information provided on them by the instruments, the result is a dangerous loss of attention.

To improve situational awareness at sea, humans and machines should interface smoothly. The task of augmented reality (AR) is to process and present information to the navigator in a more assimilable way. Augmented reality introduces a set of visual details to the navigator that are derived from data collected, reduced and processed by a computer. Information is provided within the real environment to which it is associated. The “virtual” elements inserted in the navigator’s field of view represent real characteristics of existing targets.

In virtual reality, the essence of an object is absent. In augmented reality, aspects of an existing object in sight are added that cannot be ordinarily perceived, e.g., the navigator gets in his/her field of view details on a ship’s name and course received via AIS, which are real facts that would have normally been accessed looking somewhere away from the target. One important function of AR is to present in a visualized fashion information from sensors operating at wavelengths not accessible to humans, such as in the infrared or radar bands.

By presenting real and virtual elements together in the same visual context, AR overcomes the dissociation between the target and the information on its nature. The navigator’s cognitive burden decreases because information usually dispersed on the bridge, e.g., AIS, GPS, ARPA (automatic radar plotting aid), is synthesized and focused in a single graphical user interface (GUI/UI), thus saving time in critical situations. GUIs mostly consist of screens for which a CCTV camera provides a view in the visible range comparable to that of the bridge with the AR details overlaid. Alternatively, head-mounted devices (HMD), like those used in video games, allow the navi-

gator to concentrate on the sea while receiving a layer of supplementary information in the field of view.

Icebreaker Operations

Icebreakers are indispensable for sustaining the navigation of all other ship types in the Arctic. In 2015, an international team examined AIS traffic in the North Baltic, finding five types of icebreaker operations: breaking a channel for a following ship; freeing a vessel stuck in ice; convoy escort with one or more ships following; double convoy where two icebreakers provide a lane in the ice for a larger ship; and towing a ship while breaking the ice. The team found that for the success of each of these operations, speed and mutual distances between the vessels are carefully governed depending on the type of ice encountered. Major risks derive from ridged ice and compression ice. Winds and currents pile ice floes to build barriers, or ridged ice, that form up to 60 percent of Arctic Sea ice volume and up to 45 percent of the sea ice area.

Previous research in the Baltic found navigation in a closing channel of dynamic compression ice to be the riskiest situation for a ship. Dynamic ice drifts under the effects of winds and currents and exerts a lateral pressure on the hull from all sides until the ship gets stuck and possibly damaged. In convoys, a balance between vessel distances and speeds must be attained: Intervals between members that are too short may lead to collisions, while too long intervals may result in a member stuck because of the ice or slush of a channel closing under pressure. Collisions between convoy ships or with the assisting icebreaker are a further major risk.

While scrutinizing fore and aft in darkness, icebreaker navigators must quickly retrieve a mix of instrumental information. Additional limiting factors are: poor atmospheric visibility, unstable VHF signal, and language misunderstandings between the ships involved. To facilitate navigation in Arctic waters, the augmented reality con-

cepts presented here provide a more efficient level of information on sea, vessel and ice conditions.

Icebreaker Assistance Application

In 2017, the European Union started the SEDNA program: "Safe maritime operations under extreme conditions: the Arctic case." One of the objectives was to create and demonstrate the feasibility of "a human-centered operational environ-

ment for the ice-going ship bridge using augmented reality technology to provide improved situational awareness and decision making."

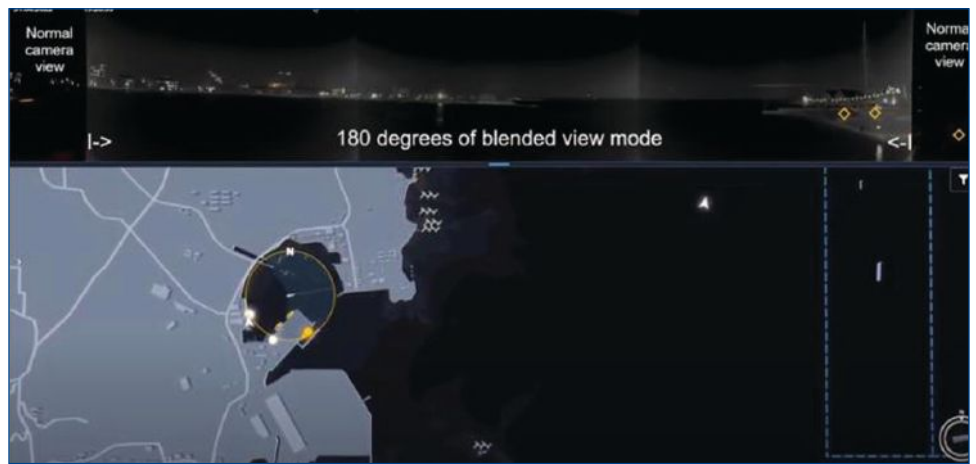
Scandinavians played a primary role in the program. The Baltic Sea partly freezes in winter, with the Gulf of Finland and the Bothnian Bay forming an accessible environment for experimenting in harsh navigation conditions.

Within SEDNA, in spring 2017, researchers of the Oslo School of Architecture in Norway and the Chalmers University in Sweden focused their attention on what AR solutions would best meet the requirements for safer operation of icebreakers. Synne Frydenberg, Jon Olav Eikenesb and Kjetil Nordby made research voyages on a Norwegian Coast Guard ship in Greenland and on a Swedish vessel in the Gulf of Bothnia. By observing bridge activities, they gained relevant knowledge on how to design an optimized UI. They refined the creative process by seeking the best professional advice from the crew. To maintain engagement level, the team then developed a virtual reality reconstruction scenario on shore: a simulation of icebreaker operations, which was used for testing AR solutions as these were conceived.

The team eventually designed an application that collects in a single pane the data from the many user interfaces that are normally consulted separately during icebreaker assistance operations, such as radar, AIS, etc. The navigator can consult the pane from his/her workplace in different ways, for example, on a fixed screen, by projecting it somewhere on the bridge, or by wearing a head-mounted device allowing for freedom of movement.

In the basic general mode, the application provides the names of the ships of interest with distances, bearing, speed over ground (SOG) and machine readings. In the convoy mode, the pane reports on its right margin similar information on all the vessels involved in the convoy, such as name, SOG, relative distances and machine readings.

The application includes a pinning feature for points of interest in which a target is represented by an arrow indicating its course and its relative significance to the safety of the convoy by changing its color from green to red. In the gazing mode, more details can be acquired



Groke Pro Deck Screen showing the advantage of image blending in dark conditions. (Credit: Groke Technologies)

on the target, such as distance, bearing, closest point of approach and time to this point.

The icebreaker assistance application was tested in a simulator using head-mounted devices on seven experienced master mariners at Chalmers University in Sweden. The masters read in the HMD navigation information seen against a mock bridge in the room. The goal was to understand whether the solution increased sea situational awareness in order to reduce risks in the operations of an Arctic convoy reconstructed in virtual reality by a computer. Post-test questionnaires revealed a general positive attitude in six of the master mariners, with one exception. An excess of confidence in the innovative technology and fears of cognitive overburden were the main reasons for general concern.

"We are not moving directly into sea trials," said Kjetil Nordby, research manager for the Ocean Industries Concept Lab at the Oslo School of Architecture. Instead, "We have established a new, larger project, OpenAR, that is going to release open-source tools for augmented reality design into the maritime community as part of the Open Bridge Design System" (www.oicl.no/projects/openar and www.openbridge.no).

"Our focus now is on generic frameworks for AR design in maritime context, and as such, our AR approach can be expanded with Arctic-specific functions," Nordby said. "Our first sea trials will be for screens. We believe that AR solutions are already here for a screen-based system and that HMD will be integrated in operation as the technology matures."

Thermal Blending

CCTV monitoring of the surrounding sea provides the basic image component on which the layer of augmented reality is superimposed and delivered to bridge screens. Image quality itself can be enriched in AR to contain navigation information plus infrared details made visible to the navigator's eye.

A software processes data from a camera operating in the thermal infrared spectrum (TIR includes the 7- to 14-micrometer wavelengths, while commercial sensors

“By presenting real and virtual elements together in the same visual context, AR overcomes the dissociation between the target and the information on its nature.”

use only part of this spectrum). The camera does not need external illumination, such as the sun or moon, because it senses the intrinsic temperature differences of objects, thus facilitating night detection. The downside lies in the limited quality of the IR images. However, under low-light conditions, the fusion of infrared and visible generates an image containing significant targets with a richer textural detail, a major advantage in the Arctic where night lasts six months.

Groke's Infrared Approach

Groke Technologies in Turku, Finland, in which Mitsubishi Corp. is the leading investor, pioneered the blending of IR and visible images for improving ice navigation in augmented reality.

“At the start, we evaluated different technologies and decided to go with a combination of day and thermal

cameras,” said Iiro Lindborg, former general manager of remote and autonomous operations at Rolls-Royce and now vice president of Groke Technologies. “The unique part of our solution is the thermal blending. We get the colors from a visible camera with a horizontal field of view of 225 degrees and the thermal signature from the thermal camera with an FOV of 180 degrees, and we join these together in our user interface.”

In Groke's system, in addition to having on one screen a summary of all relevant information for navigation, including target pinning, the master also gets an enhanced picture of the surrounding sea. The level of blending can be tuned to the best image advantage using a graded slider on the screen. Because of signal interferences and reflections, radars often fail to identify icebergs and semisubmerged ice chunks. In Groke's system, an algorithm can process the thermal signal of ice to determine its nature and consistence in darkness.

“We carried out trials on board of the vessel Polar-is VG during the winter season as well,” Lindborg said. “Our system and the thermal view can provide crucial ice ridge information to the master. With the thermal camera, we can provide detailed ice information also during night time. Night time navigation will become safer, and vessels can increase sailing speed when they have better visibility where ice has formed and where there are openings.”

Lindborg specified: “Groke Pro can be used both on icebreaking operations in fairways and ports but also on ice assistance and convoy operations. For icebreaking, our unique blended view provides a fine tool for night operations and through our sensor fusion we can also bring ice radar and satellite data to the use of the navigator. Regarding convoy and assistance, our accurate measurement tracking functionality between objects can give exact distance between icebreaker and assisted vessel, and we can provide safety distance margins for assisted vessels as well.”

The AR concepts introduced in this article demonstrate advancements that enhance ship navigation in a changing Arctic. There will be more to come as testing and refinement progresses.

References

For a reference list, contact: vlipay@physics.org. **ST**

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Advances in pH Monitoring

Long-Term, High-Salinity Sensor to Monitor Ocean Health

By Nathan Lawrence • Kay McGuinness

Physical, chemical, biological, and geological marine and coastal research are crucial for understanding the world's oceans. This research is ideally accomplished through continuous long-term monitoring to understand the characteristics and processes in the marine environment. One of the key metrics in ocean health is pH, but long-term monitoring of pH in the ocean environment is problematic. The need for frequent sensor recalibrations to maintain accuracy, along with the typical problems of biofouling and the narrow salinity range in which these sensors function optimally, make long-term monitoring of pH in oceans challenging.

ANB Sensors, based in Toft, Cambridge, U.K., has developed and patented novel calibration-free pH sensing technology. To make this sensor suitable for monitoring ocean health, the aim was to mitigate any biofouling issues and ensure optimal operation throughout the entire salinity range found in the oceans. In this article, we describe how this has been done, along with data obtained in the laboratory and in the ocean trials.

Biofouling

Biofouling has long been considered a limiting factor for prolonged oceanographic studies and has been

recognized as one of the main obstacles to autonomous environmental monitoring in coastal and ocean environments, as the rapid covering of bio growth on sensors disrupts the quality and accuracy of the measurements.

Many potential solutions to improve biofouling resistance

for these deployments have been proposed, but none are universally suitable. The most common approach for biofouling protection on oceanographic sensors is the use of mechanical devices such as wipers or scrapers. However, removing all bio growth is usually difficult due to the surface contours and fragility of the sensor.

An alternative to the wipers is the generation of biocides to kill any organisms on the sensor. Previously, the biocide antifouling market was dominated by tributyltin (TBT) coatings. The TBT slowly leaches out into the marine environment, removing any adhered substances when hydrolyzing. However, it was proven to be highly toxic toward nontarget organisms and showed very harmful environmental effects.

Today, the most used biocide system is the copper corrosion mechanism, where, as

the copper corrodes in seawater, oxidized Cu^{2+} -based molecules are released into the water, which interfere



(Top) Clean transducer after six-week deployment in the Mediterranean. (Bottom) Sensor housing covered in bio growth after six-week deployment.



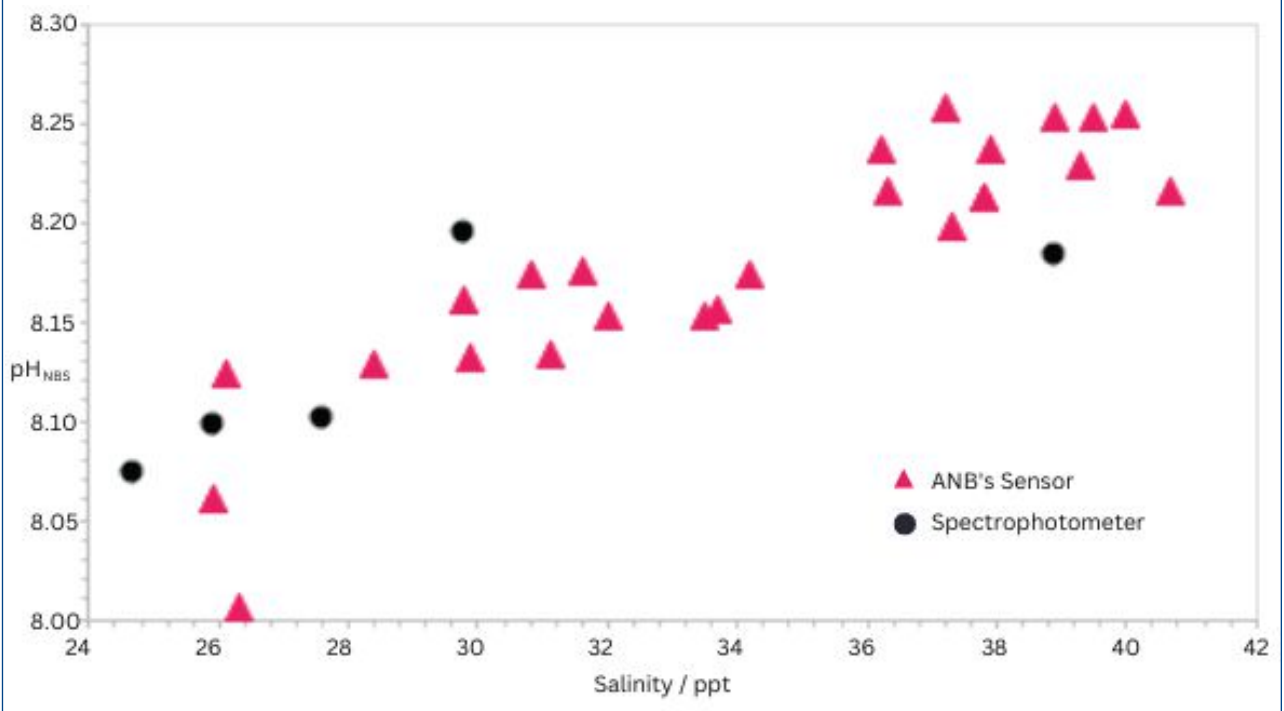
with the enzymes on cell membranes, avoiding cellular division. Copper-based antifouling paint can be classified into two groups. The first are slow-release films, releasing cuprous oxide into the surrounding environment by leaching. The second are ablative antifouling paints that have a continuously toxic surface. Even though copper is an efficient antifoulant, it is not effective against all the fouling species, such as various algae, and, furthermore, for a pH sensor, the effect the leached copper molecules have on the pH of the localized area around the sensor may lead to erroneous pH measurements.

Another common antifouling system is electrochlorination, which uses an electrolytic cell to transform the salt of seawater (NaCl) into sodium hypochlorite (NaOCl) through an electrolysis reaction. NaOCl acts as a disinfectant to the organic material and is a very effective antifoulant. Sodium hypochlorite solution has a 0.5 to 2% concentration of chlorine, which is dilute enough to be environmentally safe. Moreover, the reaction that leads to the chlorine formation is completely reversible, so NaOCl transforms back to NaCl , leaving no remaining hypochlorite.

None of the antifouling methods described above are really fit for purpose for today's pH sensors; they either change the pH of the surrounding area, leading to erroneous results, or require rigorous wiping, which can damage the pH-sensing element.

Sensor Development, Testing

At ANB Sensors, biofouling was a key consideration when designing the pH sensor, so much so that a



(Top to bottom) Control sensor (in sleep mode) completely covered in bio growth after three-week deployment. Abraded sensor ready for deployment. An example of ANB sensor's measurement of pH within a salinity range of 25 to 41 ppt, validated with a spectrophotometer measurement.

“To make this sensor suitable for monitoring ocean health, the aim was to mitigate any biofouling issues and ensure optimal operation throughout the entire salinity range found in the oceans.”

two-prong approach was adopted to ensure our solution was biofouling resistant.

The sensor is all solid state and robust enough to withstand rigorous wiping. In fact, the only maintenance required by the sensor is an abrasion of the sensing electrodes on the surface; thus, a wiper could benefit the long-term performance of the sensor.

The electrochemical method utilized produces a low concentration of hydrogen peroxide (H_2O_2), which inhibits the formation of bacterial biofilm on the sensing element. This is effective against a broad range of bacteria, including many of those that have become resistant to chlorine-based chemicals. The low concentration of hydrogen peroxide generated local to the surface of the sensor is soon diluted and broken down to be nonhazardous to the external environment, but extremely effective for biofouling purposes.

To study and prove the biofouling resistance of ANB's pH sensor, it was deployed in the OBSEA platform (expandable seafloor observatory) in the Mediterranean Sea, where biofouling is prevalent, in collaboration with Universitat Politècnica de Catalunya, using Jerico Next funding. The main objective of the OBSEA platform is to provide relatively low-cost, continuous, remote and long-term monitoring of the local coastal ecosystem, allowing real-time communication with the devices, as well as providing accessible infrastructure for the development of new marine sensors. The OBSEA platform was the perfect location for us to study and understand the biofouling resistance of our calibration-free pH sensor, since that Mediterranean region is recognized as a hot spot for climatic changes with significant seasonal variation in weather and biodiversity, making biofouling prevalent (*Sea Technology*, January 2023).

ANB's pH sensor was deployed for six weeks on the coastal observing station at 20-m depth. The results obtained were outstanding: After six weeks of deployment, the transducer (the active sensing part) showed no evidence of biofouling, despite the sensor housing being covered in bio growth.

As a control, another sensor was also deployed in the same location for three weeks but left in sleep mode. As the sensor was not sampling, no hydrogen peroxide was formed, and therefore the biofouling was not inhibited, and clear bio growth can be seen on the surface of the sensing part. After three weeks, this sensor was abraded underwater, removing all bio growth and refreshing the sensor ready for deployment.

These tests confirmed that ANB's pH sensor can be

operated autonomously in an environment where biofouling is prevalent without detriment to the results.

High Salinity

The average salinity of the world's oceans is 34 to 36 ppt, with many oceanographic-based sensors being tailored to operate under these conditions. However, there are regions in the world's waters where high evaporation and low precipitation occurs, resulting in an increase in salinity from 36 to 40 ppt.

The Red Sea is one such prime example, being one of the most saline water bodies in the world. The Red Sea is almost completely landlocked, with water flow either from the narrow Suez Canal in the north or the Bab el-Mandeb Strait in the south. Moreover, as precipitation is almost nonexistent there, there is little inflow of freshwater, which is further compounded by heavy evaporation caused by the extreme heat in this region. The salinity of the Red Sea, therefore, ranges from approximately 36 ppt in the southern part and 41 ppt in the northern part.

The Mediterranean Sea is another of the most saline seas in the world, with a salinity of approximately 38 ppt in the west and up to 40 ppt in the east in the summer. This is due to the rate of evaporation being three times higher than the influx of freshwater. The waters of the Mediterranean Sea have become saltier and warmer for the past 40 years at rates of about 0.015 ppt and 0.04° C per decade, with the rates predicted to further increase in the next decades.

Measurement of pH is key to understanding marine chemistry and biology and is of significant interest in areas of these extremely high salinity conditions. However, today's pH sensors are not fit for purpose to monitor such environments. In the case of potentiometric-based sensors such as ISFET or pH glass electrodes, the difference in ion concentration between the reference electrode chamber and the outside system will generate an unknown and uncalibrated liquid junction potential. Over prolonged use, ion exchange through the porous frit will occur, altering the composition of the reference solution. This causes a shift in the reference potential, impacting the calibration algorithms and the ultimate accuracy of the sensor.

An alternative to potentiometric technology is a colorimetric-based sensor, whereby seawater is mixed with pH indicator dyes and the spectrophotometric response is recorded. However, the algorithms used to determine the pH from the response are highly dependent on the sa-

“The electrochemical method utilized produces a low concentration of hydrogen peroxide (H_2O_2), which inhibits the formation of bacterial biofilm on the sensing element.”

linity of the solutions, so in high concentrations of chloride or sulfate ions, incorrect pH measurements result.

ANB Sensors has conducted a number of laboratory experiments with its pH sensor in conditions of high salinity where today's technologies are not suitable: synthetic seawater covering the range of 25 to 41 ppt. The accuracy of the measurements have been validated with a Jenway spectrophotometer using Metacresol purple as an indicator dye, confirming that the pH of a solution increases with salinity.

ANB Sensors has developed an accurate, long-term pH sensor that can operate in a high salinity environment and withstand biofouling. These solid-state pH sensors require no calibration and are extremely rugged and simple to use. This product is just one example of our commitment to advancing environmental sensors for sustainability.

Acknowledgments

The authors would like to acknowledge the excellent

team of scientists and engineers at ANB Sensors: Christina Day, James Dyer, Ben Legg, Brandon McHale, Monica Miranda Mugica, Rahul Raj, Neel Sisodia and Palani Valliappan, fully supported by our commercial team, Chris Copping, Vicki Georgiadis, Carl Main and Mark Pritchard.

References

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Nathan Lawrence is the CEO of ANB Sensors and a senior lecturer at Hull University. He has a DPhil. in electrochemistry and is a Royal Society of Chemistry fellow. He has written 130 research papers and holds over 30 patents. Lawrence led a team that successfully entered the Ocean Health XPRIZE, which catalyzed the birth of ANB.

Kay McGuinness is the COO of ANB Sensors. She has a DPhil. in polymer chemistry and 15 years' experience in sensors for the oil and gas industry. At ANB Sensors, she is responsible for guiding the company's technical direction and business development.



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ABB Agrees to Divest UK Consultancy

ABB has signed an agreement to divest its U.K. technical engineering consultancy business, part of its Energy Industries division, to TÜV Rheinland. The transaction is expected to close in the second quarter of 2023.

ABB's technical engineering consultancy will be integrated into the Industrial Services and Cybersecurity business of TÜV Rheinland in the U.K. The combined business will create a scalable, broad-based technical engineering provider delivering a full-service offer to the high-hazard industries, supporting customers in the energy transition and energy security.

Kyma Changes Company Name

Kyma AS has changed its company name to Danelec Norway AS. The name change is the result of the acquisition of the company by Danelec Marine A/S in December 2021. Current orders, commitments and processes remain unchanged.

Corporate Sustainability Directive in Europe

The European Parliament has approved the new Corporate Sustainability Reporting Directive (CSRD), which comes into force in 2024. Public and private organizations with more than 250 employees and over €40 million turnover will need to comply with the CSRD and start reporting in accordance with the new European Sustainability Reporting Standards (ESRS) in 2025.

Public entities with more than 500 employees that have been reporting under the Non-Financial Reporting Directive will need to abide by these new requirements a year earlier.

These new regulations on corporate sustainability reporting are going to hit the sector hard, as five times more businesses in Europe will need to comply, catching most of them unprepared in terms of internal know-how, processes and systems, according to ESG (environmental, social and governance) specialist Grow Maritime. The company urges the maritime sector to start preparing well in advance for CSRD compliance.

SEA-KIT Opens New USV Production Facility

SEA-KIT International's new production facility for its larger XL-class USV is now operational, with the first 18-m hull being fitted out for delivery this summer to Fugro. The new building was built alongside the company's existing base in Tollesbury, Essex, U.K. The company has also added employees to its technical, design, operations and administration teams.

SEA-KIT will soon prepare its testing and research vessel, USV Maxlimer, for its next mission. Maxlimer is back in the U.K. after a successful subsea volcano survey project in Tonga last August (*Sea Technology*, October 2022).

SSY Expands in South Korea

Simpson Spence Young (SSY), the world's largest independent shipbroker, has opened a new office in Seoul,

South Korea. Headed up by newly appointed partner Toby English and Regional Director Jun Seo, the team will focus on sale and purchase, in addition to exploring further potential growth areas for the business. The new presence in Seoul is the eighth in the Asia-Pacific region for SSY, which has a total of 22 global offices.

Miko Marine Enables Seabed Oil Recovery

When the *Rone*, a sunken bunker support vessel, sank to the west of Gotland, Sweden, in 1981 it was delivering 190 tons of heavy fuel oil for a local ferry, but heavy seas and icing caused the ship to go down in 98 m of water. The two-man crew was safe, but the *Rone* remained on the seabed, from where it had been releasing fuel oil into the sea around the Swedish islands for four decades.

The Swedish Agency for Marine and Water Management enlisted JD-Contractor A/S of Denmark to oversee the recent oil removal operation. JD chose Miko Marine for its Moskito oil recovery system that can be deployed by ROVs at any ocean depth. Support was provided by ROV teams from Abyss and Film Ocean and by Bunker One, whose steam generators would be on hand to heat the oil should it have become too waxy for recovery.

Miko drilled into eight of the *Rone*'s 10 tanks in just two days. Although the vessel had been carrying 190 tons of oil when it sank, because of corrosion and wreck movement, most of the tanks were emptied during the 41 years since it sank. Nevertheless, the project partners still succeeded in quickly recovering a substantial quantity of fuel oil from the remaining tank and were finally able to confirm that the vessel was no longer a pollution risk.

OSM Maritime and Thome to Merge

OSM Maritime Group and Thome Group have agreed to a merger of the two companies. The combined company will be named OSM Thome. Both OSM Maritime and Thome are deeply rooted in the Norwegian shipping tradition and expertise, and they combine this with the modern drive of Asian business enterprise. Today, the two companies manage 1,000 ships and have 550 ships on crew management. The headquarters of the combined company will be in Arendal, Norway, with technical management hubs maintained in Singapore and Europe.

Completion of the merger is anticipated during the first quarter of 2023. OSM Maritime's CEO Finn Amund Norbye will assume the role as CEO of OSM Thome, while Thome's CEO, Olav Nortun, will be COO.

RINA Acquires Patrick Engineering

RINA, an international inspection, certification and engineering consultancy, has acquired the entire share capital of Patrick Engineering Ltd., a Chicago-based engineering consultancy active in infrastructure, transport and renewable energy. Patrick Engineering, which has 19 offices, primarily in the northeast U.S., will be fully integrated into RINA Consulting, the subsidiary of the RINA Group operating in the engineering sector. Continued international expansion positions the RINA Group to better support international and local clients in large overseas projects.

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Teledyne Acquires ChartWorld

Teledyne Technologies Inc. has acquired ChartWorld International Ltd. and its affiliates. ChartWorld, headquartered in Cyprus, with additional locations in Hamburg, Singapore, Vancouver and Tokyo, is a provider of digital marine navigation hardware and software via a subscription-based model.

Commercial maritime subscribers to ChartWorld's software as a service (SaaS) receive type-approved electronic chart display and information systems (ECDIS), a lifetime warranty and global 24/7 support. ChartWorld also provides digital electronic navigational charts (ENCs) and other geospatial software and services, including digital route appraisal and voyage planning and onshore software for fleet monitoring and risk assessment.

ChartWorld affiliate SevenCs has a long history of participation in the development of standards for electronic maritime chart display. Today, SevenCs continues to provide ENC production and distribution software, as well as software development kits for the display of ENCs in accordance with maritime standards to other navigation system OEMs.

New Thordon Bearings' Distributor, Servicer

Corrosion Products & Equipment (CPE), a specialist engineering firm based in Rochester, New York, has been appointed as an authorized distributor and service provider across Thordon Bearings' marine, clean energy, and industrial seals and bearings portfolio. The agreement follows increased market demand for Thordon products in the northeast U.S. during the COVID-19 pandemic. An early focus will be on increasing Thordon's market share in the clean energy and vertical pump sectors.

Damen Partner Expands in Colombia

Damen's partner in Colombia, LINEAL Engineering, has opened a new office in Barranquilla on Colombia's Caribbean coast. Since the company was founded five years ago, it has been based in the inland capital, Bogotá, an ideal location for supporting its governmental and naval customers. The addition of an office in Barranquilla enhances service for private sector clients. The new office has both sales and engineering personnel, focusing primarily on the harbor, terminal and dredging sectors, as well as supporting vessels of other types.

Marquette Transportation Relies on Cat Marine

Marquette Transportation's relationship with Caterpillar Marine has been going strong since 1992. The first engines, three 3606s and two 3612s, were for the *Justin Paul Eckstein* and *Alix Anne Eckstein*, respectively. Then, between 1997 and 2000, the company built three new boats powered by Cat engines. All five of those original Cat-powered vessels are still running today.

The Kentucky-based company's 134 vessels move essential goods across U.S. waterways nonstop, and Cat Marine supports Marquette around the clock. For instance, when a Marquette boat encountered a problem at 10:30 p.m. one Christmas Eve, the problem was solved with a call to Cat dealer Boyd Cat. **ST**

Four Swedish Tug Vessels for Ice Navigation

The keel-laying ceremony has taken place for the series of Stan Tug 1706 ICE vessels at Albwardy Damen. Four customized ice-class harbor tugs are under construction for the Swedish Navy, to be delivered to Sweden starting in 2023. Sweden, the Netherlands and the United Arab Emirates are cooperating in the manufacturing of the tugs.

The four tugs, ordered by Sweden's defense ministry, with an option for two extra, are based on the Damen Stan Tug 1606 and will feature an extensive range of equipment. The tugs will be 17 m long and capable of navigating through ice for operation in northern harbors along the Swedish coast. They will be able to function in temperatures as low as -20° C.

Naval Group to Open in Greece

Naval Group will open a fully owned subsidiary in Greece in early 2023. This subsidiary will be the pillar for Naval Group's long-term footprint in the country and will be structured with substantial investment for a progressive ramp-up of its Hellenic personnel based on training, transfer of technology and transfer of knowledge.

The Hellenic staff will eventually constitute the majority of the subsidiary's workforce, which could sustain up to 100 jobs. Naval Group Hellas will operate out of Athens. More than 50 Hellenic companies have already joined Naval Group's supply chain.

Phoenix Supports US Navy SUPSALV

Phoenix, under the direction of the U.S. Navy's Supervisor of Salvage and Diving (SUPSALV), has located and recovered a downed U.S. Navy F-35C Lightning II aircraft in the South China Sea from a depth of 12,400 ft. Working aboard the offshore construction vessel *Picasso*, Phoenix and SUPSALV deployed the U.S. Navy's Trondheim AUV to locate the aircraft. The Phoenix and SUPSALV team then used the U.S. Navy's CURV 21 ROV to attach specialized rigging and lift lines to the aircraft. The aircraft was lifted to the surface and hoisted aboard *Picasso*.

In other Phoenix news, the company has been awarded an indefinite-delivery/indefinite-quantity contract for worldwide undersea deep-ocean search and recovery operations and engineering and technical support to the U.S. Navy's SUPSALV. Work will be performed worldwide and is expected to be completed in September 2027.

Exail DriX Participates in USV Exercise

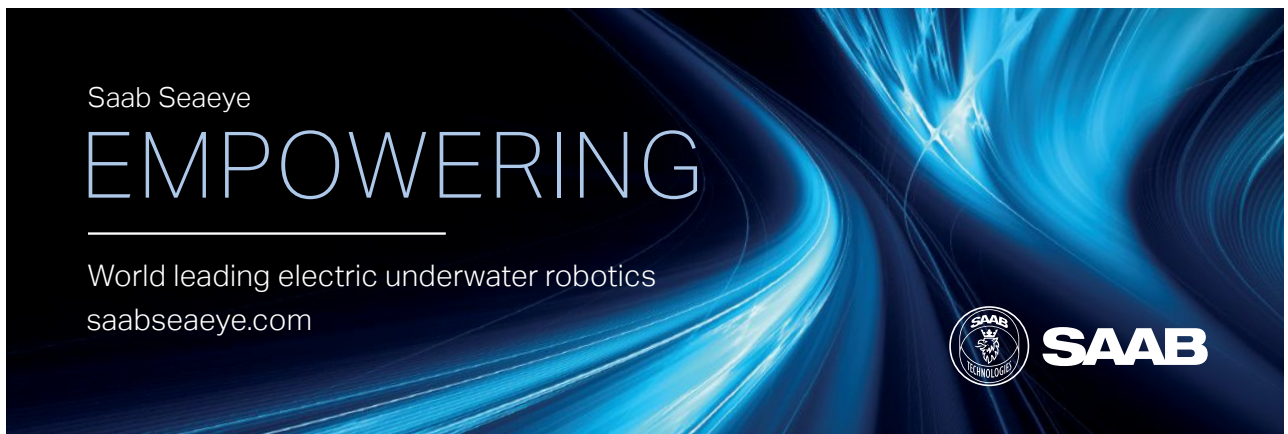
Exail, formerly iXblue, has taken part in the Digital Horizon Unmanned & Artificial Intelligence Exercise in Bahrain, organized by the U.S. Navy. The U.S. Navy's Fifth Fleet held the three-week exercise to test new unmanned technologies, as part of its plans to establish the world's first USV fleet of 100 drones in the Gulf of Bahrain by the end of the summer.

Exail's DriX USV was among the 15 USVs and unmanned aerial vehicles (UAVs) selected to participate in the exercise, which staged a maritime domain awareness mission. The USVs and UAVs were tasked with gathering data on the surface in order to detect and identify potential threats. One of the main requirements was for the drones to communicate with each other using a common OPS system. The complementarity aspect of the different drones was also important, as the Fifth Fleet aims to leverage the different capacities of each drone to cover a wide array of competencies in order to produce a common operating picture of what is occurring in a specific zone of water.

With its highly hydrodynamic monohull and drop keel, DriX showed high reliability with excellent sea-keeping and speed results, accomplishing its mission of gathering data on the surface and proving its capacity to successfully integrate third-party radar and cameras.

Team Resolute to Build Ships for UK Royal Navy

A contract has been awarded to Team Resolute to manufacture vessels providing munitions, stores, and provisions to the Royal Navy's aircraft carriers, destroyers and frigates. Team Resolute, comprising BMT, Harland & Wolff and Navantia UK, will deliver three fleet solid support ships for the Royal Fleet Auxiliary. The ships will be the second longest U.K. military vessels, after the two *Queen Elizabeth*-class aircraft carriers. Production is due to start in 2025, with the ships operational by 2032. **ST**



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Electric Manipulator Arm



The EMA-5 is a five-function manipulator module offering slew, elevation, elbow bend, jaw rotation, and jaw open/close movement. It is designed for observation-class ROVs for underwater precision manipulation, scientific and environmental sample collection, and tooling and grabbing. The EMA-5 can be controlled with a gamepad. TMI-Orion Dynamics, with distributor OceanTools Ltd.

Port State Adviser App

KR PSC ADVISER helps customers prepare for port state control (PSC) inspections. The new service is designed to reduce the risk of PSC detentions by providing the latest PSC information in real time and enabling seafarers to easily keep abreast of PSC checklists with a single app. PSC inspection aims to prevent maritime accidents and protect the marine environment by ensuring that foreign ships and their equipment entering national ports comply with international conventions. Korean Register.

Quieter Propeller

This technology substantially reduces underwater radiated noise generated by ships' propellers. The patented PressurePores system reduces propeller tip vortex cavitation by applying a small number of strategically placed holes in the propeller blades. The addition of these pressure-relieving holes allows ships to

operate with a more silent propeller. Oscar Propulsion Ltd. and the University of Strathclyde.

Weather-Resistant Monitor

SRMHV-32R is ideal for use in the inspection, marine, and oil and gas sectors. The 32-in. display features a corrosion- and water-resistant stainless steel enclosure. With 1,500 nits of brightness, this model is five times brighter than standard screens. It is designed for use in direct sunlight, with full HD resolution and anti-reflective glass. TRU-Vu Monitors Inc.

World's Longest-Range E-Boat



With up to 57 nautical mi. of expected range and DC charging, the C-8 is powered by a 69-kWh battery pack. The range is two to three times longer than what conventional electric speedboats can achieve at high speed and compares favorably with how internal combustion engine powerboats are used. Hydrofoil technology enables a long range. Candela and Polestar.

Chart Plotter, Fish Finder Combo

Version 5.0 software is an update available for the GP1871F/1971F that integrates new autopilot drive modes and alerts for the Suzuki FishHunter Drive with updated status indicators. This update improves integration between the GP Combo Units and alerts the user to the selected NavPilot drive mode. Furuno USA Inc.

Weather-Optimized Voyage

Orbit Weather+ is a digital solution powered by DTN marine weather

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Oyster Aquaculture Could Improve Potomac River Estuary
Oyster aquaculture in the Potomac River estuary could result in significant improvements to water quality, according to a new NOAA and U.S. Geological Survey study published in *Aquatic Geochemistry*. All of the nitrogen currently polluting the Potomac River estuary could be removed if 40 percent of its riverbed were used for shellfish cultivation, according to the study. [3-2 SeaTech.com](#)

Navy's Laser Weapon Ready For Summer Deployment
Navy engineers are making final adjustments to a laser weapon prototype that will be the first of its kind to deploy aboard a ship late this summer. The prototype, an improved version of the laser weapon system, will be installed on the USS Ponce for on-sea testing in the Persian Gulf. Navy leaders have made directed-energy weapons a top priority to counter what they call asymmetric threats, including missiles and small attack boats that could be used to deny U.S. forces access to certain areas. [3-2 SeaTech.com](#)

Ferry Sinks Off Coast of South Korea
With 463 passengers onboard, a ferry sailing from Incheon, South Korea, to the island Jeju sank near the southern tip of South Korea Wednesday, near the southern tip of South Korea. Most of the more than 400 people on the ship were high school students and people on a school trip to the island. In the rescue effort, more than 80 vessels and at least 18 aircraft swept in to pull passengers from the water to safety. [3-2 SeaTech.com](#)

Pay Increase for Sailors Soon to Come
Sailors serving for the U.S. Navy could see a faster paycheck in the coming weeks, reported the Virginia Pilot. On May 1, sailors serving on advanced ships will receive a pay raise. The increase in pay comes as an effort by the Navy to increase the pay of sailors who work in these hazardous environments. Currently, this spend is who work in jobs involving long deployments. [3-2 SeaTech.com](#)

US Senate Reviews DOE Budget Request
For fiscal year 2015, the Department of Energy (DOE) requested \$23.8 billion. The U.S. Senate Appropriations Committee, Subcommittee on Energy and Water Development, held a hearing last week to review the funding request and discuss financial priorities. According to Lamar Alexander (R-Tenn.), research should be a focus of spending. [3-2 SeaTech.com](#)

US Technology Helps in Search for Flight 370
More than a month after Malaysia Airlines flight 370 went missing, crews are hard at work trying to uncover what happened to the Boeing 777. Acoustic signals emitted from the plane's black box, which houses records from the flight, provide a lead to the location of the plane, and eight countries are participating in the effort to scan the waters off the coast of Northwest Australia. Chris Johnson from Naval Sea Systems Command told Sea Technology how the U.S. Navy is helping in the search. [3-2 SeaTech.com](#)

2014 Sea Technology Buyers Guide Now Available
Published annually by Compass Publications, the 2014 edition of the *Sea Technology Buyers Guide* is now available. The *Buyers Guide* features a market analysis and seven sub-directories, including industrial firms, services, federal government organizations, educational institutions, oceanographic research vessels and geophysical survey vessels.

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APIs that can find the smartest, safest and most fuel-efficient route by using AI-based machine learning to analyze constantly updated weather data fed into the Orbit vessel performance management system through DTN APIs. This tool can help ships comply with International Maritime Organization regulations to reduce the carbon intensity of shipping. OrbitMI Inc.

Sonar Software Update

SonarWiz version 7.10.2 adds capabilities for real-time monitoring, such as expansion of the sensor graph window to display more than one value of interest at a time. The Magnetometer module update increases the user's control over the display of magnetometer data, with new drawing modes. Chesapeake Technology Inc.

Biofuel-Ready Separator



Biofuels such as HVO (hydrotreated vegetable oil) and FAME (fatty acid methyl ester) can be used by diesel engines without major engine modifications. They can be a carbon-neutral alternative if produced from the right biomass, but they must be cleaned effectively to prevent performance issues and expensive engine wear. In a marine industry first, Alfa Laval high-speed separators are now compatible with HVO (EN15940) and with FAME (EN14214 or ASTM D6751) blends comprising residual fuel and/or distillate. Alfa Laval AB.

Underwater Data Management

SEA360 is an underwater data acquisition and processing service that employs instrumented AUVs

and portable, innovative, modular, and low-carbon footprint technologies to collect high-quality data. Applications include rapid environmental impact and assessment measurements; pre- and post-marine construction surveys; underwater inspections of structures, cables and pipes; UXO detection; marine geophysics; hydrography; and marine archaeology. NEOTEK.

Marine Evacuation System

MES Life Ark, with full type approval from Bureau Veritas, is a helical slide-based MES for small to medium-size passenger vessels. It protects passengers and crew on vessels with a freeboard height of up to 23 m and passenger capacities ranging from 300 to 1,500 persons, such as ferries and expedition cruise ships. Survitec Group Ltd.

Magnetic Compass

When weather conditions warrant slow speeds, GPS becomes difficult to use. The SuperSport Venture

SS-PR2 magnetic compass not only displays an accurate heading even when stopped but also instantly shows minute course changes. It is ideal for boats 16 to 35 ft. in length and has a rugged polymer housing that mounts on any surface from vertical to 40°. Ritchie Navigation.

Enterprise-Grade Firewall, Email

For commercial vessels and fleets, KVH Managed Firewall provides an added level of protection against cyber threats, and KVH Cloud Email enables commercial seafarers to send and retrieve email over any available data connection. KVH Industries Inc.

Gyro Stabilization Mount

RSM 50, a compact gimbal, offers stabilization to ensure that a sensor can collect high-quality and reliable data. The mount stabilizes in real time angular movements of boats, ships, USVs, autonomous platforms and buoys caused by sea swell. SOMAG AG Jena. **ST**



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Bill to Support Clean Hydrogen Development

Reps. Paul D. Tonko (D-N.Y.) and Stephanie Bice (R-Okla.) have introduced the Department of Energy Clean Hydrogen and Fuel Cell Research, Development, and Demonstration Act of 2022, bipartisan legislation that would empower the U.S. Department of Energy (DOE) to strengthen its efforts to support R&D of clean hydrogen and fuel cell technologies. The act authorizes a series of programs and activities at DOE to conduct research, development, and demonstration programs relevant to hydrogen and fuel cell technologies.

Currently, the Hydrogen and Fuel Cell Technologies Office (HFTO) leads hydrogen and fuel cell R&D activities within the Office of Energy Efficiency and Renewable Energy and coordinates related activities with DOE's Office of Fossil Energy and Carbon Management, Office of Nuclear Energy, and the Office of Science. This bill codifies many of the existing activities led and coordinated by the HFTO that were not included in the Energy Act of 2020 or the Infrastructure Investment and Jobs Act.

The bill also authorizes emerging activities, including: improving stationary fuel cells to achieve greater than 80,000 hr. of durability; the development of advanced computer modeling to optimize energy system operation for clean hydrogen production in different electricity markets; and R&D to improve the use of hydrogen and hydrogen blends in the production of iron, steel, cement, fertilizer, chemicals and energy-dense fuels.

Maritime Aspects of Defense Authorization Law

The James M. Inhofe National Defense Authorization Act (NDAA) for fiscal year 2023 has been signed into law. It includes U.S. Coast Guard and Maritime Administration (MARAD) reauthorization and ocean conservation provisions, including a ban on the buying and selling of shark fins in the U.S. and more tools to address illegal, unreported and unregulated fishing.

The Coast Guard Authorization Act of 2022 authorizes \$18.9 billion for fiscal year 2023. The bill authorizes funding for ships, aircraft, health care and other benefits to support Coast Guard members and their families. The NDAA also provides a 4.6 percent pay increase for Coast Guard members.

The U.S. Maritime Administration Reauthorization Act authorizes \$1.6 billion for MARAD to invest in the maritime workforce, strengthen maritime infrastructure, and expand research and development into new technologies to advance fleet sustainability and innovation.

A study published in *Nature* last year found that global oceanic shark and ray populations have declined by more than 70 percent over the last 50 years, with overfishing as the primary cause. Fins from as many as 73 million sharks end up in the global market every year.

FEMA Funding for Dredging in Puerto Rico

The U.S. Federal Emergency Management Agency (FEMA) announced a federal share of nearly \$88.7 mil-

lion to dredge the Carraízo Reservoir. The project, under the Puerto Rico Aqueduct and Sewer Authority, will allow a greater water reserve for a large part of the population of the metropolitan and eastern areas of Puerto Rico, particularly during drought seasons.

The dredging will entail the removal of some 2.6 million cubic yards of sediment from the reservoir and the removed material will be transferred to three dikes. The remaining water will be transferred back to the reservoir, and, once dry, the sediment will be used to recover the vegetation of the area through seeds or replanting.

Woolpert Surveys California Reservoirs

Woolpert was contracted by the U.S. Army Corps of Engineers and Pro-ROV Services for the Browns Valley Irrigation District under separate contracts to collect and integrate LiDAR and multibeam sonar data. These data will be used to determine the accurate capacity of two California reservoirs and to support the management of water resources.

For the Browns Valley Irrigation District project, Woolpert collected LiDAR data via an uncrewed aircraft system and acquired multibeam sonar data with a survey vessel. These data will be used to map and model Collins Lake, a reservoir located northeast of Sacramento in the foothills of the Sierra Nevada Mountains.

Under a separate contract, the Corps selected Woolpert to collect multibeam sonar data for capacity surveys conducted at Lake Isabella, east of Bakersfield. At the same time, Woolpert was under contract to fly topographic LiDAR over the region for the U.S. Geological Survey (USGS) 3D Elevation Program. By combining the hydrographic data collected at Lake Isabella and integrating it with USGS LiDAR data, Woolpert developed a high-resolution digital elevation model of the reservoir and watershed to accurately determine the capacity of Lake Isabella. Leveraging two surveys produced a valuable data set that will be used for many years.

New BOEM Director

Elizabeth Klein has been named director of the Bureau of Ocean Energy Management (BOEM), the bureau responsible for the management of U.S. offshore energy and mineral resources. She succeeds Amanda Lefton.

Klein is an experienced attorney and a leader in clean energy, climate change, and environmental law and policy. She was a key architect in creating a new federal offshore wind industry and leasing program.

BSEE Renewable Energy Program Director

Michaela Noble has joined the U.S. Bureau of Safety and Environmental Enforcement (BSEE) as the new program director for renewable energy and regulatory compliance. Noble will oversee and direct national policy and research for BSEE's Renewable Energy Program. She holds a bachelor's degree in maritime administration and a J.D. degree in maritime law.

Cheri Hunter, the current renewable energy coordinator, will serve as the new BSEE Renewable Energy Operations lead. **ST**

environmental monitoring

Pacific's Low-Oxygen Zone Predicted to Expand

For thousands of kilometers along the western coasts of the Americas, low-oxygen waters known as oxygen minimum zones stretch out into the Pacific. In part due to climate change, this oxygen-starved region is likely to get wider and deeper, expanding by millions of cubic kilometers by the end of the century, models in a new study predict. Larger oxygen minimum zones threaten marine ecosystems and species, along with the industries that depend on them.

Oxygen minimum zones are located 200 to 2,000 m beneath the surface, in the “shadow regions” of the tropical ocean, and are driven by factors such as water temperature, nutrient supply and ocean circulation patterns. Part of the difficulty in predicting changes arises from disagreements on how to define “low” oxygen levels, which the new study explores.

The study, published in *AGU Advances*, used the latest suite of climate models, CMIP6, to improve upon previous predictions for how oxygen minimum zones would change. Those predictions often reported conflicting fates of the Pacific's oxygen minimum zone.

Oxygen minimum zones comprise an outer layer and an inner core of ultra-oxygen-depleted water. If high greenhouse gas emissions continue, the study predicted the tropical Pacific oxygen minimum zone will grow 6 to 8 million km³ by 2100, expanding about 4 percent. That volume equates to about 0.6 percent of the volume of the world's oceans, or about three times the volume of the Greenland ice sheet.

As the Pacific zone grows, its outer layer will stretch over greater areas and depths, but its inner core could shrink, the study found. The growth of the oxygen minimum zone outer layer is due to weakened ocean circulation, which slows oxygen replenishment, according to the models. The oxygen minimum

zone will likely expand toward the surface by 5 to 50 m. There's a small upside to this: The core in oxygen minimum zones produces nitrous oxide, an important greenhouse gas, so a shrinking core in the tropical Pacific oxygen minimum zone may limit how much gas is released into the atmosphere.

Beyond the core, the expansion of the Pacific oxygen minimum zone's outer layer will compress the habitat for commercially important marine species, such as anchovies, tuna and crabs. Expanding oxygen minimum zones may lead to more overfishing because low-oxygen zones will likely expand upward toward the ocean's surface, compacting oxygen-rich regions where fish can live. This could negatively affect the fishery industry of the region.

Integrating Indigenous Views

“Two-eyed seeing” is an indigenous concept discussed in a *PLOS Biology Perspectives* article supported by Ocean Networks Canada. It proposes that integrating the diverse scientific traditions, systems, and methods of indigenous and Western knowledge can result in innovative advancements. When it comes to ocean sustainability, indigenous ways of knowing, such as two-eyed seeing, are critical in environments that indigenous people have stewarded for millennia.

One of the richest sources of information that indigenous peoples bring to knowledge pairing partnerships are the direct, year-round observations made by people out on the land and on the sea, over many generations.

For example, hunters, mariners, trappers and dog mushers in Alaska have been noticing signs of climate warming since the 1950s: in ocean currents, ice conditions and snowfall, and in the colonization of their peninsula by shrubs and trees. However, their warnings found few listeners outside of their region until decades later.

Even though direct observations have a low level of experimental

control, they offer the highest possible degree of ecological validity, especially in situations where the physical outcomes of ongoing climate change processes are readily visible. Observers are uniquely qualified to capture detail, identify anomalies and interpret what they have seen.

Gaps M5 Survey in Nigeria

Grandeur Subserv Ltd. has acquired an Exail Gaps M5 USBL system for shallow-water geophysical surveys on the Nigerian coast. The system was chosen as an agnostic acoustic positioning tool compatible with third-party transponders and capable of accurately tracking any asset in very shallow water.

Grandeur has used the Gaps M5 to determine the location of pipelines and hazards that could impede drilling on the Escravos field. The survey tracked sensors in water depths ranging from 8 to 100 m, with centimeter accuracy in sensor positioning. Gaps M5 offers positioning accuracy of 0.2 percent at up to 995 m operating range.

Sea Level Rise Beyond Paris Temperature Targets

While the world focuses on limiting the rise in global temperature to 1.5 or 2° C over the preindustrial average, increasing meltwater from ice sheets presents an existential threat to the viability of island and coastal nations throughout the world, according to research from the University of Massachusetts Amherst, published in *Earth's Future*.

Even the most optimistic temperature targets can lead to catastrophic sea level rise, which has already begun and will affect low-lying nations for generations to come, the researchers said.

They proffer that temperature is not the only way to track global climate change. Antarctic melt can delay temperature rise while increasing sea levels. Some areas in the Caribbean Sea and the Indian and Pacific Oceans will experience a disproportionate share of the sea level rise from Antarctic ice melt: up to 33 percent greater than the global average. **ST**

offshore oil & ocean engineering

ODE Rebrands

Offshore Design Engineering (ODE), a subsidiary fully owned by DORIS Group, has rebranded as DORIS. The rebranded company aims to make conventional energies cleaner and enable renewable and new energy sources.

DORIS offers services to the conventional energy, offshore wind, hydrogen and CCS (carbon capture and storage) sectors. It has been in operation for over six decades, including more than 20 years in the renewable energy space.

New Balmoral Advanced Composites Plant

Aberdeen-based Balmoral Comtec has completed the installation of its manufacturing plant at its new advanced composites facility at Montrose Port. The 18,299-sq.-ft. quayside facility will be where large-scale composite components, such as subsea and wellhead protection, wave energy structures and manifold covers, for the offshore energy sector will be built. The investment in these premises will strengthen Balmoral's commitment to the wind, wave and tidal energy sectors.

Founded in 1980, Balmoral already provides protection products (fatigue, impact and abrasion); buoyancy (mooring and cable); and tethering solutions (clamps) to the offshore wind sector. The new manufacturing site at the Port of Montrose will enable the company to deliver its large, advanced composite products directly from shore to ship as the sector expands in the waters off the coast of Scotland and further afield.

TDI-Brooks Upgrades MBES

In an effort to enhance mapping efficiency, TDI-Brooks has upgraded the multibeam (MBES) system on its vessel *RV Gyre* from the Kongsberg Maritime EM 302 to the EM 304 MKI.

The EM 304 MKI provides an increase of 75 percent swath performance at 6,000 m. This MBES

can map shallow to medium water depths with high resolution, as well as map to depths of more than 11,000 m. It supports simultaneous collection of multiple data types, saving time in the planning, execution and analysis phase. This low-noise echosounder requires minimal post-processing.

Shell Sells Non-Operated Interests in Malaysia

Sarawak Shell Berhad (SSB), a subsidiary of Shell plc, has agreed to sell its stake in two offshore production sharing contracts in the Baram Delta to Petroleum Sarawak Exploration & Production Sdn. Bhd. (PSEP).

The transaction is targeted to be completed in early 2023, subject to completion of conditions, which include, among others, regulatory approval to be obtained from PETRONAS and consent from PETRONAS Carigali Sdn. Bhd.

Shell retains a strong presence in Malaysia's upstream, gas-to-liquids, downstream and business services sectors.

Hybrid Energy Pilot

Caterpillar Marine and Louisiana-based Jackson Offshore Operators LLC will pilot an integrated hybrid energy solution to reduce fuel consumption and diesel exhaust emissions.

Jackson Offshore Operators is a full-service offshore transportation company providing marine services in the Gulf of Mexico. The companies will demonstrate the technology on Jackson Offshore's *MV Thunder* platform supply vessel, jointly working toward the reduction of greenhouse gas emissions while optimizing the system's performance.

The diesel-electric *MV Thunder* will be upgraded with a hybrid energy solution to complement its power plant of two Cat 3516 and two C32 generator sets.

The hybrid solution will be incorporated into *MV Thunder* with the expertise of Cat dealer Louisiana Cat, which will oversee the installa-

tion and commissioning of the new equipment.

Progress on Multi-Client 3D Survey Offshore Brazil

CGG and TGS have announced the second phase of the Foz do Amazonas 3D multi-client survey, located in the offshore Brazil Equatorial Margin. This survey, covering 11,425 sq. km, will broaden the region's 3D coverage and deliver additional high-quality data essential for the exploration efforts in the basin.

Existing 2D data and adjacent 3D data indicate the presence of reservoir depositional fairways in this location, which overlies a source interval contemporaneous with the Guyana Basin petroleum system. Basin model studies predict a mature early Cretaceous petroleum system with extensive regional reservoir distribution. The nearby Zaedyus discovery in French Guiana and the Narina and Venus wildcat discoveries on the conjugate margins of Liberia and Sierra Leone support resource potential in the Foz do Amazonas Basin.

Early-out pre-stack depth migration products will be available in the fourth quarter of 2023, with final products available from the third quarter of 2024.

Starlink Connectivity Offshore

Marlink, a smart network solutions company, continues the roll-out of its new blend of hybrid network services, equipping Solstad Offshore vessels with Starlink connectivity integrated with the highly reliable Sealink VSAT, L-band backup and 4G services.

Solstad Offshore is the first offshore vessel operator on the Marlink network to trial Starlink, testing the network in harsh weather conditions. In September 2022, the company completed the migration of its fleet connectivity to Marlink, including Sealink VSAT and 4G connectivity and is now considering further extension with Starlink integration. The solution will deliver high-speed, low-latency connectivity with maximum information rate performance. **ST**

DNV Awards First Blockchain Statement of Fact

In the first of its kind for a shipyard, DNV has awarded a statement of fact to Samsung Heavy Industries (SHI) for applying blockchain technology to its SAS (Samsung Autonomous Ship) and SVESSEL eLogbook data streams on an operating vessel.

The project was accomplished by interfacing SHI's data stream and eLogbook with the VeChainThor blockchain to demonstrate the technology's potential for secure data stream applications on ships.

As the shipping and offshore industries become more digitized, yards, shipping companies, manufacturers and class societies worldwide are actively developing and verifying smart and autonomous ships amid rising need to strengthen cybersecurity. This is increasingly important for real-time data transmissions from ship to shore, remote monitoring and equipment maintenance.

The blockchain application for the SHI data stream pertains to Samsung Autonomous Ship's navigation information, particularly the Collision Risk Index and Distance to the Closest Point of Approach. Also, the SVESSEL eLogbook satisfying IMO MEPC.312(74) were released via blockchain technology.

Seaeye Falcon Surveys Crocodile-Infested Waters

ASI Group has deployed a Saab Seaeye Falcon robot into crocodile-infested waters in East Africa. The crocodiles have been preventing manual inspection of remote inland underwater structures supporting regional power generation.

The Seaeye Falcon ventured into rivers and reservoirs, as well as inside structures and tunnels, to inspect and survey the wide variety of infrastructure supporting five power stations. The work included several inspection operations to assess the many underwater structures, including intake screens, stoplogs guides, long tunnels, drop shafts and stilling basins.

A truck crane was used to remove covers and stoplogs and to launch the Falcon into a variety of access locations. The crane's long boom kept personnel a safe distance from the crocodiles. Even in extremely murky waters, the smallest anomalies in structures were captured on the Falcon's sonar by ASI operators.

The survey data were used by ASI to construct 3D models of the various water control structures. By reviewing and comparing the collected data with known build-data, a clear understanding of the installations' conditions was established.

Repeatable assessment across the locations utilizing remote systems and acoustic inspection devices enables detection of anomalies and their change over time.

Nidec Chosen for Port Electrification in France

Nidec ASI, part of the Energy & Infrastructure Division of the Nidec Group, has won the tender to implement a "shore-to-ship" project for the Port of Sète, in the south of France.

Nidec ASI has signed a contract with Port Sud de France, aimed at setting up innovative electrical power systems that will enable ships moored in the port to draw the energy required to be fully operational from the quays, without the need to keep onboard diesel engines running.

The project will have a positive impact on the quality of life of local communities and on tourism, a key sector in the French economy. It will comply with EU directives that will become binding by 2025. These directives stipulate that all European ports must adopt electrification systems for port quays.

The Port of Sète will house three turnkey power supply systems to power three quays. The systems will comprise converters and transformers to adapt the supply network's voltage and frequency to what is required by the ships.

The converters are scheduled for delivery July 2023, and commis-

sioning of the systems is expected by November 2023.

Argos Sonars for Turkish USVs

FarSounder Argos 3D forward-looking navigation sonars have been included in the navigation control system for two USVs built in Turkey. The vessels have comprehensive automation technologies enabling them to sail autonomously. The addition of the Argos systems will help them carry out their missions safely. Promar Deniz Malzemeleri A.S., FarSounder's dealer in Turkey, was instrumental in securing this sale.

Argos sonars interface with the vessel navigation and control systems, providing vital information about the current state of the environment in front of the vessel and below the water line for situational awareness. The systems do all the data processing and provide the vehicle control system with the information needed to make intelligent navigation decisions and make real-time course alterations.

3D Models for Class Approval

Bureau Veritas has successfully reviewed a 3D design of a 2,500 m³ hopper dredger from Damen Shipyards. This is a step to granting approval in principle. The pilot project for 3D model-based class approval is meant to pave the way for using 3D computer designs as standard procedure to achieve class notation for seagoing vessels.

Vessel steel hull design evaluation based on 3D models in parallel to its classification review process has become possible thanks to the new data exchange format OCX. The OCX is an open standard that facilitates data exchange of 3D ship models for class approval.

Today's best practice is submitting 2D technical drawings of hull designs to classification societies. After the class society studies the drawings, sometimes changes are required. The designers apply changes to the drawings, and the process repeats.

Using only 3D models will save a lot of time and reduce mistakes in the submission process. **ST**

contracts

MIND Technology Inc., The Woodlands, Texas, has received orders via its Seamap unit from a major international seismic contractor for GunLink 4000 Source controller systems, BuoyLink GNSS positioning equipment, as well as related spares and ancillary items. Delivery is expected in the first half of fiscal year 2024. Undisclosed.

Damen Marine Components, Hardinxveld-Giessendam, Netherlands, has won its first multi-vessel order in the U.S. Four packages, each comprising steering gear and rudders, five winches and two towing pin systems, will be supplied to a U.S. shipbuilder for four newbuild Multi Cats 3013 workboats. Callan Marine Ltd. and C&C Marine & Repair.

Elcome International, Dubai, United Arab Emirates, has inked a memorandum of understanding with a Maldives-based maritime servicing and logistics group to provide Maldives' thriving maritime cluster with access to a wide range of original equipment brands, solutions and technical services. Triangle Maritime Pvt Ltd.

DNV, Høvik, Norway, was engaged as independent third party in the qualification process of a system injecting hydrogen as an additive in the internal combustion engines of drilling rigs in order to reduce diesel consumption and greenhouse gas emissions from drilling. Ocyan.

TechnipFMC, London, U.K., has been awarded an engineering, procurement, construction and installation contract for the design, engineering, manufacture and installation of pipe for the Dvalin North field, which will be tied back to the Heidrun Platform via the existing Dvalin field on the Norwegian Continental Shelf. Wintershall Dea Norge AS.

Fugro, Leidschendam, Netherlands, has received a contract for the Keli-

dang Cluster gas field development project to perform site characterization surveys to support the front-end engineering design for offshore production facilities and the pipelines to prospective buyers onshore. Petronas Carigali (PC) Brunei. **ST**

meetings

Note: The coronavirus (COVID-19) pandemic could affect event dates. Check event websites for the latest updates.

APRIL

April 18-20—Ocean Business, Southampton, U.K. www.oceanbusiness.com.

April 26-28—NOIA Annual Meeting, Washington, D.C. www.noia.org/event/noia-2023-annual-meeting.

MAY

May 1-3—Intelligent Ships Symposium, Philadelphia, Pennsylvania. www.navalengineers.org/Symposia/ISS2023.

May 1-4—Offshore Technology Conference, Houston, Texas. <https://2023.otcnet.org>.

May 8-10—World Utilities Congress, Abu Dhabi, United Arab Emirates. www.worldutilitiescongress.com.

May 8-11—XPONENTIAL, Denver, Colorado. meetings@auvsi.org or www.auvsi.org/events/xponential/xponential-2023.

May 9-11—UDT, Rostock, Germany. team@udt-global.com or www.udt-global.com.

May 17-19—OceanTech Expo, Zhoushan, China. www.oceantechap.com.

May 17-19—Subsea Technology Eastern Mediterranean, Limassol, Cyprus. www.subseatechnologyconference.com.

May 23-24—Blue Food Innovation Summit, London, U.K. www.bluefoodinnovation.com.

JUNE

June 5-8—OCEANS 2023, Limerick, Ireland. <https://limerick23.oceansconference.org>.

June 6-8—Capitol Hill Ocean Week, Washington, D.C. <https://marinesanctuary.org/chow-2023>.

AUGUST

August 20-24—World Water Week, Stockholm, Sweden. www.worldwaterweek.org.

August 27-September 1—IMAGE 2023, Houston, Texas. <https://ti.nyurl.com/uc2db9k3>.

SEPTEMBER

September 11-15—London International Shipping Week, London, U.K. <https://londoninternationalshippingweek.com>.

September 12-13—International Antifouling Conference, Gothenburg, Sweden. <https://antifouling-conference-2023.confetti.events>.

September 25-28—OCEANS 2023 Gulf Coast, Biloxi, Mississippi. <https://gulfcoast23.oceansconference.org>.

OCTOBER

October 3-5—International Boat Builders' Exhibition and Conference, Tampa, Florida. www.ibexshow.com.

DECEMBER

December 4-6—Marine Renewables Canada Conference, Ottawa, Canada. <https://marinerenewables.ca/event/marine-renewables-canada-2023-conference-december-4-6-in-ottawa>.

2024

NOVEMBER

November 4-7—EURONAVAL, Paris-Nord Villepinte, France. www.euronaval.fr.

For more industry meetings, visit sea-technology.com/meetings. **ST**

You Can Help Stem the Tide of Ocean Plastic Pollution—Kathryn Anderson

Kathryn Anderson is a certified adult educator and education coordinator for EPIC Academy at The Ocean Legacy Foundation. She is dedicated to building relationships with individuals, businesses, decision makers, influencers, government, fellow educators and students to inform the public about the issues surrounding plastic pollution and how communities can create plastic-free oceans.



How's your ocean literacy these days? Did you know that one out of every two breaths you take relies on oxygen produced by ocean phytoplankton? For that reason alone, it is critical that we protect the ocean and keep it healthy. Ports and harbors have a vital role to play in that challenge, since they can be key sources of ocean pollution via mishandled land waste, sewage, wastewater and bilge water.

In 2014 the United Nations estimated that there were 5.25 trillion pieces of plastic in the ocean. Today, the estimate is at an alarming 50 trillion to 75 trillion pieces!

Most ocean plastic pollution is the result of mismanaged plastic resources. Plastic litter ends up in our streets, waters, fields, forests and shorelines. Wind, rain and currents carry the plastic into rivers, lakes and oceans, even when you live nowhere near a coastline.

Single-use disposable plastics make up about half of the marine plastics and include commonly littered items such as plastic bags, beverage bottles and caps, straws and stirrers, cigarette butts, food wrappers and miscellaneous packaging, along with rope and bits of Styrofoam.

Lightweight plastics can go astray in transport to recycling handlers or end up in landfills and can be carried away by wind, rain and wildlife.

Industry has a role to play. Fishing and aquaculture equipment intentionally abandoned or unintentionally lost during use or weather events becomes ghost gear. Ships lose cargo and illegally dump waste at sea, and catastrophic events such as tsunamis and hurricanes also cause plastic to enter the ocean. Some manufacturing processes that occur in ports and harbors (including transport to/from factories) can result in resin pellets, flakes and powders being released into surface waters. Once this waste is combined with the leaks, emissions and spillages of oil, gas, pesticides, and industrial chemicals that are often present in ports and harbors, the problem becomes exponentially more complex.

Plastic that initially floated at the surface encounters UV radiation, wind, wave action and organic growth. It breaks down and becomes a platform for organic materials to grow and is subject to fouling, the accumulation of unwanted materials on solid surfaces.

Plastic pieces under 5 mm in size are considered microplastics, and they sink readily, depending on what resin code they comprise. Heavier amounts of organic growth then develop on the plastics.

Unfortunately, marine life cannot distinguish between plastic waste and food. Between the smallest marine life consumes nano or microplastic, chemicals found on the plastic begin to bioaccumulate and contaminate the food chain. Bioaccumulation is the gradual buildup of chemicals in organisms, starting with the smallest marine life form, plankton, all the way up to whales.

Shockingly, intact microplastics have been found in plankton in the Mariana Trench, the deepest known place on Earth at more than 32,000 ft./11,000 m below the water's surface. This demonstrates that no part of the ocean is untouched by plastic and places a very high priority on

underwater cleanup to restore vegetation and marine wildlife habitat.

Education is central to the solution. It needs to be paired with effective action, and that's where The Ocean Legacy Foundation comes in. We are a Canadian nonprofit that develops and implements worldwide plastic pollution emergency response programs with the goal to end plastic pollution. Ocean Legacy uses EPIC, a four-pillar approach to identify, manage and prevent plastic waste from entering marine ecosystems using: Education, Policy, Infrastructure and Cleanup. The communities surrounding ports and harbors have an important role to play where education and cleanup are concerned, and we encourage you to get involved.

To teach the public ways to better manage resources to help end ocean plastic waste, Ocean Legacy developed EPIC Academy: 10 online lessons that are self-paced; available in English, French and Spanish; and free to access (thanks to funding from TELUS). Each lesson takes about 90 min. total and is self-paced.

Level one targets individual learners and includes downloadable support for high school and post-secondary educators (classroom presentations, lesson plans, assignments and group activities). Level two is targeted to individuals and organizations, especially local leaders and industry professionals who want to learn how to take action to stem the flow of plastics into the environment. You will learn how to influence policy, communicate with government officials, media and manufacturers, and mobilize your community to initiate a cleanup in your area.

By 2050, estimates are that there will be more plastic in the ocean than fish! We urge you to sign up for EPIC Academy and be part of the solution at: <https://edu.oceanlegacy.ca>. **ST**

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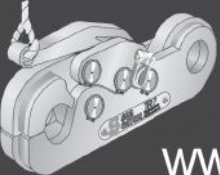
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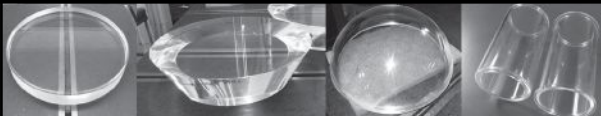
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