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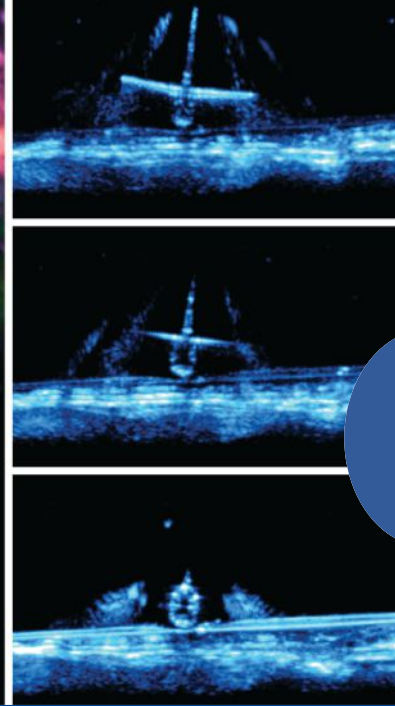
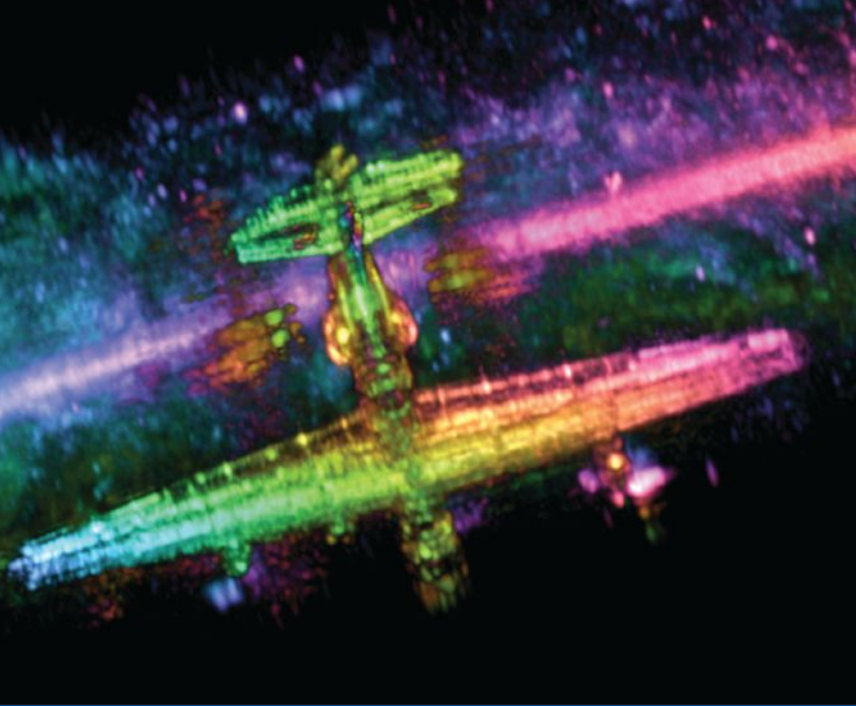
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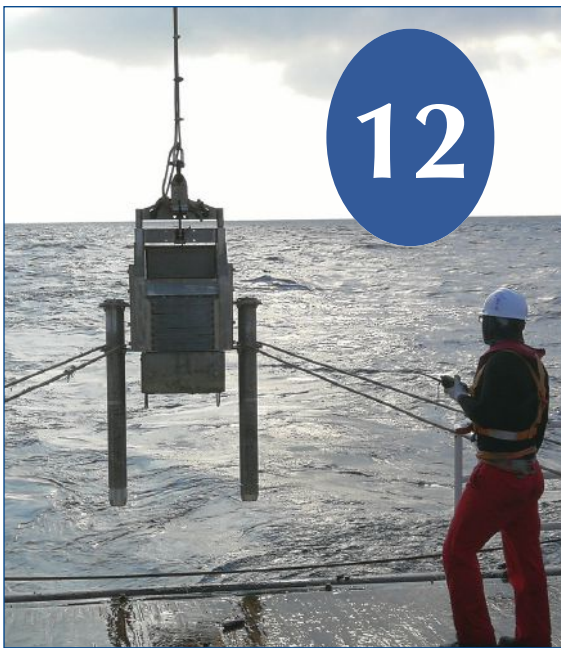
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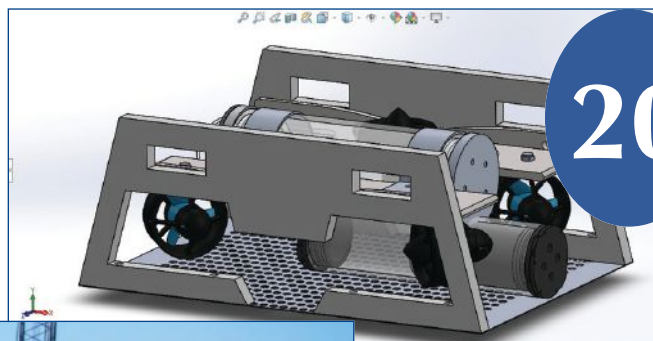
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The Multi-sensor Towbody (MuST) being deployed off the fantail of the RV *Robertson* in Sequim Bay, Washington. The Buried Object Scanning Sonar (BOSS) array is visible in the yellow housing mounted to the underside of the towbody. See story on p. 8.

NEXT MONTH

Measuring greenhouse gases with subsea sensors ... Measuring multiple parameters from a flexible, versatile platform ... Advancing safety in battery systems ... Gathering data inside hurricanes ... Wave sensor integrated into MET buoy.

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)) Communications Network of the Future. Inmarsat has unveiled plans for ORCHESTRA, the communications network of the future. ORCHESTRA will bring together existing geosynchronous (GEO) satellites with low-Earth-orbit satellites (LEO) and terrestrial 5G into an integrated, high-performance solution. ORCHESTRA will enable new services, such as close-shore navigation for autonomous vessels, next-generation emergency safety services for maritime crews, secure and tactical private networks for governments, and direct-to-cloud connections for airlines. New segments set to benefit include energy rigs and drilling platforms, midmarket business aircraft, coastal vessels, smart passenger ships and urban air mobility. LEO, GEO and terrestrial networks have never been combined at scale before to create a unified connectivity service for mobility customers. The result is a “dynamic mesh network” that allows individual customer terminals to direct traffic to and from other customer terminals. This means that a ship within reach of a 5G ground station can receive ample capacity for its own needs, as well as route capacity onward to other vessels beyond terrestrial reach. This effectively creates a mobile web of terminals that extend the network’s reach and improve its performance and resilience. Inmarsat can easily boost capacity in high-density areas such as ports and airports, ensuring that capacity is scaled directly to match customer requirements.

)) DHS Evaluates Ocean Surveillance Tech. The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) is evaluating innovative ocean surveillance technology to support the U.S. Coast Guard’s (USCG) mission of protecting the more than 95,000 mi. of maritime border shoreline and 15,000 mi. of waterways, seaports and other commercially navigable waters. DHS S&T teamed up with the Coast Guard, University of Southern Mississippi (USM), the U.S. Naval Research Laboratory (NRL), the Applied Research Laboratory (ARL) at Penn State, Ocean Aero Inc., Cherokee Nation Strategic Programs (CNSP), and the Homeland Security Systems Engineering and Development Institute (HSEDI) to develop, acquire, evaluate and test specialized, environmentally powered (wind and solar), multi-mission-capable, unmanned surface and underwater vessels. The evaluation team initiated acceptance testing of six Triton vessels at USM’s Marine Research Center (MRC) at the Port of Gulfport. During this ongoing testing, they will utilize MRC’s specialized lab facilities and waterfront access to evaluate the Tritons’ capabilities in multiple areas, including navigation; surface, diving and subsurface operations; operating effectively for long periods of time using only wind and solar power; and how well they can serve as a platform for cameras and advanced sensors to detect relevant anomalies and threats. The Triton autonomous marine vessels are being evaluated through the summer. Once NRL and ARL integrate selected advanced sensors into the Triton vessels, testing will continue offshore in Gulfport into the early fall.

)) Imaging Tech for Endurance Research Project. Voyis will provide its Insight Pro underwater laser scanner and Observer stills camera system for the Endurance22 project that aims to locate and document Sir Ernest Shackleton’s ship, *Endurance*, believed to be at a depth of over 3,000 m. Shackleton was a legendary polar explorer whose ship sunk in the Antarctic in 1915. The deployment is set to take place in February 2022, launching from Cape Town. Once the wreck has been located, survey operations will take place from Saab Sabertooth AUVs under sea ice. The Insight Pro will be integrated into the vehicle to generate 3D models of the historic shipwreck, and the Observer camera will capture high-resolution, true-color images simultaneously. These powerful optical sensors will send 3D laser data and crisp stills images to the surface in real time for instantaneous visualization of the wreck.

)) Agreement to Advance Hydrogen in Europe. The European Investment Bank (EIB) and Hydrogen Europe, an umbrella association representing European industry, research, and national and regional associations in the hydrogen and fuel cell sector, has signed an agreement for consultancy services. The EU bank will provide financing advisory support for hydrogen projects introduced by Hydrogen Europe; cooperate on market development initiatives and conduct joint market outreach; and help develop dedicated EIB financing products for green hydrogen. The current share of hydrogen in Europe’s energy mix is less than 2 percent, but it could rise to 14 percent by midcentury. The European Hydrogen Strategy, part of the European Green Deal, aims to enable widespread use of hydrogen by 2050. Consequently, investments in renewable or low-carbon hydrogen will need to increase. The strategy anticipates €180 billion to €470 billion will be required for production capacities in the EU by 2050.

)) World’s First Hybrid-Powered Surface Effect Ship. Bureau Veritas (BV) has classified the world’s first hybrid-powered surface effect ship (SES), the *CWind Pioneer*, which features an air cushion, twin hulls and an innovative diesel and electric drivetrain with considerable battery storage on board. The *CWind Pioneer* is being used at the Borssele 1 and 2 offshore wind farms in the Netherlands. The vessel’s hybrid power system enables operation purely on battery power at slow speeds, such as when transiting restricted waterways or on standby at the wind farm, which helps reduce fuel consumption, reduce diesel engine running hours and lower CO₂ emissions. BV’s notation “Electric-Hybrid” addresses the complexity of these systems, defining requirements for storage, power distribution, control and instrumentation, and testing for power management and critical safety considerations. **ST**

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Leveraging Offshore Assets For the Climate Challenge

In May 2021, the National Ocean Industries Association (NOIA) Board of Directors approved the adoption of the new NOIA Climate Change Position and Principles document.

With more than 100 members, ranging from international oil, gas, and wind operators to independent producers to major service and supply vendors to family-owned and family-operated businesses, NOIA is committed to the innovation, best practices and deployment of advanced technologies that are central to address the climate challenge. Adoption of the new NOIA Climate Change Position and Principles by such a diverse group of companies was a straightforward and relatively seamless process. The offshore energy industry has an established track record of innovation and technological advancement that is already solving energy challenges, increasing efficiency and reducing emissions.

Climate change is another challenge our industry is already working to help solve.

Fundamentally, the U.S. offshore energy industry is a dynamic space. From satellites to subsea autonomous robots and everything in between, new technologies and practices have transformed American offshore energy production. Gulf of Mexico oil and gas production has a carbon intensity that is one-half of other oil-producing regions, and deepwater production in the Gulf of Mexico, which accounts for 92 percent of the region's production, provides the lowest carbon intensity of oil-producing regions.

Offshore wind projects are progressing off the U.S. Atlantic Coast, and the U.S. federal government is opening the door to the Pacific Coast as well. Within a few years, millions of people will have access to renewable wind energy resources that, in many cases, were built by the same companies that built up the Gulf of Mexico oil and gas sector.

Furthermore, progress is being made in a host of other offshore energy areas. From the development of CO₂ storage facilities to finding new ways to produce hydrogen, the offshore energy industry is continuously innovating, placing it at the forefront of energy solutions and emissions reductions.

The combined experience and expertise of NOIA member companies strategically positions them to find solutions that balance and promote environmental, social, economic and energy pillars. These pillars are interdependent. For example, if energy or economic demand lags, then so does social or environmental progress.

Located in Washington, D.C., NOIA is in a prime position to educate and advocate to policy makers about the offshore energy industry. Through our members, we show our elected officials and regulators how it is possible to balance fundamental societal needs for things like affordable energy and for the countless products made from hydrocarbons, such as the medical equipment that was at the COVID-19 pandemic front lines, while still supporting the aims of progressive climate policies like the Paris Agreement.

The women and men of the offshore energy industry show how we can have our energy cake and eat it too. NOIA's climate change position makes us a beacon for policy makers. Our members are solving, scaling and deploying the real-world climate solutions that can be a source of bipartisan progress.

We still have a good way to go in implementing the full suite of climate solutions, but the offshore energy sector is an irreplaceable asset that puts the world closer to a much brighter future. The industry's resources provide crucial support for the global energy transition. **ST**

Multi-Sensor Towbody

Expandable Platform Detects, Geolocates and Classifies UXO

By Kevin Williams • Timothy Marston • Tim McGinnis

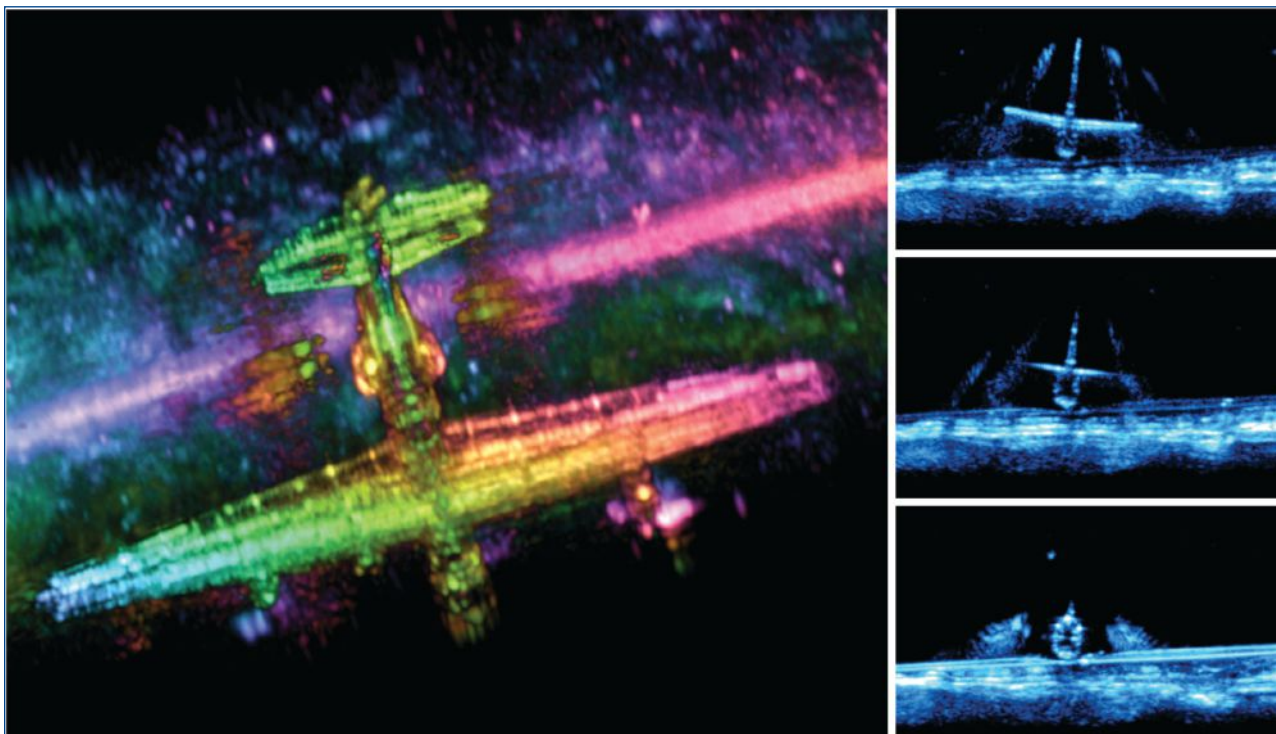
The presence of unexploded ordnance (UXO) is a major hazard in many coastal areas around the world and can affect operations such as dredging, cable and pipeline laying, and wind turbine installation. Live warheads can also be encountered by beachgoers, sport scuba divers and fishermen. Due to the numerous hazards posed, methods for detection and remediation of UXO are an active field of technological development.

Scientists and engineers at the University of Washing-

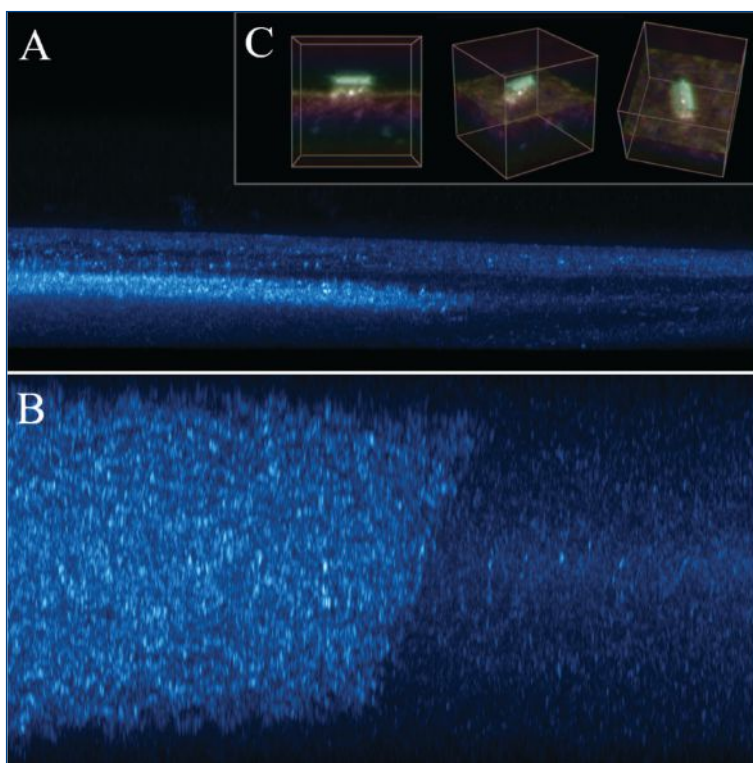
ton Applied Physics Laboratory (APL-UW) have recently designed and tested a new towbody system that will serve as a unified platform for deploying unexploded ordnance (UXO) detection and remediation technologies. The scientists at APL-UW designed the Multi-sensor Towbody (MuST) specifically to meet the need for an expandable system that can be outfitted with multiple sensor types and provide real-time feedback to operators, facilitating the testing of new UXO detection technologies as they



The Multi-sensor Towbody (MuST) being deployed off the fantail of the RV Robertson in Sequim Bay, Washington. The Buried Object Scanning Sonar (BOSS) array is visible in the yellow housing mounted to the underside of the towbody.



(Top) An alpha-blended, color-by-depth volume rendering of the Lake Washington PB4Y bomber wreck viewed from above (left), and along-track slices through the volume showing cutaways through the tail, fuselage and sediment layers beneath the plane (right). (Bottom) Plot (A) shows an across-track maximum intensity projection (MIP) through a sediment transition region in Sequim Bay. Plot (B) shows a vertical maximum intensity projection through the same volume, which measures 15 by 15 by 30 m in size. Inset (C) shows different views through a 2-by-2-by-2-m composite image of 12 fused scans containing a 30-by-60-cm solid aluminum cylinder located in the Sequim Bay testbed.



emerge. The first sensors to be integrated onto the towbody are a high-resolution side scan sonar and a novel sub-bottom synthetic aperture sonar (SAS) that generates high-resolution 3D imagery to detect and classify buried objects, ranging from cables and pipes to mortar shells and other UXO.

Hardware

The Multi-Sensor Towbody is designed around a MacArtney FOCUS 3, a platform that provides superb stability and topside control, power for sensors, and, via its NEXUS multiplexer, high-speed data links between sensors and topside data processing tools. In addition to the heading, tilt, altitude and pressure/depth sensors used by the FOCUS for control and navigation feedback, the MuST has been fitted with a sound-speed sensor, high-precision inertial navigation system (INS), Doppler velocity log (DVL) and a dual-antenna GPS that

can be used for determining heading and position when surfaced. The currently installed UXO detection sensors include a dual-band EdgeTech 2205 sonar for site obstacle clearance, imaging proud (i.e., unburied) UXO and performing rapid environmental assessment, and an EdgeTech Buried Object Scanning Sonar (EBOSS).

The EBOSS is a broadband, sediment-penetrating 3D SAS that can be used to make high-resolution images of buried objects. Accurate synthetic aperture beamform-

ing is facilitated by navigation and environmental data provided by the DVL, INS and sound-speed sensors. The MUST exploits broadband transmitters arranged in a unique configuration that, in concert with appropriate signal processing, doubles the across-track resolution that would otherwise be achievable by its 1.6-m, 64-element receive array. Preserving resolution while halving array length enables high performance at reduced size and weight; significant factors for deployment and system cost, as well as transportability. System resolution specifications are 4 cm in range and approximately 3 to 15 cm in the along-track dimension, subject to SAS sampling and integration parameters, navigation and sound-speed accuracy. The across-track resolution, which is range dependent and more accurately specified as an angle, is 1.4°.

Signal Processing

Accompanying the expanding set of sensors on the towbody is a

software library for real-time data visualization and post-processing. The three dimensional imagery produced by the EBOSS sonar poses a unique challenge due to the intensive computational burden associated with beamforming. To address this problem, a specialized algorithm has been developed at APL-UW to reduce the computational load of the synthetic aperture sonar beamforming task. The real-time data processing software, MuSTLive, leverages the principles of this specialized algorithm along with a graphics processing unit (GPU) ordinarily used for high-end gaming to beamform and render 3D volumetric data in real time as it is streamed from the EBOSS sonar. In addition to real-time volume rendering, MuSTLive provides users with system diagnostic tools, mapping and navigation information, and the ability to tag regions of interest for post-processing.

The post-processing library, still in active development, is intended to streamline the process of convert-

ing raw sonar data into high-quality data products that can be used for mapping, UXO detection and object classification. These data products include mosaics, high-resolution volume renderings of specific targets, aligned multi-aspect data combinations, and extraction of acoustic features such as target impulse response information that can be used for UXO classification by dedicated machine learning algorithms.

A heavily emphasized feature of post-processing from the MuST system is the accurate fusion of data from different scans. The number of nonoverlapping acoustic observations, or “looks,” at an object is often a determining factor for the accuracy of an associated target or clutter classification. As a result, multi-look data fusion relies on pixel-scale navigation precision—precision that the MuST navigation sensors are incapable of providing. To meet this need, a data-driven, feature-based navigation refinement algorithm has been developed that augments the onboard navigation sensor suite and improves the navigation precision to the necessary value for feature-consistent mosaicking. This feature-based “renavigation” solution enables the unique features captured by observations from different scans to be accurately aligned in combined volume renderings. Feature-based navigation refinement also results in significant improvements to mosaicked data products, which can undergo signal-to-noise ratio improvement and speckle reduction when appropriate methods are used for fusing data from different scans.

Results to Date

A survey in Lake Washington in September 2020 demonstrated the ability of the MuST system to detect cables, pipes and UXO-scale test targets deployed by APL-UW engineers. At the appropriate orientation, the EBOSS sonar even detected the nylon rope connecting the deployed targets. During this performance verification survey, the MuST system also scanned the PB4Y bomber wreckage located in



the northwestern portion of Lake Washington (Seattle). Much like a 3D medical CAT scan, the volume data from this acquisition enabled both the interior of the plane and sediment layers beneath it to be imaged. Details of the wreck, including the bomb bay, landing gear, ribbing inside of the wings, port and starboard gun turret chambers, and barrels of the rear turret, are visible in the volume image, which was constructed from a single scan. Similar to the plane wreck, a fortuitous scan of a sunken ship in the vicinity verified the ability of the MuST system to visualize the interior of the wreckage: Multiple decks were visible down to the keel of the ship.

Following system performance verification in Lake Washington, a UXO detection and classification test was performed in Sequim Bay, located on the northeast corner of the Olympic Peninsula, Washington. The test involved the survey of a UXO testbed put in place by the Pacific Northwest National Laboratory (PNNL) Marine and Coastal Research Laboratory (MCRL) for the purpose of assessing Sequim Bay as an official UXO remediation technology evaluation site. The testbed, located in the north end of the bay, contained an assortment of inert UXO of various sizes and shapes. The distributed UXO ranged in size from 81-mm mortar shells to 155-mm Howitzer shells. The UXO were positioned by divers in various orientations and burial states, ranging from proud to fully buried. Non-UXO items such as crab pots, scuba tanks and cement blocks were distributed in the survey region to act as clutter and potential false alarms, in addition to the natural and manmade clutter already present at the testbed site. The positions, orientations and burial states of the targets and clutter within the testbed were unknown to the MuST survey team; however, a calibration region containing targets and clutter with known positions and burial states was positioned south of the testbed. MuST surveys of this calibration region were used to generate environmentally specific training data for classifiers operating on detections in the blind testbed. Given the small amount of training instances, final classification scores were generated via a combination of expert-user and convolutional neural network-based classification strategies. In carrying out the classification effort, both frequency-versus-angle data and image data for each target at a variety of approach angles and ranges were used. Once classification results were obtained they were graded by an independent institution. That analysis showed that seven of the nine UXO were correctly detected and classified; only two false positives were generated, and missed targets were of the smallest size class (81 mm).

Future

A follow-up demonstration is planned this September in Sequim Bay. The system is undergoing additional refinement as the real-time and post-processing software library is being improved and additional sensors are integrated. It is anticipated that the incorporation of machine learning tools will further improve UXO detection results. The basis for this optimism is the generally recognized existence of target-specific information residing in

unintuitive domains of data representation, such as the spatial frequency response, or impulse response versus target pose. Detection and classification performance results like the ones generated at Sequim Bay have relied on initial judgments of expert users observing spatial domain data, with subsequent use of machine learning. Previous experience from classification experiments with proud targets, however, has shown that machine learning algorithms leveraging larger training sets and alternative representational domains can result in improvements to classification accuracy. In general, the amount and scope of training data are key to classifier performance; to that end, APL-UW is also involved in development of accurate target-in-environment models so as to augment training sets with modeled data, filling in gaps left by experiments.

The surveys of various wrecks in Lake Washington indicate a much broader potential for the MuST system than UXO detection. The ability to image the interior of a plane fuselage with high resolution in a single scan is, to the authors' knowledge, the first demonstration of its kind, and applications related to search and recovery, nondestructive testing, and remote sensing are numerous. Other potential applications for the system include inspection and burial depth confirmation of pipeline and/or cables, and environment surveys for offshore construction. It is anticipated that as the real-time and post-processing capabilities of the system are expanded and new sensors are integrated, even more uses for the system will become apparent.

Acknowledgments

The design and testing of the MuST was funded by the Environmental Security Technological Certification Program (ESTCP) and the Strategic Environmental Research and Development Program (SERDP).

The authors would additionally like to thank Ben Brand, Nick Michel-Hart and Vern Miller for electrical and mechanical design work and field support, and Mike Kenney for development and management of the data acquisition software. **ST**

Kevin Williams received a Ph.D. in physics from Washington State University. His thesis examined underwater acoustics scattering from spheres. Williams began his career at the Naval Surface Warfare Center Panama City Division, where he focused on mine detection and classification. He moved to the Applied Physics Laboratory, University of Washington (APL-UW) in 1988, where his research includes both acoustic detection/classification of targets and understanding the acoustic scattering from the environment that competes with these detections. He became the executive director of APL-UW in September 2020.

Timothy Marston works at the Applied Physics Laboratory, University of Washington, where his current research focuses on the fields of underwater acoustics, signal processing and synthetic aperture imaging.

Tim McGinnis's interest and expertise is in deep-ocean engineering and equipment development. For over 30 years, he has been involved with a variety of towed and bottom-landing vehicle development projects, deep-ocean cabled observatory infrastructure and instruments, and at-sea operations for mapping, imaging and sampling the seafloor and water column in water depths beyond 5,000 m.

Deep-Sea Sediment Sampling

Development of Combined Sampling/Coring System

By Haifeng Zhang • Jingjian Jiang • Fang Xie

Deep-sea surface sediments, at water depths greater than 2,000 m, record pelagic environmental changes and are basic material for marine geology, paleoceanography and paleoclimatology research, as well as studies on the carbon cycle, mineral resources and marine benthic communities.

Since the 1950s, there has been remarkable progress in deep-sea sediment collection, which has greatly contributed to marine geology and Earth system science. One of the research fields that has benefited the most is paleoceanography, which requires the effective collection of undisturbed deep-sea sediments and longer, stratigraphically continuous sediment cores.

The specific requirements for accurate oceanographic reconstructions from deep-sea sediment records has influenced the development of sampling equipment. In recent years, we, the authors of this article, have used several types of samplers on various survey vessels and encountered challenges with each type, which prompted us to modify existing designs to improve sampling efficiency. Thus, we developed a new deep-sea sediment sampling/coring system based on two existing pieces of equipment; this new design enables flexibility to collect deep-sea sediments under various conditions and science objectives.

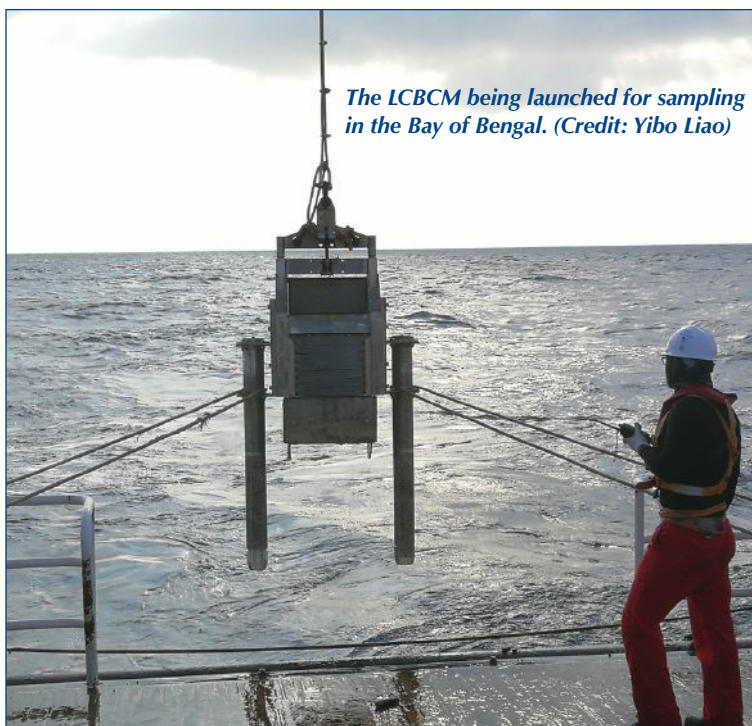
A History of Deep-Sea Sediment Samplers

The first investigations using marine sediment were recorded from the HMS Challenger expedition (1872 to 1876). During the voyage, scientists systematically studied deep-sea surface sediments but were unable to recover longer sedimentary records because appropriate coring equipment did not exist at that time.

In the 1920s, a rod-driven piston corer (PC) was developed to recover unconsolidated sed-

iment cores. In 1947, a cable-operated piston corer was developed by Borje Kullenberg that could be used in deep-sea settings; it became widely used and modified over the next 30 years. In the early 1970s, scientists at the Woods Hole Oceanographic Institution (WHOI) designed a gravity PC system based on the Kullenberg PC. WHOI also developed a replacement system named the jumbo PC in the 1990s, as well as the long-coring system in the 2000s. Contemporaneous with the jumbo piston corer, the French Institute for Polar Research and Technology (IPEV) designed the longest PC sampling device in the world, the Calypso corer.

In the late 1960s, the Deep Sea Drilling Project



The LCBCM being launched for sampling in the Bay of Bengal. (Credit: Yibo Liao)



(Top) The BCM being launched for sampling. (Credit: Haifeng Zhang) (Bottom) The SCBCM being recovered successfully from the sea. (Credit: Yibo Liao)

(DSDP), using the DV *Glomar Challenger*, ushered in a new era of marine geology. Cores collected during DSDP legs verified continental drift and seafloor renewal at rift zones and provided strong evidence for the theory of plate tectonics. The DSDP also initiated modern paleoceanography with the development and use of a hydraulic PC that recovered undisturbed sediment cores. The most striking feature of the DV was the 43-m-high derrick that housed the coring systems and could support drill pipe that extended more than 6,000 m, allowing it to be used in very deep ocean. In 1985, the DV *JOIDES Res-*

olution replaced the *Glomar Challenger* during the beginning of the Ocean Drilling Program (1983 to 2003). In 2007, Japan launched the world's largest drill ship, DV *Chikyu*, as the international partner of the *JOIDES Resolution* during the Integrated Ocean Drilling Program (2003 to 2013); this collaboration, along with a European consortium, continues with the International Ocean Discovery Program (2013 to 2023).

Many types of sampling devices have been used to collect deep-sea surface sediments, such as box corers (BCs) and television grab samplers (TVGs), and sediment cores, including gravity corers (GCs) and multiple-tube corers (MCs). However, there remain many challenges associated with collecting high-quality deep-sea sediment records. The sampling process itself requires skill and familiarity with the equipment and other factors associated with fieldwork, such as underwater positioning, water depth, sediment properties, weather and resulting sea states. For example, a strong bottom current can cause a sampler to deviate from a target site and prevent it from landing upright, which results in cores being recovered from an angle, with implications for subsequent reconstructions, or the corer overturning on the seafloor. Additionally, the deep ocean remains relatively unexplored, which increases the unpredictability of sampling. It is necessary to constantly improve sampling equipment to overcome these challenges.

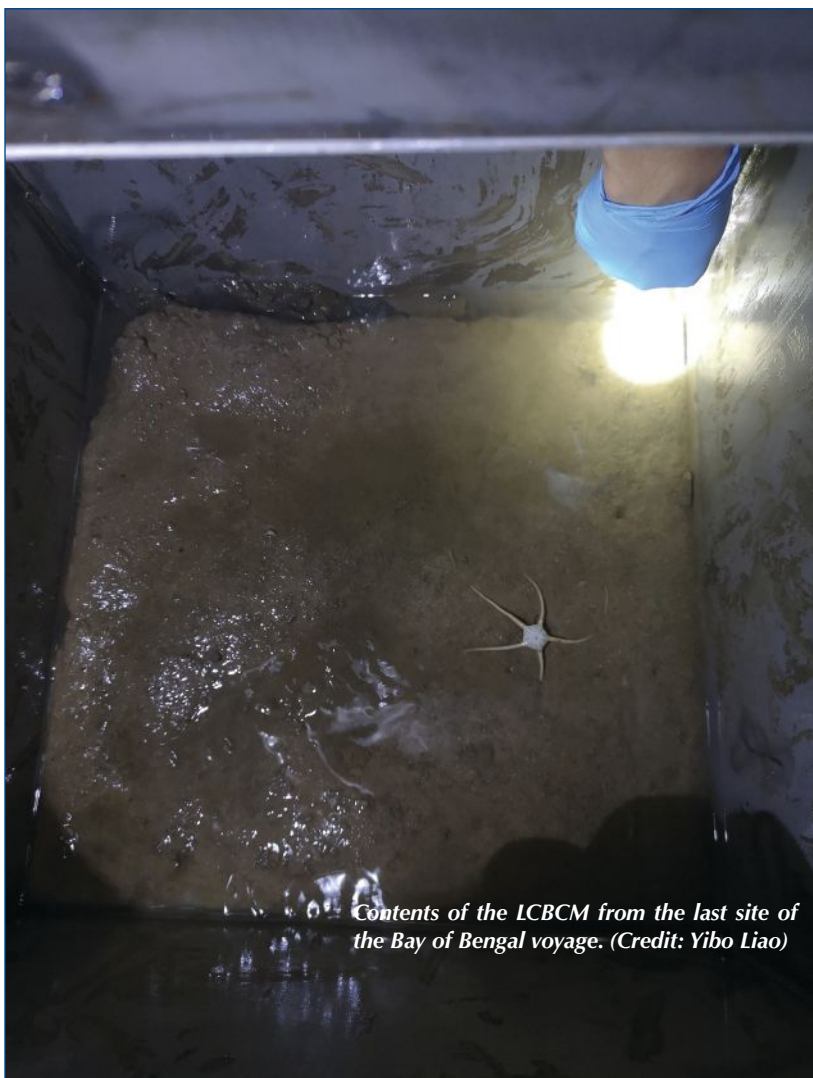
Pros, Cons of Various Samplers

During our expeditions on various survey ships, including RV *Sonne*, RV *Xuelong* and RV *Xiangyanghong 6*, we collected surface sediments and cores using some of the sampling/coring systems we have mentioned, from water depths ranging from hundreds of meters to more than 5,000 m.

A GC is one of the simplest coring apparatuses and is the easiest to use under many conditions. It penetrates sediment through a combination of kinetic energy accumulated during its fall through the water column and weights that are loaded on top of the corer. The greatest advantage of a GC is that it is a simple and rapid system for collecting relatively long cores. Additionally, the core barrel can be easily switched out, and the corer can

be handled quickly on deck. The main disadvantages are that the top 10 cm of material are generally disturbed and the recovered core length is frequently shorter than the penetration depth of the core barrel. In 2014, the longest core collected by a GC during a Chinese Antarctic/Arctic Research Expedition in the Southern Ocean was 860 cm, but its penetration was more than 950 cm; resulting in a core recovery of less than 90.5 percent.

A BC works in the same way as a GC. Deep-sea BCs generally measure 50 by 50 by 50 cm, with a total weight less than 800 kg. Its biggest disadvantage is the limited



Contents of the LCBCM from the last site of the Bay of Bengal voyage. (Credit: Yibo Liao)

depth of penetration (generally less than 30 cm). Additionally, there are frequent problems during deployment, such as incomplete jaw docking, which often happens with a deformed or overturned box or an inoperative sliding mechanism that can occur if something (e.g., a stone) gets stuck between the jaws. In each of these scenarios, the effect is that sediments are not retained in the corer when the device is brought from the seafloor onto the deck, which results in significant loss of material. Moreover, recovering surface sediment that is more coarsely grained, such as gravel or sand, is more difficult than fine-grained sediment. Despite these disadvantages, a BC is very good for collecting large volumes of undisturbed surface and shallow subsurface sediments under ideal conditions. It is also simple to operate.

To a certain extent, the consecutive use of an MC offsets the disadvantages of a GC. An MC is actually a type of gravity sampler and can be regarded as a combination of several small GCs (generally four to eight). Its main advantage is that it can recover undisturbed surface sediment, including at the sediment-water interface and overlying bottom water. The main disadvantage is that the penetration resistance is significantly higher than that of a GC, which results in much shorter cores (generally

tens of centimeters versus several meters with a GC). Furthermore, an MC is mechanically more complex. In recent years, engineers have tried to integrate video monitors or multiparameter sensors into MC systems, which would have significant advantages.

Although small grab samplers are common for sampling shallower, nearshore or lake sediments, they are generally not used in deep-sea sampling. The TVG is typically used for deepwater, comprising a sampler, armored cable and an on-deck control system. It is commonly used to collect surface deposits, such as massive sulfides, polymetallic nodules and manganese crusts. The greatest advantage of this system is the visual observation of sampling, but it also has some drawbacks: restrictions on vessel sailing speed and the fact that it is highly time consuming.

Essentially, all PCs can be called gravity PC systems because they rely on the same principle: the accumulation of kinetic energy during their relative free fall into the sediment. However, the piston within a PC ensures better sampling efficiency than a strictly GC system. Although there have been many modifications, the Kullenberg PC is still the most widely used in deep-sea sampling. Its advantages include higher core recovery rates and minimal disturbance to the entire core. Additionally, a large system can collect much longer cores. For example, the record for the longest core, at 65 m,

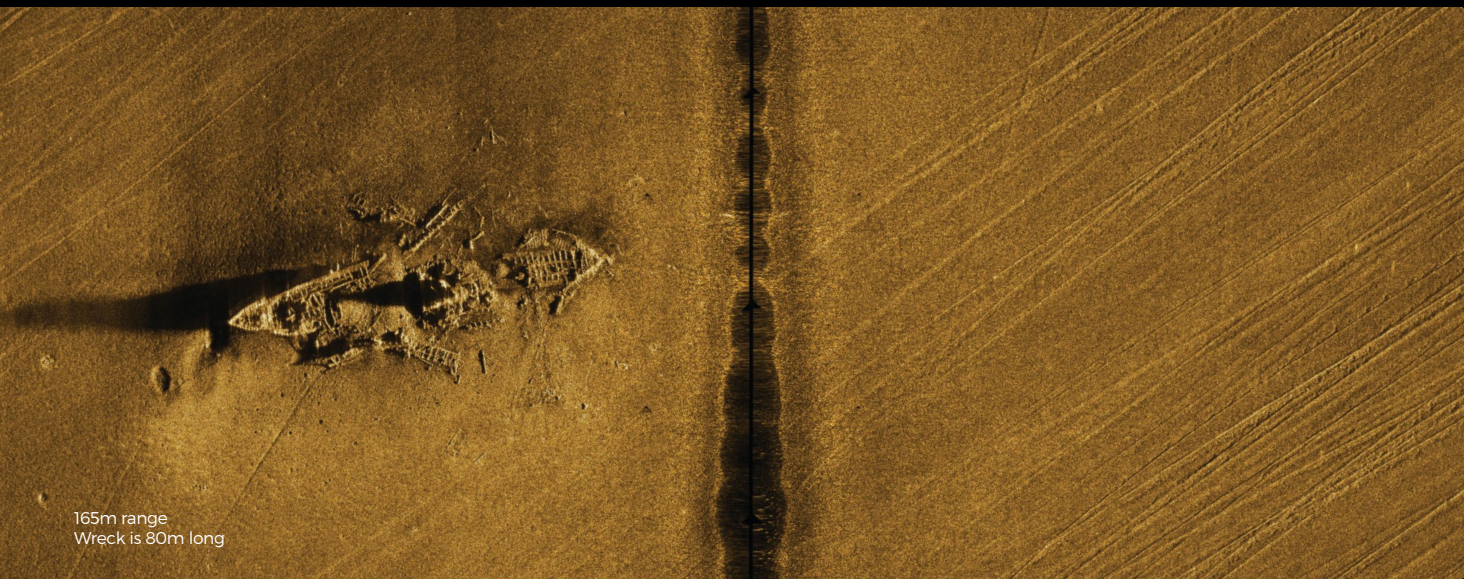
was collected with a Calypso corer in 2007. Nevertheless, the disadvantages of the PC is that it is too heavy to operate easily, even with significant infrastructure, and has been known to break at the expense of the entire system. Another shortcoming of a PC is that the uppermost sediments are typically lost or disturbed when sampling.

New Sampler

We have developed a new column box corer (CBC) system that improves upon the performance of other BC and GC systems and has been tested in deep waters in the Indian Ocean. This system is an economical choice for expeditions that have a high demand for surface sediments and cores. The CBC is manufactured from AISI 316 stainless steel and comprises a BC module and a column corer module; the latter is a simplified GC without the weights. In addition, there is a pedestal (length, width and height of 550 by 550 by 400 mm) to support the CBC on a ship's deck, manufactured from a 100-by-100-sq.-mm (6-mm-thick) AISI 316 steel tube.

There are three CBC models to address different sampling demands. The box corer model (BCM) is the simplest and most easily operated; it is a BC that weighs 1,300 kg, including 14 lead weights (50 kg each). Its

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“There are three CBC models to address different sampling demands.”

sample area is 2,500 sq. cm (50 by 50 cm), and the maximum penetration depth is 80 cm. The long-column box corer model (LCBCM) is a system of two column corers attached on both sides of the BC with detachable brackets. The length of each column corer is 150 cm, and each comprises two sections of 75-cm-long cylinders with PVC tubing of the same length, an orange-peel core catcher and a 15-cm carver with a cutting edge. It weighs 1,500 kg and has a maximum penetration depth of approximately 145 cm. Finally, the short-column box corer model (SCBCM) has a column corer with only one cylinder. Therefore, it is 50 kg lighter than the LCBCM and has a maximum penetration depth of approximately 70 cm.

The new CBC provides more targeted configurations for different sampling conditions. Samples collected by the combined use of two modules include: bottom water overlying the sediment surface, undisturbed surface sediments and uncompressed cores. Having one coring system that has the benefits of a BC/MC in recovering the sediment-water interface as well as the ability to recover longer cores is a significant advancement in coring technology.

The main disadvantages of this system are that the installation of the column module is mechanically more complex and the replacement of the column corer is physically more difficult. Improvements in this direction will be the focus of subsequent research.

Corer Test Results

During a 50-day expedition in the Bay of Bengal from December 2019 to January 2020, the CBC collected 25 overlying water samples and 28 surface sediment samples from water depths of 2,200 to 4,700 m. The sampling success rate for surface sediments was 100 percent, and included the use of the BCM at three sites. Coring with the LCBCM was successful at eight sites, with recovered core lengths from 16 cores varying from 56 to 115 cm.

However, the performance of the SCBCM at an additional 17 sites was not satisfactory. The SCBCM successfully collected 22 cores of varying lengths (10 to 55 cm) from 11 sites but lost all the column cores at four sites and half of the column cores at two sites.

We surmise that the penetration depth affects the preservation/containment of the sediments in the core barrels, with deeper penetrations demonstrating better recovery; the deepest penetration of the SCBCM was

still shallower than the shallowest LCBCM penetration.

Conclusion

For marine geologists, collecting undisturbed surface sediments and continuous sediment cores is an early step in any research project, but recovery of high-quality material can be challenging. Over the past 150 years, great progress has been made in technology for sampling deep-ocean sediments. These can be broadly divided into two categories based on operating principles, with one type using gravity and the other utilizing mechanical power.

In reality, there is no sampling device that is perfectly suitable for all types of studies in all conditions. Thus, this article provides a brief review of some of the major types of sampling/coring equipment that we have operated during expeditions.

The CBC we have developed is a new type of economical deep-sea sediment sampling/coring system. To date, the CBC has been tested in water depths exceeding 2,200 m. Its successful application demonstrates that large volumes of undisturbed surface sediments and continuous Holocene sediment cores can be simultaneously recovered by the CBC. Subsequent steps will involve addressing the system's shortcomings and performing additional tests in a variety of environments.

Acknowledgments

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Fang Xie is a senior engineer in the Division of Science and Technology at the Marine Academy of Zhejiang Province, China.

Offshore Energy

The world is changing. The industry is changing. The need to innovate and transform are key in remaining relevant and future-proof. This is true during the COVID-19 pandemic, and it will be so afterward.

The world did not stop spinning in the last year, and the energy transition is shifting into higher gear. Companies are incorporating sustainability into their business strategy. To make good decisions in times of change, it is essential to have a broad view. Information from related sectors can reveal business opportunities. Sharing knowledge with a community creates strong and valuable networks and sparks innovation.

It all starts with connecting people. Offshore Energy Exhibition and Conference (OEEC) will be held October 26 and 27 at RAI Amsterdam. We look forward to an edition where people can see each other in person. Because of the vaccination programs around the globe, some COVID-19 restrictions have been lifted. OEEC 2021 will make sure that people can connect safely face to face.

But OEEC is not returning to its pre-pandemic ways. "Like so many other companies, we learned a lot in re-



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cent times," says Director of Operations Anne Visser. "One thing is that the online connection with our audience during the event is very important. That is why OEEC is going to be hybrid this year, both on site and online."

The event will allow exhibitors, visitors, speakers and sponsors to connect both online and offline with matchmaking and roundtable discussions.

On the exhibition floor, face-to-face connections will be primary. "After a long period in which networking and sharing knowledge could only be done online, we see that the industry is longing to meet again in person," said Visser. "OEEC 2021 is grateful to provide an opportunity in which people from the offshore energy and maritime industries can see each other in a safe way."

The content program will also be broadcast live from OEEC for a virtual audience.

Content Program

The theme of OEEC 2021 is: "Offshore Energy in a Changing World." The offshore energy sector is evolving. Developments such as the energy transition and the need





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for sustainability are reshaping the industry. These changes also affect the workforce. To shed light on the different facets of this transformation, OEEC 2021's content program focuses on the energy transition and cross-market collaboration. Expect two content-packed days of industry insights and networking opportunities with like-minded peers.

Energy "talk shows" will take place in the OEEC studio. They will provide strategic vision and business intelligence for the whole offshore energy community, showing how different markets are connected in relation to the energy transition. These talks will feature front-runners, game-changers and analysts sharing fresh ideas and insights. They will be broadcast live at the studio on the exhibition floor.

Roundtables will feature interactive gatherings of like-minded peers both on site and online. There will also be an online showcase featuring informative videos from companies.

"These concepts will connect the event floor together with the digital environment of Navingo Career and the Offshore Energy platform," said Visser. "In that way, we can service our customers and a global audience regardless of their location."

Offshore Energy Platform

What makes OEEC unique is the Offshore Energy platform: www.offshore-energy.biz, a connector of communities. It delivers daily news from markets of interest,

in-depth articles and videos, insights from industry leaders, an overview of the important players in the business landscape, and job boards. It also includes the online news portals www.offshorewind.biz and www.dredgingtoday.com and *Offshore Energy Magazine*.

Offshore-energy.biz focuses on the energy transition with insights and foresight. "Being future-proof within the oil, gas, maritime, offshore wind and marine energy industries means being part of the energy transition and investing in sustainable solutions," said Visser. "This is why the Offshore Energy platform focuses on these topics. Our communities—the maritime and offshore energy industries—are front-runners in this change. By combining markets, we connect the gears that set the energy transition in motion."

Maritime ingenuity is needed to construct wind farms. Electric power is transmitted by subsea cabling. Oil and gas is supporting the transition to sustainable energy. Without dredging, ports cannot function. Everything is connected.

"Our reach over different markets and specific userbase provides clients valuable visibility," said Visser. "With our platforms, we reach a global audience of potential new clients. We tell the story of the companies that drive the energy transition. Join our platform for a targeted approach. Your company has a story. Together we can tell it."

For details on OEEC 2021, visit: www.offshore-energy.biz/offshore-energy-2021. **ST**



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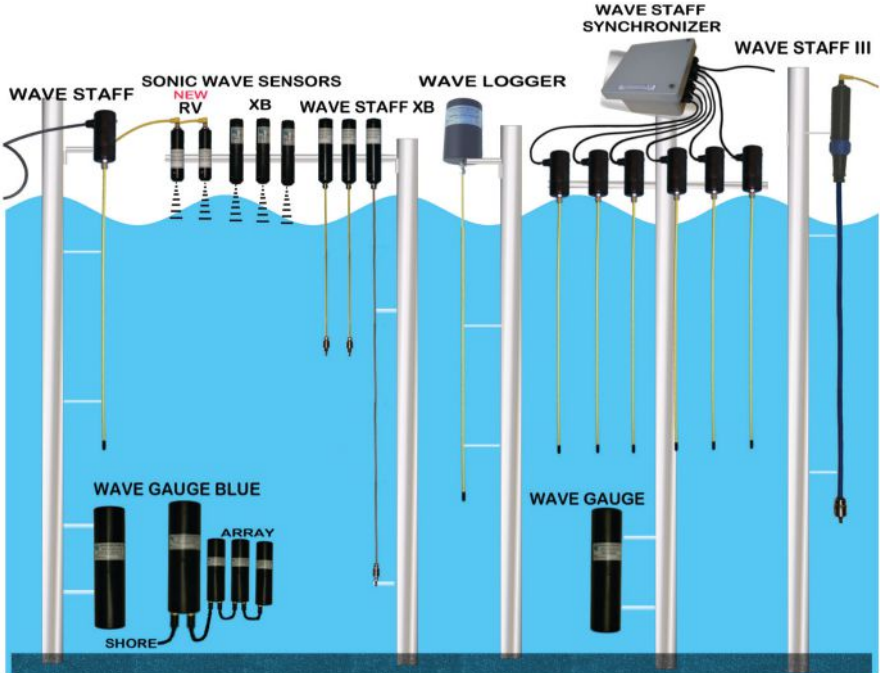
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ROV Development

Undergraduate Students Create Inspection-Class ORCA ROV

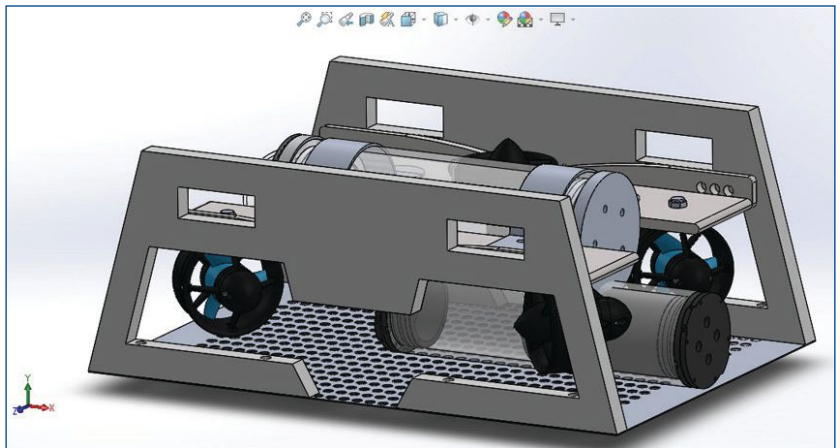
By Tejaswani Panati • Sai Deepika I. • Dr. Sakthivel Murugan

ORCA is an inspection-class ROV developed by an undergraduate team at the Sri Sivasubramaniya Nadar College of Engineering in Chennai, India. The vehicle is a 500-by-350-by-210-mm, six-thruster ROV weighing 10 kg. It is equipped with temperature and pressure sensors, an IMU, and a camera to enable underwater inspection and survey up to 300-m depth.

An open-frame design using high-density polyethylene allows the easy flow of water around the ROV. The vehicle was designed to ensure that the center of buoyancy is always above the center of gravity. This actively stabilizes the vehicle when an external force is applied on it.

An acrylic electronic enclosure at the center of the ROV has two horizontal plates on either side. Each horizontal plate measures 450 by 105 by 20 mm and has 16 M3 drills to house the horizontal thrusters; eight holes up front and eight at the rear. The presence of eight drills to mount one thruster enables the user to manually swivel it in the horizontal plane and mount it at 30°, 45° or 60° to the heading axis. This gives rise to a range of possible vectored thruster configurations, enabling effective movement in varying current speeds. The horizontal plates also have a 100-mm hole in the center to house the vertical thrusters. These horizontal plates are connected to the vertical side frames by 12 M6 tap screws. The side frame acts as the load-bearing member of the ROV. The dimensions of the side frame are 550 by 215 by 20 mm.

The electronic enclosure is made from acrylic tubes 0.5 in. thick, with an inner diameter of 4 in. The tube is closed at the ends by aluminum flanges with rubber O-rings in between them to seal it tightly. The aluminum flange on one end of the tube has been drilled with 12



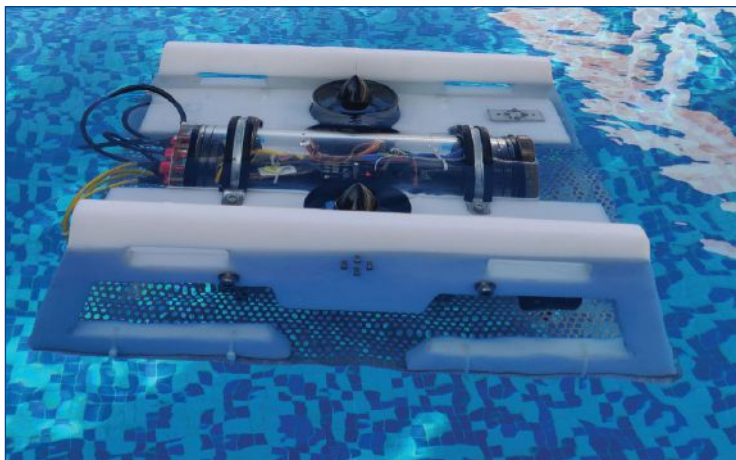
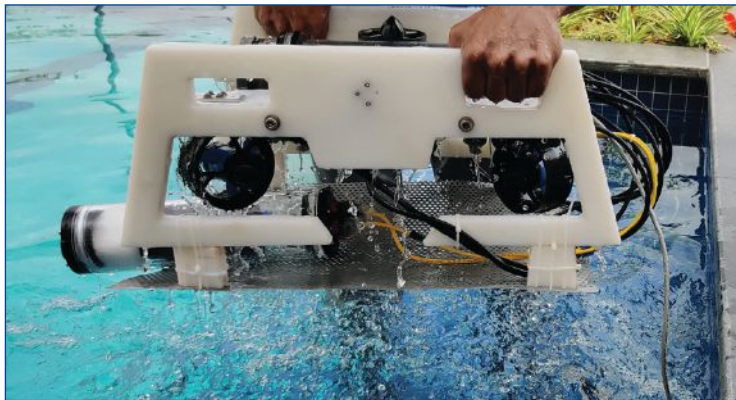
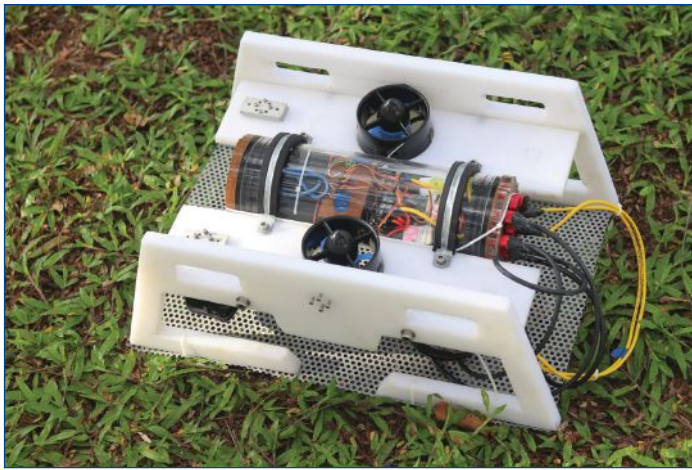
CAD design of the ORCA ROV.

holes to house the penetrators through which the wires and the tether can be drawn out. The enclosure is held in the center by the two horizontal plates on either side via C-clamps. A similar enclosure with a 3-in. inner diameter houses the battery.

Electronic System Design, Sensor Integration

The electronic circuitry of ORCA, responsible for signaling to and from the control side and for data acquisition, is securely sealed inside the electronic enclosure. The sensors required for inspection were added as payload and integrated with the circuitry. ORCA uses a Logitech joystick interfaced with a laptop for piloting.

A Cat 5 Ethernet cable with a maximum transmission rate of 1 Gbps is used as the tether for the transmission of control signals, camera feed and sensor data. It comprises a microprocessor (Raspberry Pi Model B+), a microcontroller (Arduino Uno R3) and electronic speed controllers (ESCs) mounted on a flat tray inside a leak-proof enclosure.



The desired movement as signaled by the joystick is mapped into a string at the control side and provided to the slave processor working at 1.2 GHz. These values are relayed to Arduino, which performs thrust vectorization and provides pulse-width modulated signals via the ESCs to each of the six thrusters to move the ROV. The whole system is powered using a 14.8-V, 18-Ah Li-ion battery.

ORCA is equipped with a DS18B20 temperature sensor and DFRobot analog pressure sensor. These sensors are placed along the inner walls of the ROV frame and wired into the enclosure via a slotted acrylic flange.

An HD USB camera is mounted at the front end of the acrylic housing to provide continuous live-video footage to the master side and to facilitate smooth navigation.

The Honeywell HG1120 IMU was mounted vertically on the flat tray at the vehicle's center of gravity such that the x-axis of the IMU coincides with the direction of the vehicle's heading. This IMU provides the position and attitude of the ROV to aid navigation.

Software Integration

Mission Oriented Operating Suite-Interval Programming (MOOS-IvP), a set of C++ open-source modules developed at the Massachusetts Institute of Technology to provide autonomy for robotic platforms, has been incorporated with modifications into ORCA as the primary tool for navigation.

The remote operation of the ROV is achieved by a uniquely developed MOOS Application (MOOSApp), plostick, which is responsible for interfacing the joystick and publishing the axes coordinates to MOOS-DB (MOOS database) on the master side. The mapping of corresponding signals from the joystick into the desired thrust, rudder and depth is achieved and relayed to MOOS-DB on the slave side.

Another MOOSApp called pShare has been developed to publish and subscribe messages between MOOS-DB of the master (laptop) and of the slave (microprocessor). The message that includes the thrust, rudder and depth data flows from MOOS-DB at the master to the slave, where it must be requested for subscription by another MOOSApp. Using pArDserial, another self-developed application, the string is serially communicated to Arduino.

The integration of the IMU was achieved by developing MOOSApp. The nine-axis IMU gives the vehicle's acceleration, gyroscope and magnetometer readings along x, y and z axes, respec-

(From top to bottom) The ORCA ROV. Pool testing of ORCA.

tively. The app was designed to log the data and communicate the ROV's position to MOOS as feedback to determine its next position to form a closed-loop system during the run time. An AHRS algorithm was implemented to convert the raw data to position and attitude data. A PID control system minimizes the positional errors and drift of the vehicle. Thus, the system can achieve the desired movement and navigate successfully.

Thruster Configuration

ORCA has six Blue Robotics T200 thrusters. Four of the thrusters are vectored at 45° to facilitate horizontal motion, along with two vertical thrusters for diving. The vehicle can surge, sway, dive, roll and head actively. However, the vehicle cannot inherently pitch. With the adaptable mounting system, the thrusters can also be manually swiveled to 30° and 60°.

Testing

ORCA has been successfully tested at shallow depths (up to 30 m) in natural waters for position tracking, navigation and inspection work. It was able to carry out efficient inspection using combinations of all degrees of freedom. Extensive testing of ORCA's navigation has also been performed in swimming pools up to a depth of 8 ft.

The images stored in the repository from the shallow-water testing will be used to develop a map-based localization technique, along with MOOS-IvP, to enhance autonomy. In addition, autonomy can be enhanced by

pre-feeding of maps for specific inspection regions.

Further testing of ORCA is planned with a fishing vessel in the Bay of Bengal at a maximum depth of 100 m this year.

Acknowledgments

The authors would like to thank Sri Sivasubramaniya Nadar College of Engineering for funding and supporting the development of ORCA. We also thank the Massachusetts Institute of Technology (MIT), including Michael Benjamin, principal research scientist at MIT's Department of Mechanical Engineering, for hosting the MOOS-IvP open-source project that served as the platform for ORCA's software development.

In addition to the authors Tejaswani Panati and Sai Deepika I., the undergraduate team that developed ORCA includes: Vigneshwar Veeravagu, Vishal Mohan, Rakshitha N.J., Hashmat Jeelani Bandy and Guru Prasad Gupta. Dr. Sakthivel Murugan (the third author of this article) and Dr. K. Murugesan served as mentors to the team. **ST**

Tejaswani Panati is part of the undergraduate student team that developed the ORCA ROV at Sri Sivasubramaniya Nadar College of Engineering.

Sai Deepika I. is part of the undergraduate student team that developed the ORCA ROV at Sri Sivasubramaniya Nadar College of Engineering.

Dr. Sakthivel Murugan is an associate professor at Sri Sivasubramaniya Nadar College of Engineering, where he works at the Underwater Acoustic Research Lab.

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Flexible Chemical Transfer

A Tool to Unlock New Possibilities for Marine Mining Infrastructure

By Jonathan Petit

To function, many heavy industries, such as mining, require a constant stream of chemicals that are hazardous. Economic and practical concerns mean that these chemicals are typically only produced in a few select hubs, often far away from where they are used, depending on the location of resources being extracted. This means that transport infrastructure plays a particularly important and complicated role in moving these chemicals from production site to place of use.

Bespoke chemical tankers, designed to utilize unique features and technologies to safely and efficiently carry chemicals from port to port, are at the heart of this transport infrastructure. However, the logistics chain stretches beyond these vessels, and specialist equipment is need-

ed at every link, especially in transfers. This degree of specialization often makes traditional terminals difficult to construct or prohibitively expensive. As many of the most critical chemical terminals that supply mines are relatively infrequently served, it can be difficult to justify the CAPEX required. At the same time, these terminals are often located in challenging geographic areas where fixed solutions can have disproportionate practical or environmental impact.

Marine Transfer Hose

The Mina Justa copper mining project in Peru faced a combination of these challenges. Sulphuric acid is critical to its operations, but practical issues mean that cre-



“...transport infrastructure plays a particularly important and complicated role in moving these chemicals from production site to place of use.”

ating fixed infrastructure to supply it is complicated and costly.

Copper mines use sulphuric acid to separate copper from other material during extraction. In Mina Justa, the volume of the chemical needed is huge; the project consumes a tanker full of the product every eight to twelve days.

Not only is the supply volume required considerable, but, adding to the challenge, Mina Justa is in a relatively remote area, far away from most existing infrastructure. This is also true of the nearby Marcona chemical terminal used for the project, which is an 8-hr., 525-km drive from Lima, the nearest large coastal city.

Marcona is not regularly used by other chemical tankers. Additionally, shallow water means that any fixed pier must be unusually long, which would have a significant impact on marine life and navigation for local fishing vessels. Long, fixed piers would also represent particularly high construction costs. Thus, the project owners sought to design a terminal that posed as little impact as possible and reduced complexity.

A new and innovative solution was unlocked by Trelleborg's unique Chemiline marine transfer hose. This solution uses a reel and a floating hose string, which allows all assets to be recoverable onshore when the system is not in use. The floating nature of the system means that any size of tanker can be serviced by the system, so long as it fits its multi-buoy mooring capabilities.

For the Mina Justa project, the hose is 850 m long when fully unspooled, 550 m of which is in a floating configuration. To put that into context, the unspooled hose is almost long enough to reach the top of the Eiffel Tower three times. Clearly, building a pier of this length would be prohibitively expensive.

Overcoming the Sulphuric Acid Challenge

Any marine transfer represents a risk, and operators should always properly evaluate these risks and use appropriate equipment.

A hose must be able to cope with pulling and twisting caused by sea conditions over repeated operation, and the product being transferred must be handled safely over a long period of time.

Sulphuric acid represents additional challenges. It is extremely corrosive and very dense, and can quickly damage transfer equipment. This highlights the impor-

tance of proper planning and equipment choice, based on real project parameters.

With Chemiline, long-term resistance to acidic corrosion is delivered through a fluoroelastomer (FKM) continuous inner liner. Fully encapsulated in the hose's rubber matrix, the liner runs throughout the entire hose and stops the liquid transferred from reacting with the rubber or its metal flanges. The Trelleborg dual-carass, hose-specific compact flange is then protected from acid by an FKM inner liner and from seawater by the hose's outer cover, ensuring a long-lasting, corrosion-free solution. This liner also prevents the potential disbonding that could occur with a nipple-based hose construction.

Pressure must also be considered. Sulphuric acid has a density of 1,830 kg/m³, and there is a requirement for the proper rating of hoses for repeated high-pressure transfer. The hose must be designed to ensure that sulphuric acid's pressure does not degrade its integrity. Trelleborg's Chemiline hoses have a dual carcass to provide resistance against both internal pressure and external forces, ensuring long-term durability during repeated transfers.

Resistance and durability are enhanced by a unique nippleless design, which protects the hose from bending forces by eliminating the stiff metal connector, alongside a marine breakaway coupling to protect the hose from excessive tensile forces. The risk of premature wear is therefore reduced and the routine completion of transfers safely ensured.

In conclusion, hazardous chemicals are transported in specialist ships and used in hyperspecialized equipment. It is clear that specialized transfer equipment is also critical for operators. This transfer equipment can be the key to a practical, flexible setup that can reduce the CAPEX needed to expand infrastructure in remote areas while reducing environmental impact. **ST**

Jonathan Petit is the commercial manager at Trelleborg Oil and Marine.



international

Handbook for Hydrogen Vessels

A consortium of 26 leading companies and associations, led by DNV, has launched the "Handbook for Hydrogen-fueled Vessels" to address the uncertainties surrounding hydrogen as ship fuel.

Green hydrogen could play a crucial role in the maritime industry's journey toward decarbonization.

The MarHySafe joint development project aims to create a knowledge base for safe hydrogen operations in shipping.

The handbook offers a road map toward safe hydrogen operations using proton exchange membrane fuel cells (PEMFC). It explains how to navigate the complex requirements for design and construction, safety and risk mitigation, engineering details for hydrogen systems, and implementation phases for maritime applications.

Europe's Largest PEM Hydrogen Electrolyzer

Shell has begun Europe's largest PEM green hydrogen electrolyzer project, backed by a European consortium, to accelerate hydrogen production and contribute to Europe's goal to achieve climate neutrality.

Europe's largest PEM hydrogen electrolyzer is now operating at Shell's Energy and Chemicals Park Rheinland, producing green hydrogen. As part of the Refhyne European consortium, and with European Commission funding through the Fuel Cells and Hydrogen Joint Undertaking, the plant is the first to use this technology at such a large scale in a refinery.

Plans are under way to expand capacity of the electrolyzer from 10 to 100 MW. The Rheinland electrolyzer will use renewable electricity to produce up to 1,300 tonnes of green hydrogen a year.

Shell aims to become a net-zero-emissions energy business by 2050, in step with society. As part of its Powering Progress strategy, Shell plans to transform its refinery footprint to five core energy and chemicals parks. This means Shell will reduce the production of traditional fuels by 55 percent by 2030.

Cargotec Divests Navis

Cargotec has completed the sale of its Navis business to the U.S. technology investment firm Accel-KKR for an enterprise value of €380 million.

The transition of Navis operations and employees to Accel-KKR will take place in phases before the end of 2021.

De Nora Acquires Calgon Carbon's UV Division

De Nora has completed the acquisition of the UV Technologies Division (CCUV) from Calgon Carbon Corp.

The deal covers the products, brands and assets of the UV ballast water management system (BWMS) specialist Hyde Marine. It also includes the municipal and industrial water treatment brands RAYOX, SENTINEL and C3 SERIES UV.

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The acquisition creates one of the largest BWMS manufacturers in the world. This increased range and manufacturing scale provides even more flexibility for ship-owners at a critical time, as the industry seeks to comply with the International Maritime Organization's Ballast Water Management Convention and the U.S. Coast Guard's ballast water regulations.

Formation of Joint Venture in Sri Lanka

Inchcape Shipping Services (registered in England) and John Keells Holdings PLC (registered in Sri Lanka) have signed a joint venture agreement resulting in the formation of Inchcape Mackinnon Mackenzie Shipping (Private) Ltd. Inchcape Mackinnon Mackenzie will provide a diverse range of maritime services in Sri Lanka, including: port agency, husbandry, crew logistics, ship chandeling, bunker fuel supply arrangement, liner agency, survey and inspection, oil and gas logistics, construction, dredging, cable laying, tourism, military support services, and consultancy.

Fully Electric ASV for Rig Entry Survey

First Marine Solutions (FMS) has successfully completed a rig entry survey using a fully electric ASV. The survey was undertaken in preparation for a potential rig move of Well-Safe Solutions' jack-up rig, the Well-Safe Protector. This ensured the seabed was clear of debris and that nothing would impact the safe relocation of the unit.

The ASV was equipped with a Ping DSP side scan sonar that provided both 2D and 3D side scan and bathymetric data. The entire operation was monitored live from FMS's remote operations facility in Aberdeen.

Seabed 2030 Collaborates with OET

Seabed 2030 and Ocean Exploration Trust (OET) have established a memorandum of understanding to continue working together to advance understanding of the global ocean through collaborative contributions toward the completion of a definitive map of the seafloor. The effort complements the goals of the United Nations Decade of Ocean Science for Sustainable Development.

All data collected and shared with the Seabed 2030 Project is included in the GEBCO global grid, which is free and publicly available.

Moog to Sell Navaid's Assets

Moog Inc. has entered into a definitive agreement to sell the assets of its navigation aids (Navaid's) business to Thales. Navaid's designs, develops, manufactures and markets ground and ship-based radio frequency navigation beacons and related antennas for military and civilian applications. The business is based in Salt Lake City, Utah.

Bollinger Delivers Fast Response Cutter

Bollinger Shipyards LLC has delivered the USCGC *Emlen Tunnell* to the U.S. Coast Guard in Key West, Florida. This is the 168th vessel Bollinger has delivered to the U.S. Coast Guard over a 35-year period and the 45th Fast

Response Cutter (FRC) delivered under the current program. The vessel is named in honor of the Coast Guard hero and NFL great Emlen Tunnell.

USV for Oil Spill Response

An oil and gas major has received L3Harris Technologies' first USV built specifically to protect the environment and emergency response personnel during oil spill response operations.

The 11-ft. USV, known as the C-Tug 3, is outfitted with L3Harris's ASView control system, which enables USV remote operations from a land-based control station. The USV can execute pre-programmed mission plans and real-time teleoperation via a remote touch screen.

The USV can tow an oil containment boom into position to prevent the spread of contaminants. The operator can remotely disconnect the boom and command the USV to deploy anchors to limit wind and current effects.

Winner of British Columbia Tech Competition

Open Ocean Robotics has won Campbell River's NexStream 2.0 Wild Card Challenge. The company specializes in autonomous vessels for ocean data collection.

The NexStream Tech Challenges are problem-solving opportunities aimed at strengthening and accelerating Campbell River's economy. Designed to motivate individuals and businesses to invent in areas that are immediately relevant to industry challenges of the British Columbia coastal region, each winner receives up to \$100,000 from the Campbell River Area Angel Group (CRAAG), with support from the city of Campbell River and CRAAG's investor network.

Arctic Rays Moves HQ

Arctic Rays LLC has moved its headquarters to its Indialantic, Florida, facility as it continues to grow.

Indialantic, located in the heart of Florida's Space Coast, is home to many U.S. leading technology and innovation companies.

MCE Acquires ZeroRPM

Mission Critical Electronics (MCE), a California-based designer and manufacturer of electrical power solutions for specialty vehicle, marine, network and industrial markets, is acquiring ZeroRPM.

A pioneer in anti-idling technology, ZeroRPM offers advanced energy storage and hybrid solutions that convert conventional vehicles into cost-efficient hybrid units. The acquisition strengthens MCE's presence in the vehicle electrification space and underscores its commitment to being a leader in providing clean energy solutions.

Emissions Reduction System Installed on Tugboat

Nett Technologies Inc. has completed the development and, in partnership with Pacific Maritime Group, installation of its Tier 4-compliant retrofit system, the BlueMAX NOVA 320, on a tugboat in San Diego. The system provides reduction of: 95 to 99 percent particulate matter, 95 percent nitrogen oxide, 98 percent carbon monoxide and 82 percent hydrocarbon. **ST**

3D Printing for Naval Applications

Singapore's Defence Science and Technology Agency (DSTA), France's Naval Group and its Singapore subsidiary Naval Group Far East have signed a memorandum of understanding to jointly explore new technologies, such as additive manufacturing for naval applications.

Under the agreement, the organizations will jointly identify potential use cases of harnessing additive manufacturing. This includes the sharing of production methodology, certification and qualification of additive manufactured components for naval platforms.

NSWCCD to Test Kraken Batteries

Kraken Robotics Inc.'s wholly owned subsidiary, Kraken Robotic Systems Inc., has signed a cooperative research and development agreement (CRADA) with Naval Surface Warfare Center, Carderock Division (NSWCCD). Under the CRADA, the Battery Certification and Integration Branch, Code 636 of NSWC Carderock, will test Kraken's pressure-tolerant, lithium-ion batteries. The testing is expected to take four months, starting in the third quarter of this year.

Code 636 possesses capabilities and expertise covering all aspects of power source development and deployment, ranging from generation of the initial battery design through development and prototyping, acquisition and testing, to introduction to the fleet. Code 636 also manages and implements the Navy's Lithium Battery Safety Program in conjunction with the Program Authority, Naval Sea Systems Command (NAVSEA) Code SEA05Z34.

Bollinger to Design Light Amphibious Warship

Bollinger Shipyards LLC was awarded a contract by the U.S. Naval Sea Systems Command to conduct a concept study and the preliminary design of the U.S. Navy's Light Amphibious Warship (LAW).

The LAW program envisions procuring a class of 28 to 30 new amphibious ships to support the Marine Corps, particularly in implementing a new Marine Corps operational concept called Expeditionary Advanced Base Operations. The Navy envisions the first LAW being procured in fiscal year 2023.

BMT High-Speed Patrol Vessels for UK

BMT is partnering with Marine Specialised Technology (MST), which has been selected by the U.K. Ministry of Defence Police (MDP) to provide 18 state-of-the-art high-speed patrol vessels.

The BMT design is 15 m in length and powered by twin inboard diesel propulsion engines driving twin waterjets. Specifically designed to reduce fuel consumption, the vessel will have reduced fuel emissions and improved operational efficiency. The new and more environmentally friendly design is capable of 30 kt. It will feature a fully integrated C4ISR and craft management system, utilizing the latest open architecture and shock mitigation crew seating.

BIO-UV Group to Design US Navy BWTS

BIO-UV Group and its U.S. engineering and servicing partner, The Columbia Group, have been selected to develop a ballast water treatment system (BWTS) for the U.S. Navy. The contract follows an international call for tenders to develop a military version of a UV ballast water disinfection system to equip future U.S. Navy ships.

Until now, military vessels have operated outside the scope of the U.S. Coast Guard Standards for Living Organisms in Ship's Ballast Water Discharged in U.S. Waters regulation. The ruling entered into force in 2016. Future U.S. military vessels will need to be equipped with ballast water treatment systems.

Working with The Columbia Group, BIO-UV Group will design a robust ballast water treatment system for ballast pump capacities from 300 up to 1,000 m³/h.

Shaldag MK V Vessels for Israeli Navy

Israel Shipyards Ltd. has signed an agreement to supply four of its *Shaldag MK V* vessels to the Israeli Navy, adapted to the Navy's configuration requirements. The largest member of the *Shaldag* class, the *Shaldag MK V* is a combat-proven, all-aluminum, light and fast vessel driven by powerful waterjets, with a high payload capacity for exceptional maneuverability and seakeeping. Delivering a high firepower-to-displacement ratio, it was designed for naval security missions and protection of Exclusive Economic Zones (EEZs) and littoral waters. The vessel can run over 40 kt. **ST**

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Updated Connector Series



The Millennium 1V RF connector series has new RF performance characteristics, and titanium connector components are now an option for the whole Millennium line. The 1V coax series provides an ultracompact 75-Ω contact in the same footprint as a 50-Ω contact. Cable assemblies in this series are ideal for HD/SD video with signal frequencies to 3 GHz, for short-wave antennas, or for low-power RF. BIRNS Inc.

Inspection for Lifeboats

Lifeboat Inspection 402 has been relaunched in line with regulations mandated in 2020 under SOLAS Chapter III and IMO MSC.402(96). Traditional spot market lifeboat inspections and frame- and subscription-based agreements are available. Survitec Group Ltd.

Engine with NOx Abatement

X52 is a low-speed engine with integrated selective catalytic reduction

(iSCR). The six-cylinder, two-stroke engine has a maximum continuous output of 11,640 kW. SCR is one of the most effective methods of reducing NOx emissions in line with IMO's Tier III requirements. WinGD and the China Shipbuilding Power Engineering Institute.

Acoustic Situation Awareness

SonoWatch is an autonomous, acoustic lookout system that detects, identifies and determines the navigation meaning of acoustic signals. This provides autonomous collision avoidance to both unmanned and manned watercraft. SonoWatch provides high-fidelity acoustic signal capture with advanced processing to provide accurate signal characterization, even in the presence of engine noise and wind/rain. McQ Inc.

Underwater Inspection

SW1050UW is an ROV mounted with the M310UW underwater laser scanner. It is specifically designed for dam, harbor and marine inspections. The ROV is small, nimble and extremely stable during inspections, and the laser scanner is gyroscopically stabilized. Newton Research Labs Inc.

Dash Gauge

The first in the new VMH line of premium marine gauges, the VMH 35

was engineered for single inboard or outboard engine applications. The elegant black-glass design displays a wealth of critical boat system data in a compact package that's perfect for dashboards, consoles and bulkheads on smaller vessels with limited space. Veratron US Inc.

Underwater Video



AV Connect HD is a device that seamlessly delivers high-definition video to compatible smartphones and tablets. Users can view, record, archive and share underwater video via a pocket-size device that has an internal, rechargeable lithium-ion battery, compact form factor and robust metal housing. Aqua-Vu.

Vent Top Deck Plates

A challenge with watertight deck plates is that they also keep out air, restricting ventilation to interior compartments and passageways. Vent Top Deck Plates allow circulation through these spaces and can be closed off with an included standard cover when needed. They help protect internal equipment against overheating and reduce opportunities for mold and mildew growth. Beckson Marine Inc.

Global Offshore Wind Database

Q Vision is a proprietary database

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world leader in electric underwater robotics

SAAB SEA EYE



SAAB

that holds over 75,000 data points on offshore wind projects around the world. The Power BI dashboard allows for efficient mining of data through a series of filters and dynamic charting. Q Vision is updated on a daily basis from numerous project announcements, contract awards and other industry information. Quest Floating Wind Energy LLC.

Multi-Channel Data Logger

HOBO MX1105 has four-channel inputs to measure and transmit data wirelessly from a variety of sensors to a mobile device. With a mobile device or Windows computer and the free HOBOnnect app, you can access data at any time over a 100-ft. range via Bluetooth. MX1105 is ideal for energy audits, building commissioning studies, equipment scheduling and more. Onset Computer Corp.

Downhole Logging



Rochester greaseless cable technology provides a more efficient field operation for downhole logging applications. The eco-friendlier downhole-jacketed wireline cable solution replaces steel cables in cased hole operations. Rochester greaseless wireline incorporates a specially designed steel armor package to deliver a breaking strength of 8,500 lb. TE Connectivity.

Clean Fire-Extinguishing Agents

Aerosol fire-extinguishing systems rely on a pyrotechnic reaction for activation and flood the space with a powdery dust. People have only seconds to evacuate the area. In contrast, nontoxic clean agent 3M Novec 1230 is one of the safest fire protection solutions on the market. At proper design concentrations, it can be breathed with no ill effects. Engineered and pre-engineered fire suppression systems based on clean Novec 1230 are available. Sea-Fire Marine.

Data for Fish-Tracking Research

A new module for Teledyne's Slocum G3 Gliders allows the AUVs to be dispatched out to Innovasea's VR4-UWM underwater receivers to offload data. Instead of chartering a boat and spending hours traveling from receiver to receiver, the new module lets researchers use a glider to collect data from all their receivers in a fraction of the time. Innovasea Systems Inc. and Teledyne Webb Research.

Internet Antennas

Glomex weBBoat 4G Plus EVO and 4G Pro EVO deliver secure and reliable residential-quality connectivity, plus all the benefits of the innovative EVO series. Both antennas receive 4G and Wi-Fi signals from up to 20 mi. away and deploy them throughout the vessel. As many as 32 devices can connect simultaneously via a wireless WAN or an Ethernet cable (three ports are included). GA Communications LLC.

HSEQ Management

Docmap has been updated with a mobile application and a new certificate management system and report scheduler. New functions allow for further integration and management of health, safety, environment and quality (HSEQ). OneOcean.

Cases for Storm Protection

Pelican OrionCase solutions offer weatherproof protection for batteries, chargers, phones and other electronics. A protective system can be customized according to your product specifications, usage and environmental analysis. OrionCase Enterprises LLC.

Monitoring Software

New features for T4D Control v6.2 include: geotechnical-only automated monitoring projects; alignment-based monitoring analysis and reporting for more meaningful results when monitoring relative to an object; and new site setup dialog with enhanced total station video support for improved remote site condition analysis and new target deployment. Trimble Inc. **ST**



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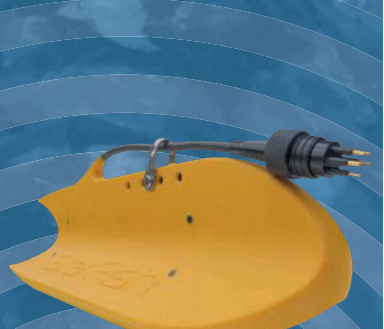
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Development of Digital Condition Monitoring

ABB has begun a pilot project with Equinor in Norway, at the Gina Krog platform in the North Sea. The project enables a digital transformation of monitoring of critical electrical systems on the platform, accelerating Equinor's condition monitoring capabilities with a focus on improving safety, reducing operational costs and increasing production efficiency.

Adopting a collaborative maintenance model enables Equinor to start the journey from today's planned maintenance program toward prescriptive maintenance.

Data will be transferred from the platform's power management system and electrical condition monitoring system to Equinor's OMNIA Microsoft Azure cloud platform, using an on-site ABB Edgelsight data pump. From there, live data

will be securely streamed to ABB's Microsoft Azure cloud to continuously improve condition monitoring technology and tools to be used by ABB's Reliability Service team.

By streaming data directly to ABB, Equinor is securely transporting high-level information from assets that will deliver transparency on performance, better predictability and process optimization.

ABB and Equinor will jointly investigate the opportunity to apply the same approach for other relevant equipment in the future.

Geotechnical Investigation Off Western Australia

Benthic, a global geosciences company and part of the geoservices segment of Acteon, has provided Santos with geotechnical site investigation services at the Dorado field off the coast of Western Australia. The work included geophysical and geotechnical surveys, compris-

ing multiple cone penetration testing and borehole locations up to 100 m.

The company used its PROD2 seabed drilling and geotechnical testing system, a proprietary portable remotely operated drill that can switch between piston sampling and rotary coring to maximize productivity. The tool can recover 75-mm-diameter cores with continuous sampling capability in water depths to 3,000 m. It also operates on the seabed and is isolated from vessel motion via a slack umbilical, which reduces weather sensitivity and downtime, resulting in more efficient operations.

PROD2 executed the project on board the MMA *Vigilant*. The project leveraged Benthic personnel in the Australian region and use of the PROD2 asset working in the region.

OSV Market Drop

Despite projected demand recovery post-2020, the global offshore support vessel (OSV) market continues to face a utilization chal-



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lenge, according to collaborative research from Braemar ACM Shipbroking and Westwood Global Energy Group.

Over the course of 2020, estimates for total utilization for the global OSV market fell from 55 percent in the first quarter of 2020 to a low of 49 percent in the third quarter of 2020, following a sharp decline in rig activity, FID (final investment decision) cancellations/deferments and significant logistical challenges posed by the global COVID-19 pandemic.

In efforts to reduce operating costs, vessel owners have been quick to stack idle fleets, with global lay-ups accounting for almost 33 percent of total capacity.

With effective utilization (excluding stacked vessels) estimated at 73 percent in the first quarter of 2021, owners and operators who wish to remain competitive must consider future tactics for fleet rationalization, including factoring in aging fleets alongside the financial and environmental costs associated with scrapping.

Mooring Line Fatigue Tracker

A Fugro-led consortium that includes AS Mosley and the University of Strathclyde has designed a mooring line fatigue tracker that safely and cost-effectively monitors offshore floating wind turbines, thanks to innovation funding from the Scottish government.

The consortium won the funding to develop the tracker, which fuses the motion and position measurements of floating hulls with a simulation model to monitor fatigue, in March 2020 through the Floating Offshore Wind Technology Acceleration Competition, which was run by the Carbon Trust's Floating Wind Joint Industry Project.

Instead of the current conventional five-year subsea inspection regime, the new tracker will track mooring line fatigue so that inspection activities, which require vessels and ROVs, are only carried out when necessary.

Another benefit is that the monitoring is continuous and can be used to detect any problems or fail-

ure scenarios, such as anchor drag or trawler snagging, as they happen, for quick resolution.

Fugro and partners are identifying opportunities to work with floating wind developers on pre-commercial projects to trial the solution offshore.

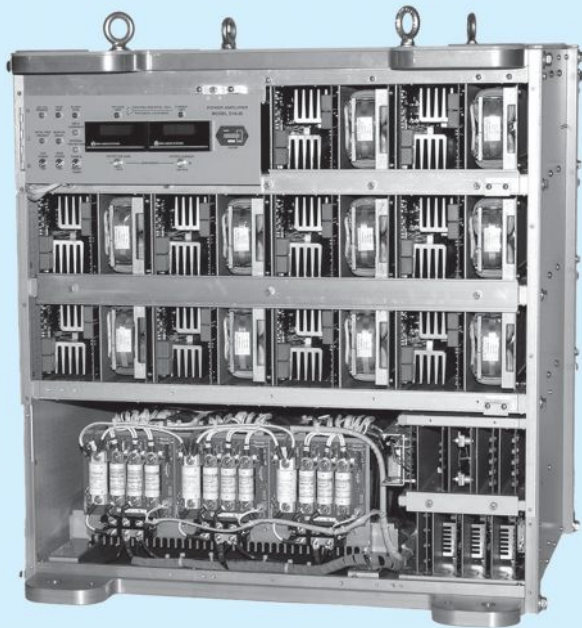
CCS Study in Dutch North Sea

DNV has been awarded the contract for the carbon capture and stor-

age (CCS) pipeline materials study by Neptune Energy Netherlands to assess the fracture and suitability of offshore pipelines for re-use in CO₂ transport (*Sea Technology*, August 2021). The pipeline materials analysis is part of a wider feasibility study by Neptune Energy, in cooperation with its license partners and CO₂ emitters, to review plans for a large-scale offshore CCS project in the Dutch North Sea. **ST**

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Surveys of River Aire

Storm Geomatics has carried out topographic and bathymetric surveys on the River Aire, at the village of Newlay, northwest of Leeds, Yorkshire, in the U.K. The surveys were required by an existing client to provide information for local asset recovery works.

In the extremely shallow river, the system supplied by THURN Group, comprising the OceanAlpha SL40 USV equipped with a Geoswath4 interferometric sonar and SBG Ekinox IMU, enabled Storm Geomatics to carry out a full bathymetric survey efficiently and safely in a difficult-to-access and fast-flowing section of the River Aire. The 250-m stretch of river surveyed comprised Newlay Weir, the riverbanks, foreshore and flood defenses.

A topographic survey was also completed to establish the geome-

try of the riverbank, foreshore, flood embankments, walls and ground behind the defenses. For this part of the work, Storm used a combination of the SL40 USV and traditional survey techniques capturing a 2-m grid. Storm also used a Trimble SX10 laser scanner. The overlapping parts of the manual and USV surveys were then cross-checked in GIS.

The results of the surveys were combined to form a 3D model, drawings and a hydraulic model in Flood Modeller Pro to inform the engineer of the current topography and conditions at the weir. The model was used to calculate water levels and flow at different rainfall return periods.

Fully Integrated Reservoir-to-Market Digital Twin

Norske Shell is using Kongsberg Digital's digital twin solution Kognitwin Energy to create a virtual

representation of the Ormen Lange deepwater gas field. Feeding into the onshore digital twin developed at the Nyhamna gas-processing facility, the two combined will become the first ever fully integrated reservoir-to-market digital twin. The twin solution from Kongsberg Digital will reimagine the ways of working at Shell and unlock new value in the subsea and subsurface arena.

In October 2019, Norske Shell joined forces with Kongsberg Digital to operationalize an "asset of the future" through a partnership development of the Nyhamna Dynamic Digital Twin, using Kongsberg Digital's Kognitwin Energy solution. The twin was up and running by the end of the year, and since January 2020 the Nyhamna Dynamic Digital Twin has been in operation and evolving continuously through monthly product releases, focusing on safe, effective and integrated work processes and optimization of production and energy use.

With Nyhamna having paved the way, the decision was made

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to expand the collaboration with another digital twin of the related Ormen Lange deepwater gas field, which feeds gas to Nyhamna.

DNV Certification for Interactive Cloud Training

Wärtsilä Voyage's NTPRO (Navi-Trainer Professional 5000) navigational simulator has attained certification according to the new DNV Class D standard for cloud-based simulators, making it the first certified cloud solution that offers both interactive instructor-led and student-led training. With this, the navigational simulator now has full compliance (Class A, B, C, D) with DNV's ST-0033 Maritime Simulator Systems standard.

As the maritime industry works to identify what learning events can be effectively conducted remotely and what requires a physical presence or team interactions at a training facility, Wärtsilä Cloud solutions are certified to provide both the interactive exercise control required for mandatory (STCW) training and examination, as well as the self-directed detached exercise and assessment that can be undertaken to enhance or supplement Instructor-controlled simulations.

Together these simulation solutions and associated value-added services equip the training providers with all the tools needed to develop effective and targeted blended learning courses that can be considered for flag or other industry approvals.

First Fully Electric Tugboat

Crowley Maritime Corp. will build and operate eWolf, the first all-electric-powered harbor tugboat. The 82-ft. vessel with 70 tons of bollard pull advances Crowley and the maritime industry's efforts toward sustainability and decarbonization. Over the first 10 years of its use, the operation of the new eTug will reduce 178 tons of nitrogen oxide (NOx), 2.5 tons of diesel particulate matter and 3,100 metric tons of CO₂ versus a conventional tug. The electric tug will replace one that consumes more than 30,000 gallons of diesel per year.

The eTug will be operational by mid-2023 at the Port of San Diego.

ZeroNorth Acquires Fuel Optimization Company

ZeroNorth has acquired the Copenhagen-based digital vessel performance company Propulsion Dynamics Inc. Founded in 2002, Propulsion Dynamics was the first company to offer full-scale digital twin ship performance analysis

through its CASPER service, making it a forerunner of vessel performance optimization, offering insight on how vessel hydrodynamics can impact fuel consumption. The fuel consumption tables provided by Propulsion Dynamics can support decarbonization. By activating Propulsion Dynamics' vessel models with machine learning, ZeroNorth can scale up CASPER's potential use cases in the market. **ST**



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First Global HAB Analysis

The first-ever UN analysis of harmful algal blooms (HAB), including 9,500 recorded globally over 33 years, shows the harm rising in step with the aquaculture industry, marine exploitation and coastal development.

The seven-year study by 109 scientists in 35 countries says reported HAB events have increased in some regions and decreased or held steady elsewhere. A widely stated view that HABs are on the rise throughout the world, perhaps due to climate change, is not confirmed by this study.

However, the study, published in the *Nature* journal *Communications Earth & Environment*, creates the world's first baseline against which to track future shifts in the location, frequency and impacts of HABs, which differ depending on which of the 250 harmful marine algae species is involved and where, requiring assessment on a species-by-species and site-by-site basis.

Ørsted Aims for Net-Positive Biodiversity

Ørsted has set the ambition to deliver a net-positive biodiversity impact from all new renewable energy projects that are commissioned from 2030 at the latest.

Ørsted develops, constructs, and operates offshore and onshore wind farms, solar farms, energy storage facilities and bioenergy plants, and provides energy products.

A net-positive impact occurs when a project has an overall positive biodiversity impact due to active measures taken to offset potential biodiversity losses.

One of the challenges is the lack of industry-wide standardized approaches to measure biodiversity impact. Especially working in offshore environments, which are more dynamic and variable due to the forces of the ocean, it is more complicated to establish a baseline and measure the change. Ørsted has joined the Science Based Targets Network Corporate Engagement

Program to help develop nature science-based targets and advance long-term development of tools and guidance to measure its impact and dependencies on biodiversity, land, water and oceans.

Monitoring Gulf Loop Current

Oceanographic instrumentation developed by Sonardyne to monitor ocean currents has been acquired by the University of Rhode Island (URI) following its successful use in a \$2 million project in the U.S. Gulf of Mexico. The project saw an array of specialist sensors, including Sonardyne's Pressure Inverted Echo Sounders (PIES), deployed for two years to monitor the hugely disruptive Gulf Loop Current.

Sonardyne's PIES were installed down to 3,500-m depth early in 2019. Following successful wireless acoustic data harvesting campaigns from the instruments in 2019 and 2020, their deployment was extended through May 2021. Funding for the project was also extended, allowing URI to purchase the Sonardyne PIES used on the project outright, as well as a Dunker 6 telemetry transceiver for wireless data harvesting from the instruments when they are on the seafloor. This will allow URI to use the instruments on future projects.

The Gulf Loop Current system is a highly energetic ocean circulation feature that influences all ocean processes in the Gulf and is characterized by disruptive Loop Eddy events affecting a wide range of human and natural activities, from oil exploration to coastal ecosystems.

PIES work by transmitting an acoustic pulse from an instrument on the seabed upward. The pulse is reflected off the water-air boundary at the sea surface and returns back down to the seabed, where it is detected by PIES. This enables an exact measurement of the two-way signal travel time to be calculated. At the same instant, an accurate depth measurement is made using internal pressure sensors. Combining data from an array of PIES instru-

ments and near-bottom current meters with historic water profile data can be used to calculate currents throughout the full water column over an extended area, in this case, totaling over 50,000 sq. km. For this project, Sonardyne enhanced PIES with an integrated single-point current meter, tethered above the units.

Study of Toxic Blooms in IRL

Over the last 30 years, urbanization has increased along the Indian River Lagoon (IRL), which stretches about 250 km on Florida's east coast. As a result, water quality has deteriorated, and there is widespread loss of seagrasses and persistent harmful algal blooms, which threaten ecological, human and marine animal health, such as the health of manatees.

In the IRL, two types of toxic blooms raise significant concerns: *Microcystis aeruginosa* (blue-green algae known to produce *microcystin* toxin) and *Pyrodinium bahamense*, which produce a neurotoxin called *saxitoxin* that causes paralytic shellfish poisoning.

Researchers from Florida Atlantic University's Harbor Branch Oceanographic Institute, in collaboration with the St. Johns River Water Management District, collected surface water samples during the 2018 wet and 2019 dry seasons. The team of scientists evaluated the toxicity of organic extracts of the water samples from across six segments of the IRL. They assessed the water samples against a panel of mammalian cell lines and characterized the composition of micro-organismal communities and their correlations with concentrations of toxins.

Results of the study, published in the journal *Harmful Algae*, show that concentrations of both toxins were generally higher during the wet season, highlighting the connection between precipitation (e.g., via nutrient loads), number of cells and toxins. The data suggest that *microcystins* were present only under specific environmental conditions and that *saxitoxin*, even when detected, was present in concentrations insufficient to affect the cell lines. **ST**

US Shipyards Support \$42.4 Billion in Gross GDP

The U.S. Department of Transportation's Maritime Administration (MARAD) has released a new report finding that U.S. private shipyards support \$42.4 billion in gross domestic product (GDP). MARAD's new report, "The Economic Importance of the U.S. Private Shipbuilding and Repairing Industry," measures the economic importance of the shipbuilding and repair industry at the national and state levels for calendar year 2019.

In 2019, the nation's 154 private shipyards directly provided more than 107,000 jobs and contributed \$9.9 billion in labor income to the national economy. On a nationwide basis—including direct, indirect and induced impacts—the industry supported 393,390 jobs, \$28.1 billion of labor income and \$42.4 billion in GDP.

The report states the U.S. shipbuilding industry has run a trade surplus in six out of the last 10 years, with a cumulative trade surplus of \$7.3 billion over this period. From 2015 to 2020, U.S. shipbuilders delivered 5,024 vessels of all types, including tugs and towboats, passenger vessels, commercial and fishing vessels, and ocean-going and inland barges, reaching 608 vessels in 2020. More than 60 percent of vessels delivered during the last six years have been inland tank and dry cargo barges.

The Biden-Harris Administration recognizes the economic importance of the maritime industry and has proposed \$17 billion in inland waterways, coastal ports, land ports of entry and ferries as part of the American Jobs Plan. These investments would make U.S. infrastructure more resilient while improving efficiency and creating new capacity to enhance freight movement in the U.S.

New Head of NOAA Fisheries

Janet Coit was appointed to lead NOAA Fisheries, which is responsible for managing U.S. marine fisheries and conserving protected marine species, as the assistant administrator under the Biden-Harris Administration.

Coit will also serve as acting assistant secretary of commerce for oceans and atmosphere and deputy NOAA administrator, for which she will support and manage NOAA's coastal and marine programs.

A native of Syracuse, New York, she is a magna cum laude graduate of Dartmouth College. She holds a law degree from Stanford Law School. Coit has worked on environmental issues, natural resource management and stewardship for more than 30 years. She brings extensive managerial and leadership experience to NOAA Fisheries, having worked at the intersection of policy and science throughout her career. Coit directed the Rhode Island Department of Environmental Management for over 10 years.

New US National Marine Sanctuary

The ranks of U.S. national marine sanctuaries has grown by one as NOAA and the state of Wisconsin announced the designation of America's 15th marine sanctuary: the Wisconsin Shipwreck Coast National Marine

Sanctuary. It will encompass 962 sq. mi. of Lake Michigan that contain a multitude of cultural and historical treasures. Among the 36 known historic shipwrecks, the sanctuary includes Wisconsin's two oldest shipwrecks and several others preserved almost completely intact due to the lake's icy cold freshwater.

Resilient PNT Conformance Framework Transitions to IEEE for Standards Development

The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) has transitioned the Resilient Positioning, Navigation, and Timing (PNT) Conformance Framework to the Institute of Electrical and Electronics Engineers (IEEE) as an approved project (P1952) that will further refine the framework into international industry standards for resilient PNT user equipment. The framework is nonprescriptive and defines four levels of resilience so that end-users can select a level appropriate for their needs. This common framework will enable critical infrastructure owners and operators to make risk-informed decisions when determining the most appropriate PNT systems to deploy.

PNT services, such as GPS, are more than just a navigation tool; they are "invisible utilities" that enable many applications within critical infrastructure, including the electric grid, telecommunications, agriculture and port operations. PNT services are a national critical function and, if disrupted or manipulated, have the potential to adversely effect the national and economic security of the United States.

Furuno Navigation Suite for NPS Vessel

The U.S. National Park Service (NPS) has taken delivery of its latest passenger/utility vessel, outfitted with a complete suite of Furuno navigation electronics at the ship's state-of-the-art helm. The 74-ft. all-steel vessel was designed and built by TAI Engineers and constructed at Aluma Marine in Harvey, Louisiana.

The vessel's namesake, Annie Moore, was the first immigrant to pass through federal inspection at the Ellis Island station in New York Harbor. The vessel's mission will be to transport VIPs, including national and international dignitaries, supplies and equipment from Battery Park to Ellis Island, home of the Statue of Liberty.

SBIR Grant for Offshore Monitoring Vessel

SubSeaSail LLC (SSS) has been awarded a Small Business Innovation Research (SBIR) Phase One grant from the U.S. Department of Energy Water Power Technologies Office. This one-year grant for \$206,500 will be used to create a low-cost, user-friendly environmental monitoring vessel for offshore marine energy sites.

The vessel will be designed to work on the surface and continue to monitor and measure when submerged down to 30 m. The vessel will be based on the company's patented semisubmersible, monohull design and incorporate an SSS-developed passive acoustic array to monitor underwater soundscapes and third-party magnetometers to measure electromagnetic fields generated by in-water hydrokinetic installations. **ST**

contracts

KVH Industries Inc., Middletown, Rhode Island, will supply Agile-Plans, its subscription-based connectivity-as-a-service program, for VSAT connectivity to vessels. Installations for four vessels have been completed, with plans for an additional 25 through the second quarter of 2022. RIX Shipmanagement Ltd.

Vard Electro, Ålesund, Norway, has a contract for a hybrid battery power system to be integrated on the vessel *Atlantic Shrike*. This multiple-mode application of battery technologies on a single vessel is a first for the Canadian offshore oil and gas industry. Atlantic Towing.

Korean Register, Busan, South Korea, has signed a memorandum of understanding to work together to develop and commercialize hydrogen fuel cell systems to propel marine vessels. Hyundai Motors and Hyundai Global Services.

Marlink, Oslo, Norway, has teamed up with an environmental research group to support the Gombessa 6 project with smart hybrid connectivity to collect and transmit large amounts of data. The project will research coralligenous atolls off Cap Corse in the "Parc naturel marin du Cap Corse et de l'Agriate." Andromède Océanologie.

Svitzer, Copenhagen, Denmark, has signed a 10-year time charter party for the provision of towage and other vessel support services required by the Interim Offshore LNG Terminal. These will feature a floating storage and regasification unit (FSRU) at the First Gen Clean Energy Complex in Batangas City, Philippines. FGEN LNG Corp.

Kraken Robotics Inc., St. John's, Canada, has signed a contract with a major international energy company for Kraken's SeaVision 3D laser scanner to conduct underwater inspection of an umbilical termination assembly to acquire metrology

data on tubing within the internal structure in West Africa. Undisclosed.

Trelleborg's, Trelleborg, Sweden, marine and infrastructure operation will supply all of the closure joints, including a bespoke seal, for the Dalian Bay immersed tunnel in Dalian, China. Upon completion in 2024, it will be the longest immersed tunnel in Northern China. China Communications Construction Co. First Harbor Engineering Co. Ltd. **ST**

meetings

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

OCTOBER

October 4-5—Maritime Transport Efficiency Conference, Geneva, Switzerland. <https://mte-conference.com>.

October 5-6—Subsea UK Underwater Robotics Conference, Virtual. www.subseauk.com/10927/underwater-robotics-conference.

October 5-7—Deepwater Operations and Topsides, Platforms & Hulls Conference and Exhibition, Galveston, Texas. www.offshore-event.com.

October 5-7—Seawork, Virtual. www.seawork.com.

October 12-14—Ocean Business, Southampton, U.K. www.oceanbusiness.com.

October 20-22—NOIA Fall Meeting, Point Clear, Alabama. www.noia.org/2021fallmeeting.

October 25-29—SNAME Maritime Convention, Providence, Rhode Island. SNAMEconvention.com.

October 26-27—Offshore Energy, Amsterdam, Netherlands. www.offshore-energy.biz.

October 26-28—MAST Europe, Toulon, France. <https://mastconfex.com/europe2021>.

NOVEMBER

November 2-5—Aquatech Amsterdam, Amsterdam, Netherlands. +31 (0)6 51815306 or a.koomen@rai.nl.

November 2-5—Europort, Rotterdam, Netherlands. www.europort.nl.

November 15-19—BlueTech Week, Virtual. www.tma-blue-tech.org/bluetech-week.

November 16-17—Subsea Asia, Kuala Lumpur, Malaysia. www.subseauk.com/11668/subsea-asia-2021.

November 16-18—CLEAN GULF, San Antonio, Texas. cdavie@accessintel.com or www.cleangulf.org.

November 24-25—Marine Renewables Canada, Halifax, Canada. <https://marinerenewables.ca/marine-renewables-canada-2021-annual-conference-november-24-25-2021>.

DECEMBER

December 6-10—World Ocean Summit Asia-Pacific, Virtual. ocean.summit@economist.com or <https://events.economist.com/world-ocean-summit-asia-pacific>.

December 15-17—UDT, Rostock, Germany. www.udt-global.com.

2022

JANUARY

January 10-13—Nor-Shipping, Oslo, Norway. www.nor-shipping.com.

January 26-27—ACIs Ship Recycling Congress, Rotterdam, Netherlands. +91 9921 81 9902 or skanwar@acieu.net.

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

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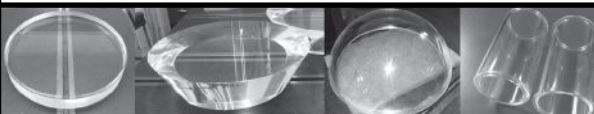
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Don't Ignore the Warning Signs When It Comes to Offshore Safety—David Jamieson

David Jamieson is the founder and managing director of the Aberdeen-headquartered process safety consultancy Salus Technical. Following two



high-octane seasons on the Formula 1 circuit, Jamieson transferred his skills to the offshore safety sector, working in house for several operators and service providers. He went on to launch Salus Technical in 2019, <https://salus-technical.com>.

Picture this scenario: You are at a swimming pool, and there are two lifeguards on duty. You learn that one of them recently saved the lives of two people, on separate occasions. The second has never had to perform an emergency rescue. Which is the “better” lifeguard?

Personally, I'd put my trust in the latter. Why? Well, in the words of “Futurama”: “When you do things right, people won't be sure you've done anything at all.” While lifeguards are trained to respond to life-threatening situations, their most important job is undoubtedly incident prevention.

The same applies to safety in the oil and gas industry, where being proactive and taking action before an incident occurs is imperative.

According to the Health and Safety Executive's (HSE's) Offshore Statistics and Regulatory Activity Reports and its online library of approximately 160 enforcement notices over the past four years, fatalities and injuries are in decline, with no fatal injuries since 2016 and a drop in the number of “over-seven-day” injuries reported, from 86 in 2018 to 73 in 2019.

However, an area where we are falling short is hydrocarbon releases. In 2018, the director of the HSE's energy division wrote to all North Sea oil and gas operators about his concerns over unplanned gas releases; yet the number rose from

100 in 2018 to 126 in 2019, and over the last four years, at least one in four offshore topic inspections across all disciplines has resulted in a score of poor or very poor, meaning that they are “significantly” below HSE standard.

Further, of the 160 HSE enforcement notices, 30 were due to hydrocarbon releases. That means 30 instances were deemed significant enough to warrant enforcement action by the HSE.

Failures during isolation and reinstatement of plant constitute one of the main causes of “loss-of-containment” incidents. This emerged as another common theme, with 13 enforcement notices issued by the HSE in the last four years due to inadequate process isolations.

There are a number of factors that may have contributed to this. One being that, over time, we may become desensitized to risk. Our mindset, and the actions we take or don't take, are crucial in managing risk.

As OGUK's former supply chain manager Matt Abraham said in 2019: “A sense of chronic unease has to be maintained.” That's because even the weakest signals could lead to a catastrophe, as illustrated by the Mendocino Complex fire in northern California in 2018, caused by a “spark or hot metal fragment landing in a receptive fuel bed.”

The complexity of process engineering and the cumbersome nature of process isolations is another factor. This is particularly true on older assets where it is sometimes impossible to execute certain tasks while achieving the required process isolation. Often, we need to deviate from the standard, which isn't exactly a recipe for success.

In a previous role, as an engineering technical authority, I often had to say: “No, you can't do the job as planned because it falls short of the required standard.” Those are

tough conversations to have because some requirements can be hard to understand or appear overly onerous.

HSE's “The Safe Isolation of Plant and Equipment” (HSG253) is what most isolation standards are based on. Of course, writing and issuing a standard is not the end goal; you've got to roll it out effectively to those who need to know. I'm also a big advocate for standards and procedures that are written in such a way that, if a deviation is required, the required action is clearly and simply laid out.

Poor alarm management also stood out, with 14 enforcement notices being given. One notice was issued in response to a control room operator who had been dealing with over 100 “urgent” alarms. Alarms should always have a defined operator response. Without that, they have limited value.

Process safety competency is the final area I'd like to highlight. Of the enforcement notices issued, many involved at least one decision made onshore. If you're an employer or employee who thinks health and safety is someone else's job, then think again. Preventing major accidents is a team effort. If you are making decisions that directly or indirectly influence the health and safety of others, then you need to understand the implications of those decisions. Process safety education is important. The IChemE's Process Safety Competency Guidance is a good reference for many operational and functional roles.

In summary, we need to focus on three areas: process isolations and hydrocarbon releases, alarm management, and competence. While the COVID-19 pandemic has affected planned maintenance programs and safety audits, by making sure the right people have the right information at the right time—and the demonstrable competence—we can continue to improve safety. **ST**

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