

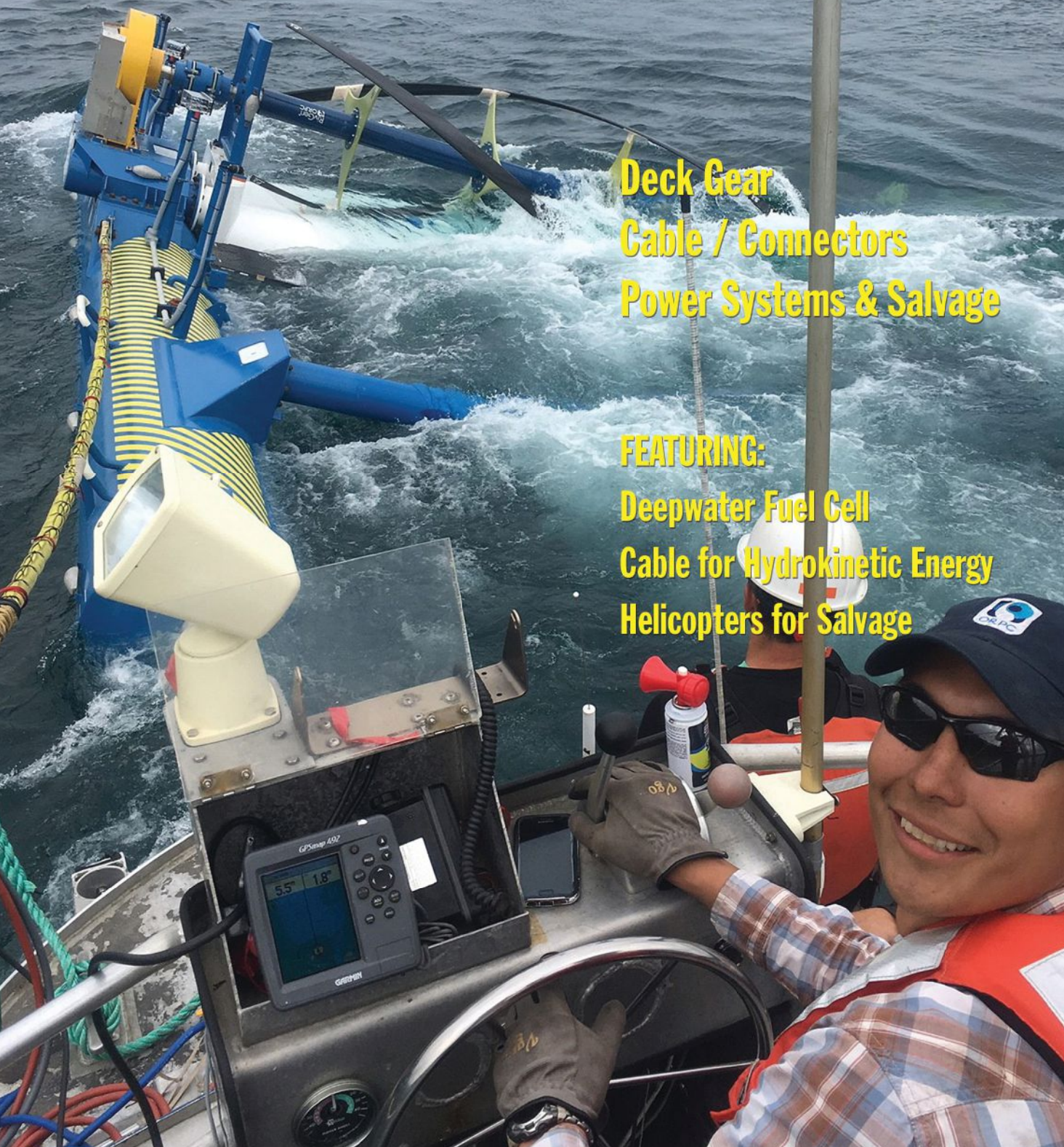
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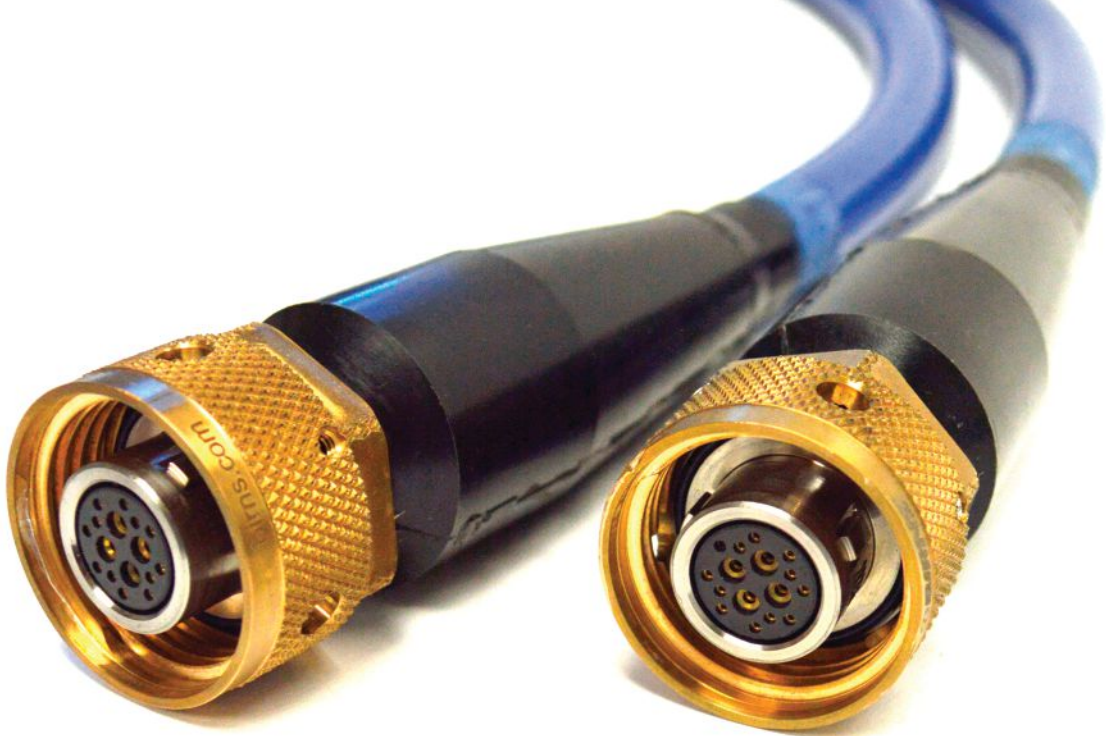
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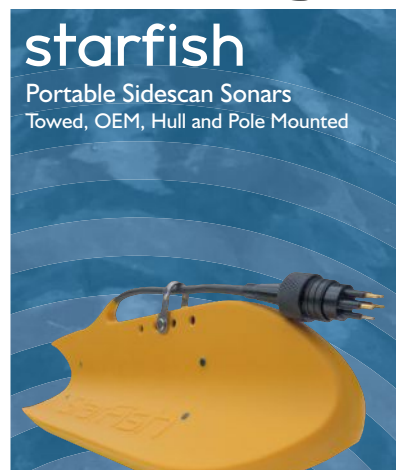
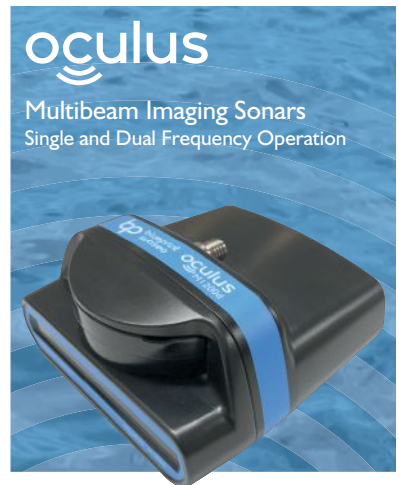
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The RivGen Power System being deployed at a diagonal in the Kvichak River, Igiugig, with local pilot Jon Salmon captaining the launch vessel with ORPC engineer team. (Credit: ORPC)

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The Human Element In Autonomous Systems

Autonomous systems are a key topic in the debate over the future of the maritime sector. Much of the discussion has focused on the possibility of vessels operated without crew, sparking controversy at times. Today, however, many ships already operate with autonomous systems that require little or no human intervention.

The Nautical Institute, a professional body representing those in control of sea-going ships, has asked mariners their thoughts on the introduction of autonomous systems. Mariners were fairly pragmatic about the increase of technology on board. They can see scope for improvement but also feel guarded about the potential risks. Many praised technology for improvements such as automatic positioning systems (ECDIS) making maneuvering in tight areas easier, and automatic monitoring of cargo and unmanned spaces giving greater confidence.

Most mariners accept that increasing use of autonomous systems is inevitable and that it is necessary to learn to work with them. However, they are understandably cautious about the way these systems are designed and implemented. In the past, implementation of technology has not always been handled well, particularly where cost is an issue. Users have all too often not been fully consulted, and most mariners are concerned about the risk of autonomous systems causing problems if they are not put in place correctly.

Concerns range from not understanding the correct use of a system to the quality of the algorithms and who bears the ultimate responsibility if the system is either followed or overridden. Cybersecurity and recovery were also flagged by those who find themselves relying heavily on older systems.

One of the big issues identified by The Nautical Institute's survey was trust. For an autonomous system to be useful there needs to be a high degree of trust that the system won't fail, or that if there is a failure there will be a "graceful degradation" in the system, giving the people on board time to take over control safely.

Seafarers recognize the importance of additional training in order to feel competent and confident using new technology. They are cautious about skill fade in areas where technology reduces the time spent practicing their existing skills, which they may need to fall back on. They recognize that some technical and automated processes have the potential to improve safety and efficiency and reduce fatigue.

If autonomy is to be a success, it is vital for ship and shore to have a shared understanding of the purpose of automated technology. Is it intended to replace an existing task (perhaps automatic reporting), support mariners in their current role (such as providing better lookout and decision support), or are the mariner and the system working in tandem?

Autonomous systems will become more widespread, and mariners must be consulted at the design stage to ensure that new systems are fit for purpose and support people, rather than the other way around. Dependability and trust are key pillars for successful implementation and operations. Without trust the system becomes a burden, and this can increase the risk of it not being used or used in inappropriate ways.

It will be essential to observe how mariners use current and future systems in practice. These observations can drive real change, and The Nautical Institute is working with industry leaders to train assessors to be better at observing behavior on board. These trained assessors will encourage feedback on competency, procedures and design for the shipping industry, in autonomous systems and beyond. User-led design of autonomous systems is an excellent start, but only once we see how these systems are being used in practice can we hope to get the best possible results. **ST**

)) New Head of ONR. The U.S. Office of Naval Research (ONR) ushered in a new era of leadership as RAdm. Lorin C. Selby—a decorated submarine commander, naval engineer and acquisition officer—was sworn in as the new chief of Naval Research (CNR). In a first for ONR, the change-of-command ceremony took place at ONR headquarters in Arlington, Virginia and was streamed virtually to the wider CNR community, due to COVID-19 safety concerns. Vice Chief of Naval Operations Adm. Robert P. Burke was the guest speaker at the ceremony. As the new head of ONR, Selby will oversee the roughly \$2 billion Department of the Navy budget for naval science and technology programs. Selby holds a B.S. in nuclear engineering from the University of Virginia and an M.S. in nuclear engineering and a nuclear engineer degree from the Massachusetts Institute of Technology. He takes ONR's helm after serving as the Naval Sea Systems Command's chief engineer and deputy commander for Ship Design, Integration and Naval Engineering. Selby succeeds RAdm. David J. Hahn, who is retiring after a distinguished naval career.

)) Hydrogen Rising as Oil, Gas Sector Priority. A new report reveals that hydrogen has surged up the priority list of many oil and gas organizations, taking a primary position in the sector's decarbonization efforts. A fifth (21 percent) of senior oil and gas industry professionals say their organization is already actively entering the hydrogen market, according to a new report published by DNV GL, the technical advisor to the sector. The proportion intending to invest in the hydrogen economy doubled from 20 percent to 42 percent in the year leading up to the coronavirus-induced oil price crash. "Heading for Hydrogen" draws on a survey of more than 1,000 senior oil and gas professionals and in-depth interviews with industry executives. The report suggests that recent shifts in the industry's investment priorities are unlikely to affect the sector's long-term efforts to reduce carbon emissions. DNV GL found a significant rise in those reporting that their organization is actively adapting to a less carbon-intensive energy mix: up from 44 percent for 2018 to 60 percent for 2020. Carbon-free hydrogen production, transmission and distribution is now widely recognized as a central component to the oil and gas industry's decarbonization efforts.

)) Coronavirus Effects Could Lessen Ocean Absorption of CO₂. Volcanic eruptions and human-caused changes to the atmosphere strongly influence the rate at which the ocean absorbs carbon dioxide, according to a new study pub-

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lished in the journal *AGU Advances*. The ocean is so sensitive to changes such as declining greenhouse gas emissions that it immediately responds by taking up less carbon dioxide. The authors say we may soon see this play out due to the COVID-19 pandemic lessening global fuel consumption; they predict the ocean will not continue its recent historic pattern of absorbing more carbon dioxide each year than the year before, and could take up less in 2020 than in 2019. The new study largely resolves the uncertainty about what caused the ocean to take up varying amounts of carbon over the last 30 years. The findings will enable more accurate measurements and projections of how much the planet might warm and how much the ocean might offset climate change in the future. Nearly 40 percent of the CO₂ added to the atmosphere by fossil fuel burning since the dawn of the industrial era has been taken up by the ocean.

)) Extension for Input into IPCC Climate Change Report. The Intergovernmental Panel on Climate Change (IPCC) has extended the cut-off date for scientific literature to be included in the contribution to the Sixth Assessment Report (AR6) of Working Group I, which deals with the physical science basis of climate change, by four months from September 30, 2020 in the original Working Group I schedule to January 31, 2021. IPCC Working Group I has run surveys with climate scientists and editors of relevant scientific journals and consultations with authors of the assessment report underway to assess the current situation with the COVID-19 pandemic and inform the adjustment of the schedule. The Working Group I contribution to AR6, *Climate Change 2021: The Physical Science Basis*, will assess large-scale climate changes, climate processes and feedback and regional climate information. The Working Group I report includes an interactive online atlas, also open for review comments.

)) Coronavirus Natural Decay Calculator Online. The U.S. Department of Homeland Security Science and Technology Directorate added a new calculator to its online tools to estimate the natural decay of SARS-CoV-2 (the virus that causes COVID-19) in the air under various environmental conditions: www.dhs.gov/science-and-technology/sars-airborne-calculator. The tool will assist response efforts and minimize person-to-person transmission by analyzing environmental factors that may impact the ability of the virus to spread. The tool allows officials, the medical community and individuals to make more informed decisions to protect their own health and well-being. **ST**

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Untethered Subsea Power

H-O-Reactant Fuel Cell Produces Up to 30 MWh at 1,000-M Depth

By Dr. Thomas I. Valdez • Robert C. Utz • Robert K. Wynne

The delivery of untethered subsea power with multiple megawatt-hours (MWh) of energy storage capacity would be game-changing for many applications in the subsea community. Power is required for science outposts, to extend the operating duration of UUVs, and to support various subsea assets for the commercial oil and gas industry. A power source with multiple MWh of energy storage capacity will specifically minimize the ship time required to maintain subsea assets, addressing both the carbon footprint and the financial cost associated with maintenance.

The most mature untethered power systems for the subsea community are battery-based. The issue with batteries is they become cost prohibitive at energy storage capacities greater than a few 100 kilowatt-hours (kWh). Energy-harvesting systems are a pathway to providing untethered power at multiple MWh of energy storage capacity. These energy harvesting systems span turbines that harvest the wind, buoys that harvest tidal energy, and subsea turbines that harvest the energy of ocean currents.

However, energy-harvesting systems are still in development and application-specific. A new approach to provide power with multiple MWh of energy storage capacity is in development by Teledyne Energy Systems and is called the Subsea Supercharger.

Design Basics

The Subsea Supercharger is a fuel cell-based power source fed hydrogen and oxygen reactants to produce electrical power, heat and water. The Subsea Supercharger comprises four main components: a fuel cell module, a pow-

Ejector-driven reactant (EDR) fuel cell system.





(Top) Subsea Supercharger prototype being readied for deployment. (Bottom) Subsea Supercharger prototype in a pool.

these chemical states affords various pathways to marinization. Cryogen and solid-state reactants are typically stored in steel or titanium pressure vessels, allowing for a direct path to marinization. Gas reactants are also commonly stored in steel pressure vessels.

However, the nature of gas compression, specifically hydrogen, can make the mass of a Subsea Supercharger, configured with multiple MWh of energy storage capacity, difficult to deploy at sea. Thus, composite

overwrapped pressure vessels (COPVs) are preferred over steel pressure vessels for gas storage. The pathway to marinize COPVs has been in the application of surface coatings to decrease the rate of saltwater impingement on the pressure vessel surface.

er electronics module, a reactant storage system and a subsea structure. A fuel cell module houses the fuel cell system. The power electronics module houses the hybridization battery and power switch gear. The reactant storage system, in the base configuration, comprises pressure vessels for the gaseous storage of hydrogen and oxygen. The subsea structure holds the individual components of the Subsea Supercharger and is designed to be deployed and recovered. Special pressure compensation systems are not required when deployed subsea because the fuel cell system and electrical components are housed in pressure vessels. The module pressure vessels, the reactant pressure vessels and the subsea structure are the components that require marinization.

The Subsea Supercharger is reactant-state agnostic, meaning it can be fed hydrogen and oxygen stored as gas, cryogen or solid-state. Reactant storage for each of

To date, only a small number of COPV manufacturers have qualified their pressure vessels for use in saltwater. Even fewer have qualified pressure vessels of sufficient volume to be used by a Subsea Supercharger configured for multiple MWh of energy storage capacity. A vendor has been found with such a pressure vessel, which is presently on contract for fabricating these COPVs for the Subsea Supercharger.

The Heart of the Technology

An ejector-driven reactant (EDR) fuel cell system is the electrochemical “engine” featured in the Subsea Super-



Subsea Supercharger manufacturing prototype in 100-kWh configuration.

charger. The EDR fuel cell system is dead-ended, meaning reactants are fed, and only byproducts are expelled. This EDR fuel cell system is also passive. There are no moving parts to circulate reactants during deployments, which decreases failure modes. When power is drawn from the Subsea Supercharger, the reactants fed to the EDR fuel cell system are converted to water and heat.

The heat generated from the electrochemical oxidation of hydrogen in the EDR fuel cell system is used to maintain the Subsea Supercharger operating temperature, enabling it to efficiently operate at temperatures below -20°C .

The water produced during the electrochemical reduction of oxygen in the EDR fuel cell system is passively expelled. This byproduct water is used as the working fluid in the thermal subsystem of the Subsea Supercharger. The thermal subsystem of the Subsea Supercharger maintains the operating temperature of the EDR fuel cell system, as well as any ancillary components such as the hybridizing batteries employed in specific Subsea Supercharger configurations. When the working fluid of the thermal control subsystem is full, the Subsea Supercharger then expels the byproduct water into a holding tank or, if allowed, into the environment.

Development Focus

The focus of the Subsea Supercharger development was on operating a fuel cell system in a sealed environment. As reactant leakage in hydrogen-oxygen fuel cell systems is always present, it is paramount that the Subsea Supercharger maintains an operating environment in the fuel cell module that eliminates one of the reactants.

Teledyne previously patented a hydrogen-oxygen re-

combination system to address fuel cell reactants found in the purge gases of a fuel cell system. A variant of this technology is employed to address reactants leaking from the fuel cell system into the fuel cell module. The Subsea Supercharger control electronics measure the oxygen concentration to ensure it is only present in trace concentrations. If the oxygen concentration in the fuel cell module were to increase, the control electronics will shut off the reactants feeding the fuel cell system and shut the Subsea Supercharger down.

Value Proposition

The value proposition of the Subsea Supercharger is increased safety in deploying untethered power systems with MWh-level of energy storage capacity. As the Subsea Supercharger is modular, the reactants can be disconnected during transportation.

Each reactant, hydrogen and oxygen, is connected to the Subsea Supercharger at the time of deployment. During deployment, the Subsea Supercharger has redundant engineering controls to maximize safety. The reactant feeds have mechanical flow cut-off valves, which close if the reactant feed is greater than a preset rate. The mechanical flow cut-off valves address issues related to the reactant feed connections to the fuel cell module being compromised.

The Subsea Supercharger control electronics are part of a second safety control system. If the control electronics sense any issue with the EDR fuel cell system or the fuel cell module environment, they close the fuel cell module reactant flow valves, shutting off the ingress of hydrogen and oxygen.

The third safety control system includes the power

electronics module of the Subsea Supercharger. The EDR fuel cell system in the fuel cell module cannot operate unless its electronics are fed power from the power electronics module. The power electronics module contains the master switch to enable the fuel cell electronics in the fuel cell module. The fuel cell electronics operate the reactant feed valves, which feed reactants to the EDR fuel cell system. If power is lost or the fuel cell control electronics are compromised, the reactant feed valves will default to their normally closed state, and the Subsea Supercharger is placed in a safe state.

Unlike lithium-ion batteries, there is no mechanism for failure propagation in the fuel cell system. Both passive and active engineering controls are employed to help ensure that if a fault is detected, the Subsea Supercharger will default to a safe state.

Lastly, when deployed, the Subsea Supercharger is completely immersed in water, which provides a passive safety environment.

Prototype Capabilities

The prototype Subsea Supercharger has been designed to deliver 1 kW of continuous power at approximately 60 percent thermal reactant conversion efficiency. Although the system can provide power up to 3 kW, it does so at a lower efficiency. As a fuel cell-battery hybrid power system, peak power greater than 3 kW will be supported by the Subsea Supercharger's battery.

The prototype Subsea Supercharger features a 48-V, 18-Ah lead-acid battery. The battery is sized to support fuel cell system start-up, power bus load balancing and peak power draw. The hybridizing battery allows the Subsea Supercharger to provide the user with immediate power when connected and activated. The prototype Subsea Supercharger is being qualified for operation to an ocean depth of up to 1,000 m.

Technology Validation

The prototype Subsea Supercharger has been tested in pools

and dockside in a marine environment. The goal of the prototype testing was to validate the basic Subsea Supercharger concept: a fuel cell system operating subsea in a sealed environment.

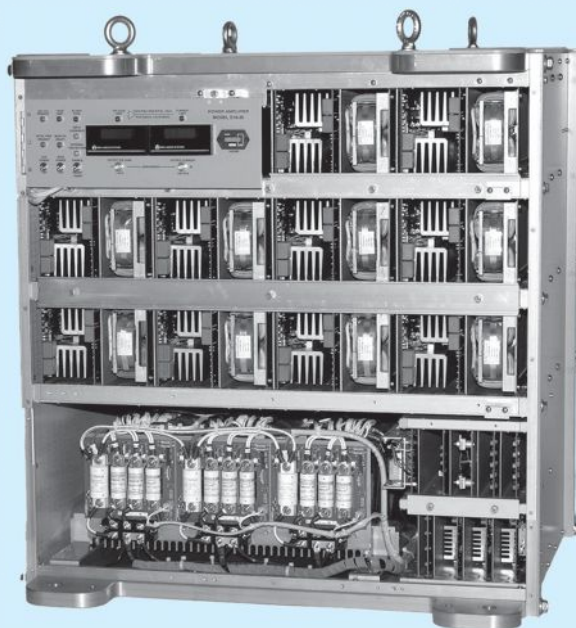
For initial pool testing, the Subsea Supercharger was transported to the test facility to qualify the system for dockside testing in July 2018. The test facility featured a pool of 7-m depth. The prototype Subsea Super-

charger was lowered into the pool and operated. The operation consisted of powering a resistive load with a load profile of 1-kW steady state with 2-kW excursions approximately every 30 min. The prototype Subsea Supercharger was qualified for transportation, deployment, load profile testing and recovery.

The prototype Subsea Supercharger was transported to Newport, Rhode Island, to complete dockside

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“The Subsea Supercharger is a fuel cell-based power source fed hydrogen and oxygen reactants to produce electrical power, heat and water.”

testing in a marine environment in August 2018. During this testing, the prototype Subsea Supercharger powered a Teledyne SeaBotix inspection-class ROV while it performed ship husbandry exercises. During the exercises, the ROV would traverse the length of a pier and inspect a simulated ship hull deployed in nearby waters. The Subsea Supercharger supplied all the power required by the ROV and the ROV command station. The ROV featured a camera and a suite of mobility controls, which could draw up to 1 kW of power. The ROV command station featured the ROV controls, a monitor to display data received from the ROV camera, and a data capture system. During this testing, the prototype Subsea Supercharger was recovered and redeployed to demonstrate robustness. After dockside testing, the prototype Subsea Supercharger was shipped across the United States for demonstrations to further validate the technology.

Pilot Testing

To date, most applications for untethered subsea power are found in the commercial oil and gas indus-

try. Untethered subsea power is needed to provide back-up power to subsea oil and gas assets such as controls, chemical injection and well start-up systems. To address the untethered subsea power needs of the commercial oil and gas industry, a Subsea Supercharger is being readied for sea trials in the fall of 2020. The goal of the sea trials is to validate the Subsea Supercharger technology to provide backup power to assets operating in a subsea oil and gas field. For these sea trials, the Subsea Supercharger will be sufficiently marinized for deployment and recovery via a ship.

A subsea structure is being developed to house the Subsea Supercharger. The subsea structure will feature the requisite lift points, anchor points and mud mat, so it can lie resident and embedded into the subsea oil and gas field. The Subsea Supercharger will interface with a subsea asset via Teledyne Marine wet-mate connectors. Although the Subsea Supercharger can be configured with a Teledyne Benthos acoustic modem, this system will be deployed with a control panel so a working-class ROV can manually operate the system. The Subsea Supercharger will be deployed in the North Sea to a depth of 600 m. Temperature measurements at the site indicate it will be required to operate at temperatures near -4° C. The deployment phase of the sea trials is expected to last a minimum of three months. The Subsea Supercharger will be recovered and brought back to Teledyne for performance assessment and refurbishment, if required. The system is then expected to travel to Norway to support field trials of underwater intervention drones (UIDs).

Next Steps

Upon completion of the pilot testing, the Subsea Supercharger will be available to the ocean community as a demonstration system. Teledyne is preparing to begin production of Subsea Superchargers for both sale and rental in 2021. **ST**

Dr. Thomas I. Valdez is the senior technical manager of the chemical engineering group at Teledyne Energy Systems in Hunt Valley, Maryland. He has over 28 years' experience leading teams in developing electrochemical technologies for space and deep-sea. He is the principal investigator on the Subsea Supercharger commercialization effort.

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Robert K. Wynne is a technologist in the chemical engineering group at Teledyne Energy Systems in Hunt Valley, Maryland. He has over 37 years' experience developing fuel cell systems for commercial and space applications. He is the lead engineer in the development of the Subsea Supercharger.

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Custom Armored Cable

Assembly for Hydrokinetic Energy System in Alaskan Village

By Amy Brown

The mighty Kvichak River rushes past the village of Igiugig, located at the mouth of Lake Iliamna on the Alaskan Peninsula. With a year-round population of 70, primarily Yup'iks, Aleuts and Athabascans, Igiugig depends on the Kvichak for fresh drinking water, and for subsistence and sports fishing of enormous sockeye salmon and rainbow trout.

In 2019, the river began providing electrical power for the village as well, thanks to a unique renewable power system by Ocean Renewable Power Co. (ORPC Inc.) from Portland, Maine. The new RivGen 2.0 Power System delivered a clean, sustainable hydrokinetic power solution, powered by two submerged, cross-flow river current turbines. Igiugig had been relying primarily on a 40-kW diesel-fuel power plant since the 1970s for its electrical needs, but ORPC's RivGen technology has supplied approximately one-third of the community's electrical requirements and may reduce its diesel usage by 90 percent once a second RivGen device, expected in 2021, is added.

Igiugig is one of 250 Alaskan communities generating electricity from diesel-powered, small-scale, autonomous microgrids. The community's power plant costs in 2018 were \$255,708, and the plan was for the RivGen project to significantly reduce heating and electrical bills for the village, and decrease reliance on diesel fuel that is incrementally flown or barged in at approximately 4,000-lb. batches at up to \$7 per gallon.



BIRNS developed a custom cable assembly with a BIRNS Millennium 30-4F-CP, a 3M-13-CP, as well as a BIRNS Primus MSSL-3-4 connector, terminated in a "Y" split and overmolded to a single junction cable.

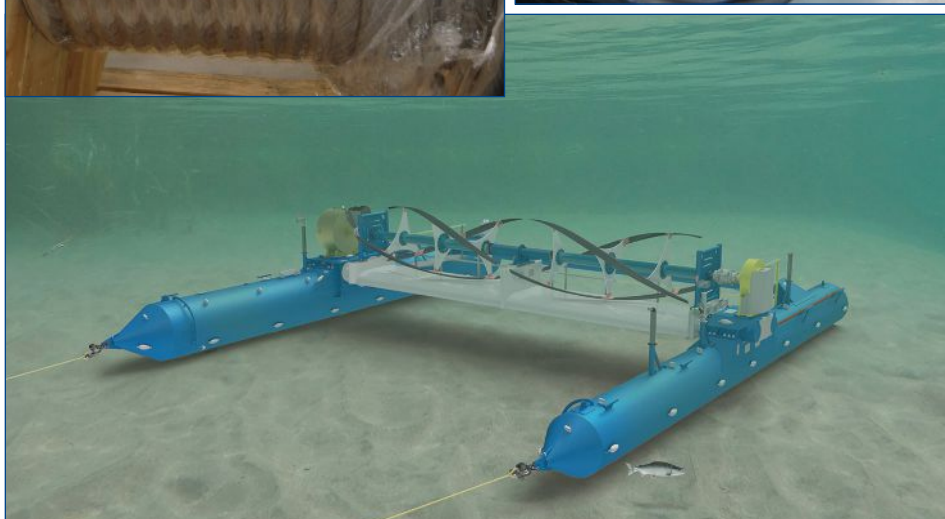
System Features

This custom standalone power-generating system operates completely underwater, powered only by the kinetic energy of the Kvichak River currents at a 15-ft.-deep installation.

The RivGen Power System has a rated power output of 40 kW in a resource with 2.25 m/s current speed, and 80 kW in a 3.5 m/s current speed, with power output dependent on resource speed. The speed of the river current fluctuates somewhat over the course of a year.

The system's turbine generator unit (TGU) is mounted on two pontoons at a low profile and at a river flow velocity of approximately 2.5 m/s.

The entire system is 15.7 m (51.5 ft.) by 14.3 m (46.9 ft.), 3.5 m (11.5 ft.) in height, and weighs 65,036 lb. It's constructed of composite materials optimized for performance and long life underwater.



(Clockwise) RivGen's application required the cable assembly terminated to a 675-ft.-long underwater armored cable, connecting the turbine generator unit (TGU) installed to the junction box. BIRNS technician performs continuity and IR testing on the final cable assembly. Graphic of RivGen device deployed. (Credit: ORPC)

The RivGen System can operate 24/7, and as it functions while completely submerged, it's safe from storms, wind and ice interference.

The RivGen device was transported from Maine to Alaska on two flatbed trucks across the lower 48, barged from Seattle to Anchorage, over ground from Anchorage to Homer, barged across Cook Inlet, overland a short distance, and finally barged down Lake Iliamna to the setup area at Igiugig.

It was then assembled and deployed by ORPC engineers who worked with local contractors, vessels and equipment.

System Connectivity

The RivGen System needed a robust armored cable assembly for several of its key operating components, and according to ORPC, a primary driver was the ability to house all of the connectivity in a single assembly that was also rugged enough to rest on a riverbed for weeks at a time during maintenance intervals. BIRNS Inc. of Oxnard, California, was called upon to develop a bespoke complex cable assembly terminated to the armored underwater power cable, which is used to connect the system and transfer power to the community grid. The solution includes a large assembly with three different cable plug (CP) connectors: a BIRNS Millennium 3O-4F-CP and a 3M-13-CP, as well as a BIRNS Primum MSSL-3-4 connector, in an assembly terminated in a "Y" split and overmolded to a single junction cable.

The robust BIRNS Primum MSSL-3-4CP was made specifically for high power loads and features three 4AWG sockets and a rugged coupling ring. The MSSL-3-4 is used for the three-phase power for RivGen's underwater permanent magnet generator.

Three-phase power provides three alternating currents with greater power density while making it easier to balance loads, along with consistency in power delivery.

The RivGen's cross-flow turbines are designed with a helical twist and spin in one direction, eliminating gears and lubricants. The device is placed perpendicular to the river's flow to capture energy from it. These rotating turbines feed into a direct-drive permanent magnet generator. This generator does not use a gearbox and includes a fully encapsulated rotor and stator, making it a robust electrical system for extended operating periods, without requiring maintenance.

The BIRNS 3M-13-CP is a high-density electrical connector with five 16AWG sockets and eight 20AWG sockets. It is used for control power for the RivGen's underwater supervisory control and data acquisition (SCADA) components, which provide real-time remote monitoring and oversight of the TGU. Sensors on the SCADA system monitor a range of functions, including water speed, direction and the speed of the individual turbines, as well as temperature, oil pressure and other



tubing, with three 2AWG conductors, and two twisted shielded pairs of 22AWG conductors, and one 16AWG twisted quad. It had polypropylene insulation, a polyurethane jacket and two layers of galvanized improved plow steel (GIPS) armor.

Results

According to ORPC, the RivGen System has been operating continuously, other than pauses for maintenance events, since the summer of 2019, and is functioning extremely well. There were intensive environmental studies done prior to the launch to ensure that the system would not create harmful interactions with either smolt (young salmon) that migrate to the ocean and return to spawn or resident young trout, or have issues with ice interference in the winter. There has been no impact on fish to date, it has caused no known environmental harm, and it continues to generate a meaningful amount of electricity—and is expected to deliver a total annual generation of 404 MWh delivered to the shore station. It is predicted that CO₂ will be down 230 metric tons per year, Igiugig's diesel costs will decrease by \$170,000 per year, and operating and maintenance costs will also decrease by \$50,000 per year once both RivGen devices are installed in 2021.

During her presentation at the 2020 Northern Lights conference, Village Council President AlexAnna Salmon reported that this unique hydrokinetic system and Igiugig's partnership with ORPC is expected to contribute to the citizens of Igiugig's strategy to live sustainably, in perpetuity, in their homeland—where their ancestors have lived for the last 9,000 years.



(Top) RivGen device deployed in Kvichak River, Igiugig, Alaska, 2019. (Credit: ORPC) (Bottom) RivGen device deploying to riverbed, Igiugig, Alaska, 2019. (Credit: ORPC)

systemic functions, all fed to shore-station monitoring. The BIRNS Millennium 3O-4F-CP connector in the cable assembly provides four optical-fiber ferrules supporting the system's fiber-optic data communication lines going to shore from the RivGen device.

The 3M-13 and the MSSL 3-4 electrical connectors in the assembly were both terminated and inspected per J-STD-001, Class 3 IPC/WHMA-A-620, Class 3. Testing of both individual electrical connectors and the final assembly included continuity and insulation resistance (IR) testing—IR required to be greater than 300 megohms at 500 VDC. The 3O-4F optical-fiber connector was tested in accordance with EIA-455-A at dual wavelengths (1,310 and 1,550 nm). The entire assembly was overmolded in BIRNS's NAVSEA PRO-020 certified lab.

The application required an armored 675-ft.-long underwater cable, connecting the installed TGU to the junction box onshore. BIRNS delivered the specialized armored cable—with a total reel weight of 2,500 lb.—consisting of six single-mode fibers inside stainless-steel

Acknowledgments

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References

For a list of references, you may contact the author: abrown@birns.com. **ST**

Amy Brown is the chief marketing officer for BIRNS Inc. Prior to joining BIRNS in 2009, she served in leadership marketing communications roles, including director of public relations for Bear Marketing Group, vice president of corporate communications for DataRemote Inc. and senior editor/public relations manager for Drizen-Dohs Corporate Communications.



When Salvage Jobs Take Flight

Sometimes the Right Tool for Vessel Salvage Isn't on the Water

By Charity Gourley

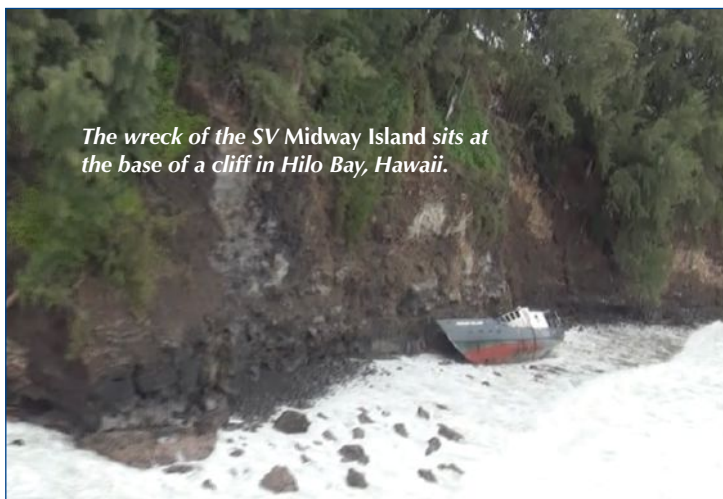
Some salvage jobs are straightforward—it can be obvious that using a certain tool to clean up or remove a vessel is the right choice. But sometimes, the solution is not always so clear.

Salvage jobs are the result of unique events and situations—from shipwrecks to groundings to collisions—and occur in unique conditions and environments, so they can vary widely from one to the next. The best solution can depend on a wide variety of variables, including the resources that are available to the salvage company called in for the job. Being able to assess the situation and come up with solutions that are often as unique as the problem itself is what makes salvage masters truly masters of their craft.

“One of the first things you have to do is put eyes on the situation to truly assess the risks and damage,” said Katy Stewart, a salvage master with Global Diving & Salvage. “That’s pretty standard stuff. You talk through the various scenarios, costs, time lines, danger to the environment and people. We try to see if a more straightforward or conventional route can be taken, but if not, that’s where we need to get creative.”

Stewart has been with Global for seven years. She’s seen a lot of projects in her time—shipwrecks, groundings, natural disasters and subsea wrecks. In March 2020, she was called in to assess the FV *Tamara Alane*, a shrimp boat that had lost power and ran aground on the Shackleford Banks Marine Protected Area, a barrier island system in the Outer Banks in North Carolina. The *Tamara Alane* was up on the beach and exposed to the Atlantic Ocean swell.

Shackleford Banks is home to more than 100 wild horses that feed on the grasses of the island. When called in by the United States Coast Guard (USCG), Global was informed that no damage could be done to the grass of the island during the defueling of the grounded vessel, and, since the loggerhead turtle nesting season



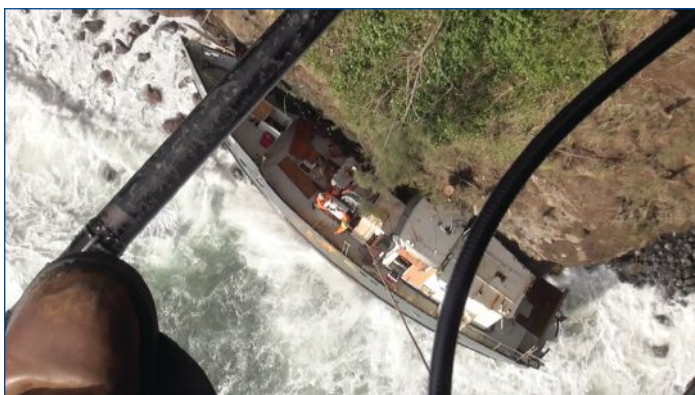
The wreck of the SV Midway Island sits at the base of a cliff in Hilo Bay, Hawaii.

was beginning soon, the work must not disturb the sandy beaches. Those two requirements alone would make it difficult to haul any gear to the wreck or reach the vessel, but in addition, an entire section of the western side of the island could not be accessed since it was a plover bird nesting ground.

“How do you get fuel off an island when you can’t gain access from the water because of the breaking surf, and you can’t haul equipment across the island from the lee shore?” Stewart and her team asked themselves.

They debated a few options. From studying satellite imagery, they considered running a defuel hose across the narrowest part of the island to the beach. But the hose would have around 60 separate connections, each one a potential failure point, and, as Stewart put it, “no one liked those odds.” It was suggested that they consider transporting equipment around the tip of the island, but to do so they would need to excavate the sand to create a path, so that option was out, too.

“That’s when we suggested that we fly the fuel off,” Stewart said. “People often think of using helicopters on



(Top to bottom) The helicopter hovers above the wreck of the SV Midway Island as members of the salvage team work below to prepare the vessel for removal. The SV Midway Island pressed against the steep cliffside. Rough seas and a steep coastline made the vessel inaccessible, except by helicopter. FV Tamara Alane sits stranded on the lee shore of Shackleford Banks Marine Protected Area in North Carolina, a sensitive island habitat for wild horses, sea turtles and shore birds.

a job as possibly expensive and dangerous. And sometimes it can cost more, but it is also an extremely efficient way to quickly remove fuel—and in this case, it was our safest option for our team because of the ocean exposure, and for the environment, if we weren't going to do further damage to the island in the process."

Global contracted with a local helicopter company

that had the right kind of craft and experience for the fuel removal. A Sikorsky S61N helicopter was loaded with the needed equipment, and the Global crew, along with personnel from parent company Moran Environmental Recovery, traveled via ATV on the island's existing trail systems to meet the helicopter. They rigged 550-gallon stainless totes and made 58 individual lifts to remove the 12,000 gallons of fuel and other hazardous materials from the *Tamara Alane*.

"Using a helicopter to defuel a vessel may not be an everyday standard procedure, but in this case, it was the fastest, safest, most efficient solution," Stewart said. "We were able to successfully complete the job very quickly, and without endangering the wildlife."

"Using helicopters in salvage jobs is not new," said Kyle Watson, Global's director of casualty response, "but there can definitely be some reluctance to using them—especially if you've never been on a job with one before. But usually once you see how safe they can be, and that they can often do the work in half the time, you're sold."

Watson listed job after job where a helicopter was Global's best choice: In Neah Bay where they flew in a mini-excavator to remove contaminated soil without disturbing the rest of the area; during a large dive project in California that was hike in/hike out only; on the Washington coast where a vessel ran ashore in an area surrounded by a marine sanctuary, state and national parks, and tribal lands that contained native petroglyphs; in North Carolina where a fishing boat ran aground on a Marine Corps training base where live-fire exercises are conducted and the beach was literally filled with buried unexploded bombs.

"And then there was the *Midway Island* wreck in Hawaii," said Watson. "That was particularly tricky as the grounded vessel was up on rocks, pushed against a steep cliff face and being pounded by breaking surf. Flying in also took some planning and coordination. Nothing about that job was standard."

In February 2020, a privately owned steel sailboat and fishing vessel, the *SV Midway Island*, went aground in Hilo Bay near Wainaku, Hawaii. The owner lived aboard the vessel and was asleep at the time of the collision. While he was safely rescued by the fire department, the *Midway Island* was being continually battered by high surf and was deeply lodged on the rocks against the cliff. The USCG called in Global to remove the fuel and prep the vessel to be towed.

"It was obvious that a helicopter would be our only option," said Kerry Walsh, Global's salvage master and project manager on the job. "But even that didn't come without a challenge."

The cliff was so steep that you couldn't see the *Midway Island* from the top edge, and large overhanging trees blocked helicopter access needed to place personnel and equipment onto the vessel. To approach by air, these trees would have to be trimmed back, so as not to tangle with the helicopter's blades. Specialized arbor-

ists were brought in who rappelled down the cliff face and trimmed the trees enough to allow the helicopter to maneuver in and over the *Midway Island* wreckage.

Global had pre-staged defueling equipment in Hawaii and supervised Hawaii-based teaming partner Sea Engineering Inc., which provided personnel and additional equipment to conduct defueling operations. Working also with Pacific Helicopter, Global delivered equipment and personnel to the *Midway Island*. Over the course of two days 1,320 gallons of diesel, 35 gallons of lube/hydraulic oil, and two cubic yards of miscellaneous household hazardous waste and batteries were removed from the vessel.

"Because the boat was against the cliff, the starboard side fuel tank wasn't completely accessible for defueling," said Walsh. "The Coast Guard had directed us to develop a plan to recover the vessel from the shoreline and deliver it to a safe location for final pollution mitigation. In prepping for that, we discovered that the vessel was too badly damaged to float."

Based on the damage to the vessel and its proximity to the main shipping channel, a recovery plan was devised that included filling the vessel's internal compartments with expanding foam to eliminate the possibility of the vessel sinking.

The two-part foam mixture had to be carefully mixed by hand and then applied quickly. Global used the helicopter to fly in the drums of the two mixtures, placing them at a 45° angle on the wrecked *Midway Island*. The helicopter was also used to airlift two crew members one by one onto the vessel, with the assisting helicopter HEC technician staying on board in case the crew members had to evacuate quickly—which happened once due to particularly rough seas—during the delicate work.

The foam mixture generates heat when mixed, presenting the risk of fire if misapplied. This risk was mitigated by mixing appropriately sized batches of foam and by monitoring core temperatures before laying additional layers of foam on top of previous pours. The full process to fill the *Midway Island* took 10 days.



(Top) A worker gives hand signals as a Sikorsky S61N helicopter arrives to lift materials from the Tamara Alane wreck site. (Bottom) Salvage Master Katy Stewart and her team used ATVs on the island's existing trail system to reach the Tamara Alane.

"The mixture gets hot and pretty quickly expands to six times its size," said Walsh. "You have to be patient, careful, and it takes skill. Add to that they were doing it at an angle, being pounded by the surf, and we had some bad weather days."

When the vessel's interior was completely filled with expanding foam, the next part of the recovery plan was put into action: pulling the *Midway Island* off the shoreline. Due to the rocks and surf, a tugboat couldn't get close enough, so in its final task, the helicopter was used to span the gap for teams to attach the tow line.

Once successfully towed off the shoreline, the *Midway Island* was delivered to a dock at the Port of Hilo, where she was demobilized and transferred to the state of Hawaii for final disposition.

"At the start, we considered bringing in teams on a small boat, but the risk to our people was just too great," Walsh said. "A helicopter was just a no-brainer in this instance. It allowed us to successfully defuel the vessel, float her and attach the tow line to pull her off the rocks."

There are a lot of tools at the disposal of a salvage master, and, as it turns out, not all of them are on or beneath the water. A salvage master's job is to take all factors into consideration when deciding how best to protect people, property and the environment from further damage.

"The right solution for a job isn't always so cut and dry," said Watson. "We've had jobs where we've

used remotely operated vehicles [ROVs] in some unique ways, from rigging a vessel in deepwater to investigating deep subsea wrecks. We use roller bags to lift, refloat or move vessels but turn to solutions like the two-mixture foam when those won't work. And when you have sensitive environmental areas, or after disasters, we have to get creative on how we can get to a site and safely complete the job. Something like a helicopter isn't right in every instance, and not something we would suggest unless it was really needed. But part of a successful salvage is knowing how to choose, and use, the right tools for the situation." **ST**

Charity Gourley is a Seattle-based writer who provides strategic marketing communications support to a variety of maritime clients.

Synthetic Mooring for Conservation

Alternative Mooring Protects Seagrass Habitats for Marine Life

By Maryanne Dutka

Globally, the shipping industry is relied upon heavily for the import and export of goods around the world. This trade allows for countries to sustain their economies through global trade. It also exposes consumers to new products and markets that aren't available locally.

Shipping is heavily regulated by the International Maritime Organization (IMO), which is responsible for the safety of life at sea and the marine environment. The IMO has drafted guidelines relating to safe mooring practices for vessels that are due to take effect in 2024 ([ti.nyurl.com/y8hzhrpg](https://www.ti.nyurl.com/y8hzhrpg)).

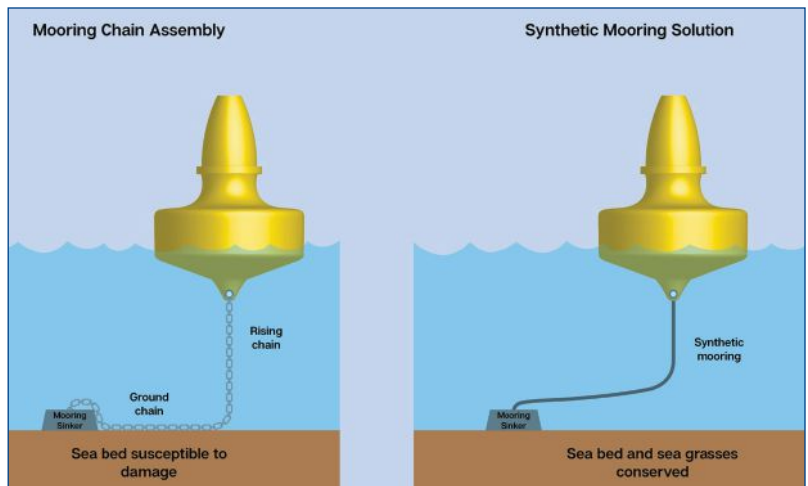
Moorings are a necessity for the safety of the shipping industry. They must be used to effectively secure commercial vessels, recreational craft and marine aids to navigation (AtoN) products. Typically, the industry uses heavy-duty chain mooring affixed to an anchor or sinker that is positioned up to a few miles offshore.

The impact that moorings have on the marine environment can be significant. They can impact water quality and seagrasses that serve as habitats for marine life.

The Significance of Seagrass

Seagrasses are a vital part of the marine environment. In a recent blog, "Green superheroes of the sea," CSIRO, Australia's science agency, discusses the positive impact seagrass has on the world's oceans. Seagrass is responsible for capturing carbon dioxide (CO₂) from the water and storing it, usually for more than 100 years. Interestingly, this is twice the amount of carbon that a tropical forest can store.

According to CSIRO, "the grasses of the sea hold the key to a low-carbon future and are helping the planet tackle climate change."



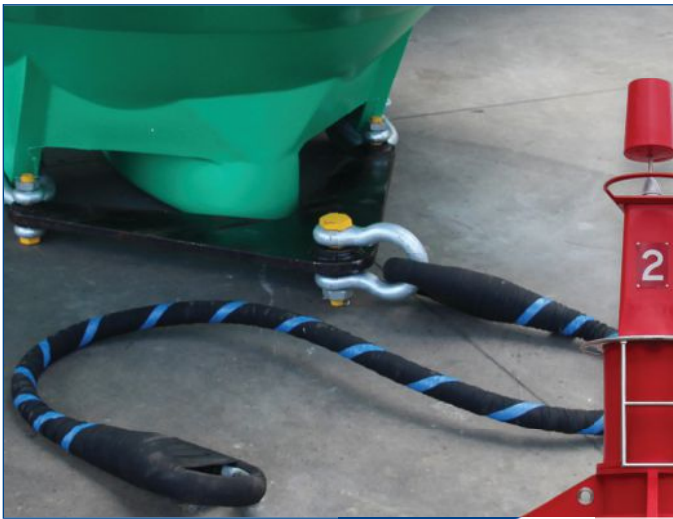
Synthetic mooring versus chain mooring.

In addition, seagrass provides food, habitat and a home for marine animals and marine organisms. Marine animals use the seagrass not only for sustenance but also as a sanctuary to help keep them safe from larger ocean predators. The habitat of the seagrass also creates a refuge for smaller fish and sea creatures, protecting them from being swept away in stronger currents.

Seagrass and their dense, wide root systems are vital to maintaining the stability of our seabeds. Their presence helps to reduce the movement of sand across the seabottom, particularly where strong currents exist, during heavy storms or strong wave activity. This is important because sand movement is related to accelerated erosion that affects coastline communities.

Finally, seagrass filters pollutants out of the water and traps fine particles and sediment. This helps to improve water clarity.

Bearing all this in mind, shouldn't we consider better mooring alternatives to help protect such a necessary resource?



er. This causes another problem, as the excessive wear requires ongoing monitoring and maintenance. Failure to do so increases the risk of the mooring breaking and the buoy coming adrift. This poses a further safety issue for mariners relying on the positioning of the buoy for navigation.

For marine animals and ecosystems, high levels of heavy metals present in seawater can impact their health. Commercial fisheries need to consider the quality of the seafood they source, with chain mooring likely affecting quality.

The research from UOW indicates that marine-friendly mooring options are a good alternative. From an industry perspective, this is also known to be the case.

Sealite's synthetic mooring solution.

Traditional Chain Mooring And Its Impact on Marine Ecosystems

The impact of chain mooring on marine environments is two-fold. The first is the instance of drag and its implications on the seabed.

When chain is used as a mooring line, it is connected to the sinker. For some distance, due to its sheer weight and allowance for drag, it lies on the seabed. An allowance for thrashing is made during installation to allow for tidal conditions. This takes into consideration the rise and fall of the chain associated with current and wave activity at that particular site.

The University of Wollongong (UOW) has been working on a long-term research project into the effects of anchor and chain scour across seafloor environments. The project is called "Dragging the Chain" and investigates the impact of ship anchoring and the use of mooring chain, in particular, its impact on the seafloor and related marine ecosystems.

In an interview with ABC Radio (tinyurl.com/yay6de4), UOW Researcher Allison Broad explains the impact of drag and the scour it leaves behind: "as the chain moves on the seafloor, damage can be significant, with the potential to change ecosystems and reduce the biodiversity in that area. Seagrass is the habitat and the nursery area for marine life, and depending on the species, can take a very long time to regenerate."

The second impact mooring chain has on marine environments is from corrosion. The marine industry normally uses galvanized steel, as it is protected by a zinc layer. This layer is better equipped to inhibit rust; however, over time, the zinc coating degrades, leaving the metal exposed to the elements.

The process of wear—and therefore corrosion—occurs more rapidly in high-salinity environments. This is particularly evident with mooring chain where the natural current causes the chain links to rub against each other.



Synthetic Mooring Solutions For a Sustainable Future

Sealite set out to source an alternative to traditional chain mooring. The new solution's objectives are: to be able withstand the high-salinity environment of the sea; to have an improved life expectancy; to be easy to maintain; and to be environmentally sustainable.

The solution is synthetic mooring, which was released to the market in 2012. Synthetic mooring is a much lighter, environmentally sensitive alternative to traditional mooring chain, ideal for many applications. Its neutral buoyancy means that the issues associated with drag and scouring of the seafloor are mostly eliminated. It allows for the seabed to be left undisturbed and provides the opportunity for seagrass to regenerate.

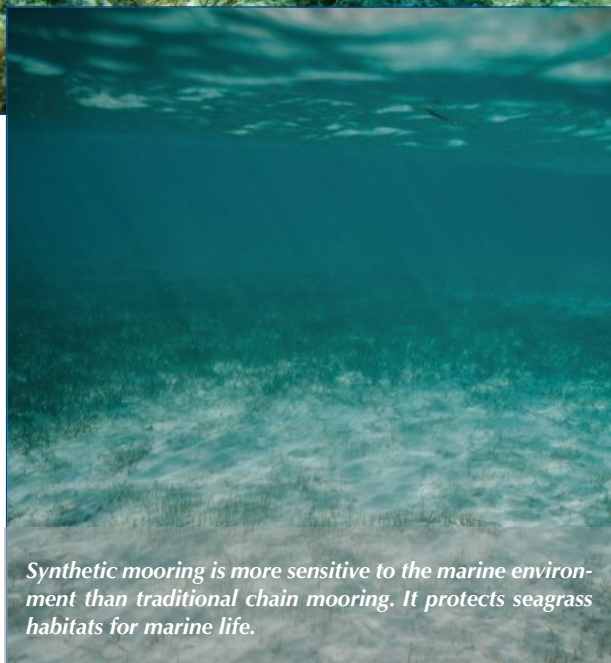
Sealite recommends the use of a cast-iron sinker instead of concrete, as it has a much smaller product footprint. Offering greater durability, iron sinkers are a better environmental choice for the long term.

The industry has begun to discover the benefits of using synthetic mooring. Many customers prefer to use it over chain, or in combination, for their installations.

While the initial commercial investment for synthetic mooring may be higher, the flow of benefits to the customer in terms of longevity, reduced maintenance and environmental consideration are significant. Customers save money due to: a reduction in service replacement; being able to commission smaller vessels due to the reduced weight of mooring; reduced occupational health and safety risk for service personnel installing and maintaining the product; and the product being quicker and easier to handle.

To assist customers, Sealite has developed an easy-to-use, online mooring calculator. This software takes into consideration the buoy model, water depth, mooring size, watch circle, wind speed, current, simulated mooring length and sinker mass. It then simulates the calculation, allowing users to visualize the effect of their selections on their installation.

Sealite synthetic mooring has been accepted for use by governments, ports and harbors, consultants, and aids



Synthetic mooring is more sensitive to the marine environment than traditional chain mooring. It protects seagrass habitats for marine life.

to navigation service providers throughout the world. We offer advice on mooring solutions in line with the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) recommendations. Over 50 different types and sizes of synthetic mooring are available. Applications include rivers, lakes, estuaries, harbors, bays and oceans. Mooring lines range from 300 mm and upward, with break strengths from 4 to 100 tonnes.

Case Study

Corporations with a sense of responsibility are striving to make better business and environmental choices. This is of particular concern to the United Arab Emirates (UAE) and Gulf Cooperation Council (GCC) because their marine environment is subject to extreme conditions. According to North West Marine, Sealite's authorized distribution partner for the UAE and Oman region, water temperatures in Dubai can reach as high as 38° C in the summer and drop to a low of 20° C in winter. These temperatures, combined with high water salinity, can create a challenge when designing project solutions. The salinity is expected to get worse in the future due to global warming and an increase in desalination. For these reasons, it is important to ensure products have a long life expectancy when exposed to these harsh conditions.

North West Marine was the first Sealite distributor to take up the synthetic mooring option. It has been supplying and installing synthetic moorings in the UAE since 2014, with outstanding results. North West Marine has deployed synthetics on at least 340 buoys, which were recently inspected and passed favorably.

"The client is so happy, they have purchased more to replace all their remaining traditional steel chain moorings," said General Manager of North West Marine Mohamad Darwish.

He said the company had been recently involved in the commissioning of AtoNs using synthetic mooring for the Dubai Harbour Project approach channel. Using a synthetic solution over chain made things much easier on the client.

"Had our client chosen to use chain on the Dubai Harbour Project, they would have needed 45 pallets at a total weight of 21 tonnes. The decision to use synthetic mooring reduced it down to just two pallets and total weight of 700 kilograms," said Darwish.

The approach channel and Sealite AtoNs will be used to guide the world's largest cruise lines safely into the Dubai Harbour cruise terminal berth. This significant project forms part of the 20-million-sq.-ft. Dubai Harbour precinct, currently under construction. **ST**

Maryanne Dutka is the product marketer at Sealite Pty Ltd.

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Autonomous LARS for AUVs

Launch and Recovery Systems Support Minesweeping in Norway

By **Henrich Henriksen • Paul Eastaugh**

When the Norwegian Defence Research Establishment (FFI) started investigating the autonomous deployment of mine-hunting AUVs, it felt natural to include detailed discussions with Henriksen AS in the process. Norway is a relatively small country, so it was not surprising that the two organizations had already enjoyed regular contacts working on a variety of projects over the years. Henriksen's Marine Division fit the needs of FFI's new project with expertise in the design and manufacture of launch and recovery systems (LARS) for fast rescue boats and naval craft.

The company is located in Tønsberg, at the southern end of the Oslo Fjord, where the company's Marine Division occupies a modern and well-equipped workshop. In recent years, the Marine Division has evolved a comprehensive range of launch and recovery systems for AUVs that have all been tailor-made to meet the customers' specific needs. The range has grown to the point where it now includes a containerized system that enables an AUV to be easily mobilized on the vessel of choice and launched directly from the container.

Background

As work on the FFI project progressed, it became apparent to the Henriksen designers that they had created a system with far greater utility than originally envisaged. Preliminary designs then began to appear for a wide range of modular systems that could be carried and deployed autonomously and could completely change the

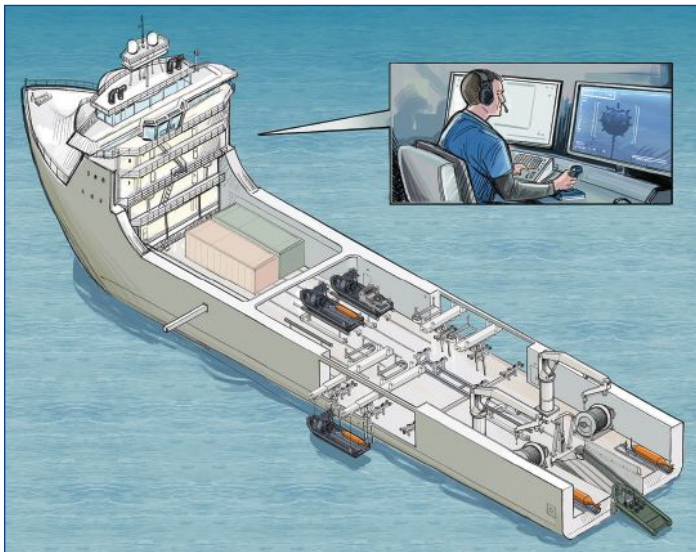


The Henriksen fully autonomous AUV launch system completing its first test successfully in the Oslo Fjord.

ways in which mines are swept.

The Scandinavian archipelago and the long Norwegian coast make marine mines a particular threat to shipping and the region's coastal communities. Norway has consequently developed considerable expertise in the techniques and technology needed to counter this threat. In common with other navies around the world, the FFI had already been looking at the use of unmanned craft for mine countermeasure (MCM) operations, as they offer the benefit of covert and efficient clearance while minimizing risks to personnel.

For this project, the Kongsberg HUGIN AUV was identified as the most suitable vehicle for conducting the underwater element. It is well proven and capable of carrying a variety of acoustic search and mapping packages.



(Top) The Henriksen AUV launch and recovery system installed aboard unmanned surface vessel during testing. (Bottom) Deployment of AUVs from a mothership carrying Henriksen LARS-equipped autonomous surface craft and boat-handling systems.

Additionally, the FFI needed a means of delivering the AUV to its area of operation. It therefore developed an autonomous system capable of navigating a fast-moving surface vessel carrying an AUV to a suspected minefield, possibly over the horizon.

Once at its destination, the system then had to be capable of launching the AUV, enabling it to search for and locate mines before recovering it and returning it to the mothership with its data—all without human intervention. Henriksen was tasked to design and build the electromechanical system that would make this happen.

The Henriksen name is known in Norway as a family of marine engineers who have been making equipment for ships since 1857. Their company has evolved through various iterations into its present profile as H Henriksen AS, which is divided into four distinct divisions. These include the REBS Division, which supplies rapid entry and boarding systems for navies and police forces, and the Sea Safety Division, which designs and manufactures rescue, oil recovery and anti-pollution systems. The other two divisions, the Marine and Underwater Systems Division and the Henriksen Hooks parts of the company, offered the most valuable expertise for the FFI project.

LARS Design

All of the previous Henriksen systems have typically been intended for deployment aboard ships and support vessels where there is manpower available to control the operations and to resolve any technical issues that may arise. In contrast, for the FFI project, the Henriksen system had to be capable of working reliably without any human intervention whatsoever. There could be no technical issues. This not only imposed high demands on the system's mechanical integrity and reliability, but also upon the software and communications links that would control it.

Because every action of the launch vessel and the AUV is performed autonomously, it is more efficient than a conventional minesweeper. Several AUVs can be de-






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(Top) Henriksen Marine Division workshop in Tønsberg. (Bottom) An AUV launch and recovery system under construction in the Henriksen Marine Division workshop.

ployed simultaneously and at a distance that eliminates any risk to personnel involved. After the surface craft has left the mother vessel, it motors at speed to the designated search area, which might be a considerable distance away, over the horizon.

Once on station, it will then launch the AUV automatically and either loiter in the area or proceed to a rendezvous point where the underwater vehicle is programmed to surface once it has completed its search. A pressure switch on the AUV detects when it has surfaced and automatically raises its Henriksen nose hook. This makes recovery of the AUV possible in rough sea conditions regardless of whether it is powered or not.

Using a radio link, the surface craft maneuvers itself so that the nose of the AUV is brought onto the stinger bed where its nose hook automatically captures a

self-tensioned winch line. This is then self-activated to pull the AUV out of the water and up onto the stinger bed. The stinger is then raised and retracted automatically bringing the AUV in-board, where it is made fast and transported to the mothership. When the launch boat is alongside the mothership, a davit is then used in conjunction with a fitted Henriksen dual point lifting hook so that it can be hoisted back onto the ship along with the launch and recovery system and the AUV.

The mechanical principle of any hook is simple enough to understand, but it can require an important degree of experience and expertise to safely implement any refinements to its function. Fortunately, Henriksen Hooks was able to support the Marine Division with the development of this vital component. It had to be totally reliable regardless of sea and climatic conditions, so the Hooks Division applied its 40 years of experience gained in the development of a wide range of off-load boat-lifting hooks. These are in use with the world's navies and with the global marine and offshore industries. They include products with features that can monitor a hook's subjected load over its lifetime, or can be released electrically at any temperature and sea condition. The over-riding principle of every hook made by Henriksen is that it must be totally reliable and must guarantee the safety of its users. Applying this principle to the recovery hook for an AUV was, therefore, reassuring for all concerned.

Work on the design of the new LARS system began in 2017 when the team, led by Remi Fjellidal, held its first meeting in the Henriksen design office in Tønsberg. It

“Because the entire launch and recovery system can also be adapted to fit any boat the operator requires it opens an entirely new spectrum of technology for navies seeking to modernize their minesweeping capabilities.”

was the first of many when the minutiae of the challenge were examined and addressed. The launching system had to support and handle an AUV measuring 5.5 m and weighing 780 kg, yet remain light enough for the entire package to be carried aboard the relatively small USV. Marine-grade aluminum was therefore used throughout, and on completion the entire system weighed just 540 kilos.

Testing

An initial trial to assess the mechanical functionality of the design was performed using a modified launch and recovery system that had been designed for bigger ships. This was soon followed by a first-generation system dedicated for use on smaller boats such as the unmanned surface vehicle designated by the FFI.

The new system was designed to optimize weight, have a lower center of gravity and reduce hydrodynamic drag when the stinger is extended into the water for AUV launch and recovery. By using the smallest boat capable of carrying the AUV and its launch system, the user benefits from lower operating costs and reduced stowage space combined with the increased maneuverability that smaller boats provide. From a naval point of view, smaller boats are also important because more can be carried aboard a mothership. This is a feature that later became important to the Henriksen design team.

For the purposes of the FFI project, the launch vessel (USV) was an 11-m Polarcirkel workboat with an inboard Volvo engine. It possessed the appearance, load-carrying ability and performance characteristics of a conventional RIB, but its side tubes were of foam-filled rigid polyethylene so it was classed as an RBB (rigid buoyancy boat). Besides being virtually unsinkable, it provided the Henriksen engineers with a sturdy work platform while they were installing and working with the new launch and recovery module.

The first test of the system was conducted in the Oslo Fjord on a clear day in May 2019 and continued over two weeks when the launch and recovery process was performed 30 to 40 times. The launch operation saw the new system's stinger extended over the stern of the boat with the AUV carried on its bed. The stinger was then tilted to position its end just under the water. At a given signal, the AUV's nose hook opened to release the retaining line, and the AUV slid down the stinger into the water to begin its mission.

Recovery of the AUV was conducted effectively from a distance using a video link aboard the USV. On surfacing, the AUV transmitted its position and heading, and the USV was directed to make a rendezvous. Even in the 1-m seas active at the time, it was possible to remotely steer the USV into position directly in front of the HUGIN. The nose hook was then caught, and the AUV was hoisted onto the stinger, which was then retracted onto the RIB for transport.

The trials were considered a success, and the stinger has since undergone some design changes for improvement. These will be assessed during a second phase of testing scheduled for summer 2020.

Adaptability

Although the system was developed around a HUGIN AUV, a key feature of the Henriksen unmanned launch and recovery system is that its unique remotely controlled nose hook can be fitted into any underwater vehicle that the user chooses to employ. Because the entire launch and recovery system can also be adapted to fit any boat the operator requires it opens an entirely new spectrum of technology for navies seeking to modernize their minesweeping capabilities.

A small squadron of unmanned surface vessels berthed aboard a mothership can be equipped to accept any one of a range of autonomous task modules.

These might include a minesweeping module with cables, generator and deck handling gear needed for deployment, a winch for handling sweep cables, anti-submarine detection hardware, and even drone deployment and recovery.

For coastal states without the resources to finance a substantial surface fleet, autonomous systems using Henriksen's interchangeable equipment modules could answer the need to apply the latest defense technology. **ST**

Henrich Henriksen is president and business development director for H Henriksen AS. He joined the company's management team 20 years ago and is a fifth-generation member of the family business. A mechanical engineering graduate from Glasgow University, he began his career developing underwater robotics with the Norwegian Defence Research Institute.

Paul Eastaugh is a professional writer and PR consultant based in the U.K. who specializes in working for organizations in the marine and offshore industries. He has over 30 years of experience in presenting all aspects of marine technology and commerce for both professional and generalist audiences.

international

Greensea Expands to Europe

Greensea Systems Inc. is expanding its international presence to meet increasing customer demand for its open-architecture navigation, control, autonomy and human-machine interface technology. Wight Ocean Ltd. will now represent Greensea products to a growing number of customers across Europe. This will include the Greensea INSpect GS inertial navigation system and EOD Workspace software.

Temporary Free WISTA Membership

The Women's International Shipping and Trading Association (WISTA) has a new initiative aimed at seafarers. WISTA Norway, WISTA UK, WISTA Singapore, WISTA Brazil and WISTA Argentina have come together to offer free WISTA membership for seafarers through August 31, 2020. Membership allows seafarers to access the largest network of female managers in the shipping industry, as well as online seminars, webinars and workshops.

Successful Remote Audits for Thome

The Thome Group has successfully undergone a series of remote audits with DNV GL in various locations due to coronavirus-related lockdown restrictions around the world. Thome Mumbai office's annual ISO 9001:2015 audit was performed online using video conferencing software. This was the first remote inspection that Thome had carried out, and it encouraged the group to use the digital option for other audits, including the annual Document of Compliance (DOC) surveys for Thome Ship Management, Thome Shipping and Thome Offshore Management.

First Sail Using Airkeel

For the first time ever, a vessel has sailed using an airfilled keel that automatically limits heeling. Dacoma's unique swing keel, Airkeel, was put to the test under a Tuco vessel in Faaborg Harbor with only its inventor on board. An airfilled keel, which swings in tune with the waves and counteracts heeling, has completed its maiden voyage underneath a 7-m hull from the Tuco shipyard.

Drawing 1.5 m below the boat, the keel's lower part is a hollow, oblong compartment filled with air. The keel automatically swings from side to side. Its movements are controlled by the keel's computer and Dacoma software.

Cargotec Commits to UN Climate Goal

Cargotec has committed to the United Nations Global Compact's Business Ambition for 1.5° C, joining leading companies in a promise to pursue science-based measures to limit global temperature rise to 1.5° C.

By making this commitment, Cargotec strives to mitigate climate change by making the logistics industry more efficient and developing solutions to enable a low-carbon economy.

The commitment will be validated by the Science Based Targets initiative.

Lubrizol Joins Zero-Emissions Effort

The Lubrizol Corp. has become the first lubricant additive technology supplier to join the Getting to Zero Coalition. An international group currently endorsed by 14 governments and composed of more than 100 organizations, it aims to drive the development of commercially viable, zero-emissions deep-sea ships by 2030. This partnership between the Global Maritime Forum, the World Economic Forum and Friends of Ocean Action boasts leading shipowners, ports, technology providers and fuel companies, as well as academic and research institutions.

Formal Crew Changeover Process in Cyprus

The Cyprus Shipping Deputy Ministry (SDM) formally announced a new process to facilitate crew changes during the COVID-19 pandemic. Three conditions must be met: isolation (people arriving in Cyprus by aeroplane have been subject to self-isolation conditions for 14 days before arrival); negative coronavirus test; and logistics management (the company or agent arranging the crew change is entirely responsible for arranging the transfer of all seafarers between the vessel and the airport, taking all the necessary precautions).

The relevant decrees issued by the Ministry of Health also permit the long-term stay in anchorage of vessels, including cruise ships.

Bibby Hydromap Fleet, Assets for Sale

Gordon Brothers, a global advisory, restructuring and investment firm, has been instructed by KPMG to market for sale the modern and fully equipped marine survey vessel fleet of Bibby Hydromap Ltd., together with the extensive inventory of marine survey and test equipment and associated assets. Gordon Brothers are partnering with Offshore Shipbrokers Ltd. (OSL).

Aqueos Turns 20

Aqueos Corp., a provider of subsea services to the Gulf of Mexico and Pacific Coast, celebrates its 20th year in the marine construction, commercial diving, ROV and vessel services industry.

"It has been an unbelievable journey from our beginnings as a small company primarily servicing the California offshore market to a much larger, more diverse company with multiple service lines, increased assets and an expanded geographic footprint," said Ted Roche, Aqueos president/CEO.

Ritchie Navigation Reopens

Ritchie Navigation, the world's largest and oldest manufacturer of magnetic compasses, according to the company, reopened in May after a mandatory COVID-19 closure in Massachusetts. During the closure, Ritchie received compasses in need of maintenance or repair and continued to take orders. Preceding the mandate, Ritchie ramped up manufacturing to prepare for reopening.

For 160 years, Ritchie Navigation products have guided generations of professional mariners and recreational boaters.

Partnership for Dive Technologies' AUV

Dive Technologies Inc., a Boston-based subsea robotics designer and manufacturer, has entered into a formal partnership with the Center for Marine Autonomy and Robotics at Virginia Tech.

This multi-year partnership will directly support the rapid development and testing of Dive Technologies' large, novel AUV. The commercial product is on schedule for sea testing this summer.

E-Book to Prepare for Shipbuilding's Future

Denis Morais, SSI's co-CEO, has a new e-book available: "Navigating the Transformations Coming to Shipbuilding" (tinyurl.com/yaezr2dc).

Implementing new technologies always has great potential, but truly successful shipbuilders ensure that any change to processes doesn't impact the business today, or the ability to meet a coming deadline. The key to consistently seeing a quick ROI is that incremental approach.

Bollinger Delivers Fast Response Cutter

Bollinger Shipyards LLC has delivered the USCGC *Myrtle Hazard* to the U.S. Coast Guard in Key West, Florida. This is the 162nd vessel Bollinger has delivered to the U.S. Coast Guard over a 35-year period and the 39th fast response cutter (FRC) delivered under the current program. The vessel is the first of three FRCs to be homeported in Apra Harbor, Guam, increasing the presence for the U.S. Coast Guard in the Indo-Pacific Theater.

Progress on Savannah Harbor Expansion

The deepening of the Savannah Harbor has set a new precedent with four dredges working simultaneously, the U.S. Army Corps of Engineers announced. The Savannah Harbor Expansion Project (SHEP) includes two dredges keeping the channel at its current authorized depth of 42 ft., followed by two dredges taking the channel to its new depth of 47 ft. The dredges work without disrupting the flow of commercial traffic.

Grant for Sensor Technology

The Women Entrepreneurship Fund has awarded Sensor Technology Ltd., a custom piezoelectric and hydrophone producer, a \$100,000 grant to support the expansion of the company into Atlantic Canada. The Women Entrepreneurship Fund supports Canada's vision to encourage and elevate female entrepreneurs.

Investment Advising for Port Facility

Harris Williams, a global investment bank specializing in M&A advisory services, has advised Carolina Marine Terminal Inc. (CMT), a privately owned port facility, on its investment from Transportation Infrastructure Partners, a joint venture between Ridgewood Infrastructure and Savage. The transaction represents a successful outcome despite today's uncertain market. **ST**



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High-Torque Pan and Tilt



Designed as a variation of the miniature Hammerhead, the Hammerhead XT is suitable for applications on ROVs, HOVs, ASVs, landers and fixed platforms. The standard 316 SS unit can be supplied in 6061 aluminum for weight-critical applications. The Hammerhead and Hammerhead XT are available as single-axis rotators. Arctic Rays LLC.

GNSS Receiver

LD900 is a marine-certified receiver that can track four GNSS frequencies simultaneously to ensure a precise position is always available at sea. When combined with Apex5 correction services, it delivers accuracy levels as precise as 5 cm (95%) to provide robust positioning for the most challenging applications, including deepwater drilling, seismic, construction and survey. VERIPOS.

Safe Hydrocarbon Storage

DryFoam is a UL certified nonwater fire prevention solution that is designed to suppress up to 98% of vapors, thus protecting people and property from fire. It is completely passive and works with most flammable liquids, including crude oil, gasoline and alcohol. Trelleborg AB.

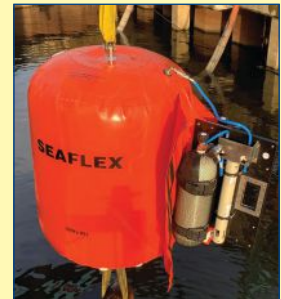
Dual Redundant Radar Tracking

Updated SPx Tracking Server supports high-reliability radar tracking by protecting against system failure via two processing paths for the radar data, allowing automatic switching from one to the other. It is designed for developers of high-reliability or remote systems in maritime and coastal surveillance applications. Cambridge Pixel.

Omni-Directional Sector Lantern

ODSL offers a range of 7-11 nautical mi., far greater than comparative ODSL models on the market. The small form factor ODSL provides up to 2,600 cd in white and includes high-quality LEDs and enhanced refractive optics to project light where needed. Sealite Pty Ltd.

UXO Recovery System



UXO-LSDS is an unexploded ordnance lifting and safe disposal system for contactless mine recovery. It has housing for two 9l, 300-bar composite cylinders and a Sonardyne acoustic lightweight release transponder. Working with known UXO weights and water depths, the UXO-LSDS can be precisely filled to begin UXO recovery, with excess air vented from the pressure release valves. Unique Group and Bodac.

Port Management Solution

In light of the current coronavirus pandemic, work is required to be performed remotely where possible, while the maritime industry still needs to keep vital supplies moving. The Marlin SmartPort is designed to share key information and, as a cloud-based solution, can be fully deployed with zero footprint. ION.

Electric Cutter Suction Dredger

ECSD 650 is powered by electric motors for zero-emissions dredging.

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ing projects. The electric power provides a significant reduction in noise, adding an extra tier of sustainability and ensuring the dredger's suitability for projects in densely populated and environmentally sensitive areas. Damen Shipyards Group.

Shortwave Infrared Camera

Phoenix is a 640 x 512-pixel SWIR camera with the industry's smallest VGA sensor and an extremely small 5- μ m pixel pitch. The revolutionary sensor is ideally suited for broadband imaging and daylight and night-time laser see-spot and range-gated imaging. Attollo Engineering LLC.

Propeller with More Efficiency



Sharrow Propeller Model MX-1 is 9-15% more efficient than the industry standard Wageningen B-Series design and has higher top speed, better handling, reduced vibrations and greater strength. It is available in a custom-made, CNC-machined model (aluminum or stainless steel). A mass-produced version will roll out in spring 2021. Sharrow Marine LLC.

Laser Detection and Ranging

A laser-based navigational aid, LADAR combines long-distance object detection with high-accuracy measurement, giving users a full 2D/3D/4D (3D plus time) perspective for optimal maritime awareness. Its water-penetrating capabilities enable very high-resolution detection of objects in the surface layer up to approximately 1.85-km distance and up to 10-m depth in ideal conditions. Ladar Ltd.

Addition to Cylinder Oil Range

Mobilgard 540 X is a lubricant specifically formulated for use with both 0.10% and 0.50% sulphur fuels and LNG. It is designed to meet

the advanced cleanliness and protection needs of newer engine designs. ExxonMobil.

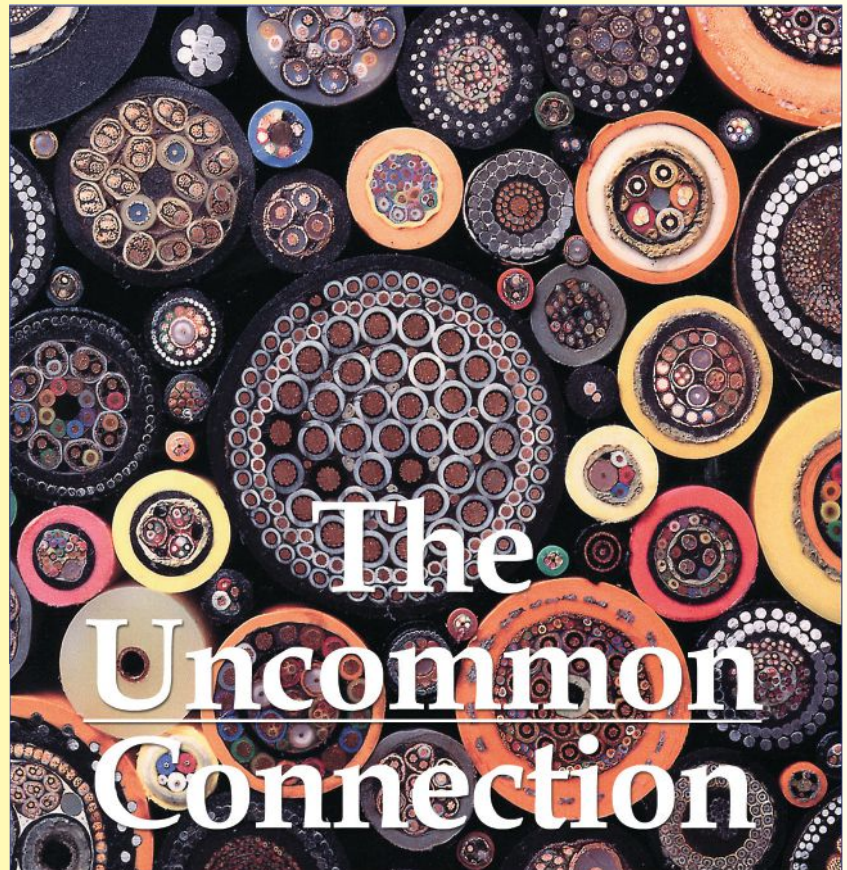
Global Raster Chart Data Set

Raster Chart XL Oceans (RCXL Oceans) is a fast service that is widely accessible using most GIS software. It enables access to global nautical charts in desktop and web GIS environments. RCXL Oceans is ready to be paired with the us-

er-preferred land mapping data set, e.g., Google Maps. OceanWise Ltd.

Subsea Clamping Cylinder

Designed for fully automatic bend stiffener connectors, the clamp can be used for up to 25 years. It offers powerless holding operation and easy installation with no need for manual work by divers. It can withstand forces up to 120 tons. Bosch Rexroth AG. **ST**



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Philly Shipyard to Construct National Security Multi-Mission Vessel

The U.S. Maritime Administration (MARAD) has announced that TOTE Services LLC has selected Philly Shipyard Inc. of Philadelphia, Pennsylvania, to construct the newest class of training ship, the National Security Multi-Mission Vessel (NSMV). The shipyard will construct up to five new ships to provide world-class maritime training for America's future mariners and to support humanitarian assistance and disaster relief in times of need.

Following construction and delivery of the ships to TOTE Services, the vessels will be transferred to MARAD. The NSMV will feature numerous instructional spaces and a full training bridge, and have space for up to 600 cadets to train in a first-rate maritime academic environment at sea. The NSMV will also be available to support federal government efforts in response to national and international disasters such as hurricanes and earthquakes in its role as a National Defense Reserve Fleet vessel.

Members of Congress Ask GAO About Federal Response to HABs, Hypoxia

Eleven members of Congress sent a bipartisan, bicameral letter to the Government Accountability Office (GAO) Comptroller Gene Dodaro requesting the examination of multiple issues concerning the federal government's response to harmful algal blooms (HABs) and hypoxia, including how it is helping state and local governments address the problem, what adaptation methods are being employed, and what are the plans for studying and addressing the role of climate variability and extreme weather events in exacerbating HABs and hypoxia.

"Federal agencies, along with states, international organizations, and others, play a significant role in researching, forecasting, monitoring, and responding to HABs and hypoxia," the letter says. "As federal agencies continue to conduct HAB and hypoxia-related activities to address these growing threats to our nation's public health, environment, and economy, Congress must ensure that taxpayer dollars are used effectively and efficiently."

EMEC Weighs in on US Ocean Energy

The European Marine Energy Centre (EMEC) has strengthened its international collaboration with the United States by contributing ocean energy expertise into the 2019 Project Peer Review Report released by the U.S. Department of Energy (DOE).

The 2019 Peer Review was conducted by a review panel coordinated by DOE's Water Power Technologies Office (WPTO), which focuses on research and development efforts to accelerate the development and deployment of innovative technologies for clean power generation from resources including hydropower, waves and tides.

The report provides a review of the marine hydrokinetic (MHK) and hydropower programs.

Conducted every two years, the Project Peer Review is a key tool offering a holistic understanding of where U.S. research and development efforts are being focused.

WWII Merchant Mariners Receive Congressional Gold Medal

On Maritime Day in May, the U.S. Department of Transportation and the Maritime Administration (MARAD) honored the men and women who serve the industry "in peace and war," while paying a special tribute to World War II merchant mariners.

President Donald J. Trump recently signed the Merchant Mariners of World War II Congressional Gold Medal Act of 2020, awarding "a Congressional Gold Medal, collectively, to the United States merchant mariners of World War II," in recognition of their dedicated and vital service during that conflict.

This year marks the 75th anniversary of the Allied victory in World War II. During the war, U.S. merchant mariners sailed dangerous seas prowled by enemy vessels to maintain vital supply lines.

FEMA, MARAD Provide Cloth Masks to Ports

Federal shipments of 2.4 million reusable cloth facial coverings have begun to ports and related maritime transportation operations around the U.S. that requested them, thanks to the urging of the American Association of Port Authorities (AAPA) and port industry partners, including the U.S. Department of Transportation's Maritime Administration (MARAD). The face masks are being distributed to about 400 maritime transportation entities for use by essential personnel, including those working at seaports, inland ports, marine terminals, tug and barge lines, vessel pilot groups, dredging operations, supply chain logistics companies and others. The masks are part of a Federal Emergency Management Agency (FEMA) multi-prong approach to keep essential businesses working while limiting the spread of coronavirus (COVID-19).

Senate Bills on Maritime Emissions, Cybersecurity

Sen. Edward J. Markey (D-Mass.), ranking member of the Senate Commerce Subcommittee on Security, introduced two maritime bills in advance of the annual Maritime Administration Reauthorization Act's consideration by Congress.

The first bill, the Expanding Maritime Environmental and Technical Assistance Program Act, supports research on zero-emission port and vessel technologies. The legislation specifically authorizes an additional \$3 million for the Maritime Administration's Maritime Environmental and Technical Assistance Program to research and support activities related to zero-emission technologies.

The second bill, the Enhancing Maritime Cybersecurity Act, increases awareness of cyber risks and best practices for security in the maritime sector. The legislation specifically instructs the Maritime Administration to work with the Coast Guard and Department of Homeland Security to ensure the availability of resources that can help maritime operators identify, detect, protect against, respond to and recover from cyber incidents. **ST**

offshore oil & ocean engineering

Deepwater Horizon Review

Ten years ago, a powerful explosion destroyed an oil rig in the Gulf of Mexico, killing 11 workers and injuring 17 others. Over a span of 87 days, the *Deepwater Horizon* well released an estimated 168 million gallons of oil and 45 million gallons of natural gas into the ocean, making it the largest accidental marine oil spill in history.

Researchers from the Woods Hole Oceanographic Institution (WHOI) quickly mobilized to study the unprecedented oil spill, investigating its effects on the seafloor and deep-sea corals and tracking dispersants used to clean up the spill.

In a review paper published in *Nature Reviews Earth & Environment*, WHOI marine geochemists Elizabeth Kujawinski and Christopher Reddy review what they and their colleagues from around the world have learned from studying the spill over the past decade.

The key takeaways are: some coastal ecosystems around the Gulf of Mexico recovered, but in areas such as deep-sea coral communities, the oil, gas and chemical dispersants combined with other stressors to create long-lasting impacts; gene analysis tools, used on a wide scale for the first time, provided unprecedented insights into which microbes consumed oil, gas and dispersants in marine ecosystems; advanced chemical analysis showed for the first time that weathering on the ocean surface, particularly by sunlight and oxygen (photo-oxidation), changed the composition of oil but reduced the effectiveness of dispersants applied to the surface; and the spill science community can be most effective by working collaboratively across academia, industry and government in the event of future oil releases in the deep sea and high latitudes.

Australia Development Work

TechnipFMC has been awarded an integrated engineering, procurement, construction and installation (iEPCI) contract by Woodside Ener-

gy Ltd. for the development of the Lambert Deep and phase three of the Greater Western Flank fields, located offshore northwestern Australia. TechnipFMC will design, manufacture, deliver and install subsea equipment, including a subsea production system, flexible flowlines and umbilicals for connection to the Angel platform.

This is the second contract under the recently announced five-year iEPCI frame agreement between TechnipFMC and Woodside.

Remote Data Harvesting

Sonardyne International Ltd. and XOCEAN have successfully completed a live seabed-to-shore data-harvesting mission using a USV for A/S Norske Shell as part of a seabed monitoring campaign at the giant Ormen Lange field offshore Norway. The project was completed without a single person having to travel offshore or from their home office.

An XOCEAN XO-450 USV harvested data from an array of Sonardyne's Fetch pressure monitoring transponders, which accurately collect pressure, temperature and inclination data at the seafloor at preprogrammed intervals. Using the data, any vertical displacement of the seabed can be calculated. The data will help Norske Shell to proactively inform its reservoir management strategy.

Antiviral Snood to Protect Against Coronavirus

Safety specialist Survitec is supplying the offshore oil and gas sector with the Virustatic Shield antiviral snood, following calls for better protection for offshore workers during helicopter transfer to and from their workplace.

Oil & Gas UK (OGUK), the representative body for the U.K. offshore oil and gas industry, has been working with Survitec on the use of a snood-type face covering for the U.K.'s offshore workforce through its Pandemic Steering Group. The snood incorporates an antiviral

coating to neutralize 96 percent of airborne viruses and reduce the risk of cross-contamination.

Integrated Rig Services Off South America

Oceaneering International's Remotely Operated Survey (ROS) group has successfully completed an integrated rig services campaign for a major operator offshore South America and recorded a milestone 150,000 hr. of ROS operations with 99 percent uptime and no client operations or vessel downtime.

Oceaneering was contracted by Apache Corp. to provide these services on the *Noble Sam Croft* drillship. The workscope included the provision of ROS, ROV and ADCP for a potential three-well campaign.

Competence Assessment Tool

Kongsberg Maritime's K-CAT (KONGSBERG Competence Assessment Tool) is receiving positive reports from Siem Offshore. An innovative digital tool that enables personnel assessments to be carried out online, K-CAT's abilities range from pre-employment evaluation through to crew competence verification. It is available via all computers and smart devices with an internet connection and can be configured in offline mode.

K-CAT's range of competence assessments can determine how well personnel understand dynamic positioning (DP) systems, as well as gauging the knowledge level and practical expertise of DP operators.

Nigeria Multibeam Survey

TDI-Brooks International Inc., under contract to TGS, has completed a multibeam-phase survey offshore the Niger Delta at 750- to 3,500-m depth. This is Nigeria's first regional multi-client multibeam and seafloor sampling study.

TDI-Brooks' RV *Gyre* acquired 82,000 km² of high-resolution, hull-mounted multibeam echosounder data. A total of 1,223 active hydrocarbon seeps were detected. Hydrocarbon seep analysis was conducted in near real time on board the vessel to expedite the process of core selection. **ST**

ASI Expands LiDAR Portfolio

Teledyne Optech, specializing in advanced LiDAR sensors, has signed an agreement with Aerial Surveys International (ASI) to sell a Galaxy T2000, upgrade an existing Galaxy Prime to a Galaxy T2000, and install both sensors in the productivity-doubling G2 sensor system. By combining both sensors on the G2 sensor system, ASI will bolster its capacity to a true, effective 4 million points per second that provides unmatched point density with the highest available efficiency, according to the companies.

The Galaxy T2000 is engineered to point all its 2 million laser shots per second to the ground within a programmable field of view. With faster scanning at up to 320 lines per second and the smallest laser footprint, the T2000 is ideal for applications involving small-object identification.

ChartWorld Partners with JRC

ChartWorld is cooperating with JRC on the addition of ChartWorld's Information Overlay service, known as CIO+, onto JRC ECDIS.

CIO+ is a data overlay shown in ECDIS as a user chart, loaded on top of electronic navigational charts. CIO+ is a tool to help the bridge team with the task of developing and executing efficient voyage plans by automating the process of applying additional data in ECDIS by means of user chart objects.

CIO+ enhances crew efficiency and voyage plan accuracy and provides onshore teams with increased oversight of navigational planning and risk management.

Cybersecurity Classification For New LNG Carrier

France LNG Shipping SAS (jointly owned by NYK and Geogas LNG) has taken delivery of the *Elisa Larus* from Hyundai Samho Heavy Industries in South Korea. The 174,000-cbm gas carrier is classed by Bureau Veritas (BV) and has been awarded a BV cybersecurity notation. The BV cybernotations provide procedures

and methodologies to address design and operational requirements for cybersecurity in compliance with IMO 2021 requirements, as well as the new IACS recommendation 166.

Connectivity Combo

Telenor Satellite, a European satellite operator, has approved Intellian's v85NX antenna after successful sea trials. It will be used with Telenor Satellite's THOR 7 Anker Maritime Ka-band service.

THOR 7 serves clients with premium VSAT connectivity across Europe. Even for smaller antennas, its highly focused spot beams make it an ideal choice for operators throughout the main European sea routes, from the Barents Sea in the north to the Mediterranean Sea in the south.

The combination of THOR 7 and the v85NX series of antennas is a competitive choice for excellent connectivity paired with a high-quality, compact antenna that requires low capital and operational expenditure. The size and weight of the antennas make them easy to install, and there is a step-by-step commissioning wizard built into the antenna management and control software.

Dual-Fuel Engine Approval

WinGD (Winterthur Gas & Diesel) has received type approval for what the company calls the biggest and most powerful LNG-fueled engines ever built. Class society Bureau Veritas awarded the approval for WinGD's dual-fueled 12X92DF engines, the first series of which is currently being built by China State Shipbuilding Corp. (CSSC) and will power nine ultralarge container ships (ULCS) owned by the CMA CGM Group, a shipping and logistics business.

These vessels will become the largest container ships powered by liquefied natural gas, and they represent a significant step on the path to the energy transition of the shipping industry.

The type approval was awarded following a series of extensive full-load tests in diesel and gas operation and has brought the use of LNG as a marine fuel into an entirely new vessel sector, said WinGD.

Partnership for Wireless Tech in Offshore Systems

WFS Technologies (WFS) has joined forces with Subsea Energy Solutions (SES) to harness their combined global expertise and range of live condition-monitored cable protection systems for the offshore energy industry. The collaboration will see WFS utilize its smart wireless Seatooth technologies, which provide real-time insight in extreme environments, with SES's offshore cable and subsea umbilical, riser and flowline protection systems.

Together, the firms aim to help the industry further extend asset life and boost productivity by reducing costs and increasing efficiencies while cutting its carbon footprint. They also anticipate increasing their marketshare in new areas across oil and gas, offshore wind and marine energy (wave, tidal and river).

Naval Dome Warns of Pandemic Cyber Vulnerability

The coronavirus pandemic is leaving the maritime and offshore energy sectors vulnerable to cyber attack, with Naval Dome citing a massive 400 percent increase in attempted hacks since February 2020.

An increase in malware, ransomware and phishing emails exploiting the COVID-19 crisis is the primary reason behind the spike, said Naval Dome.

The global crisis and social distancing measures are preventing OEM technicians from flying out to ships and rigs to upgrade and service critical OT systems, resulting in operators circumventing established security protocols, leaving them open to attack. IT and OT systems are no longer segregated, and individual endpoints, critical systems and components may be susceptible. Some of these are legacy systems that have no security update patches and are, thus, even more susceptible to cyber attack. **ST**

environmental monitoring

Port-Log Monitoring Expands to Bangladesh

OceanWise was contracted recently by Next Generation Graphics Ltd. (NGGL), working for the Bangladesh Inland Water Transport Authority (BIWTA), which controls, manages and develops the inland water transport capacity of Bangladesh. NGGL was chosen to supply, install and maintain water level gauges at 53 locations across the inland waterways network, including tidal and nontidal waters. OceanWise was selected to provide the data telemetry, management and visualization components for the project.

Port-Log, OceanWise's commercial off-the-shelf environmental monitoring platform, was installed at BIWTA's offices in Dhaka to collect, manage and display the data gathered from the extensive network of tide gauges. Port-Log is popular across the ports, harbors and energy sectors. This project extended Port-Log's capability to include nontidal waters.

Update on AZFP Recovery From Lake Victoria

In 2019, Dr. Laura Hobbs (University of Strathclyde and Scottish Association for Marine Science) and Dr. Roland Proud (University of St. Andrews) won the ASL Environmental Sciences annual early-career scientist competition to obtain, free of charge, an acoustic zooplankton fish profiler (AZFP) to study fisheries ecology in Lake Victoria (East Africa). The instrument was deployed in the deepest part of the lake (circa 70-m depth) in November 2019.

Proud and Professor Andrew Brieler (University of St. Andrews) returned to Uganda in February 2020 to recover the AZFP. As part of the trip, they ran an acoustics course with 20 fisheries scientists from the Lake Victoria Fisheries Organisation (LVFO, Uganda); Tanzania Fisheries Research Institute (TaFIRI, Tanzania); Kenya Marine and Fisheries Research Institute (KMFRRI, Kenya); and the National Fisheries Resour-

ces Research Institute (NaFIRRI, Uganda). Participants learned how to process AZFP data, converting raw files into echograms using Python and Echoview.

Preliminary analysis of the data revealed patterns in the vertical movement of organisms in the water column and the complex interplay of predator-prey interactions during daily and seasonal cycles.

Back in the U.K., Proud and Hobbs are working on the data to answer key ecological questions linked to the Lake Victoria fishery, which supports more than 35 million people in East African communities. They hope that this work will lead to future deployments in the lake and further collaboration with local scientists.

C-FLUOR for Algal Culture Growth Monitoring

Monitoring algal growth in test tubes without affecting algal cultures is a challenge for researchers. Turner Designs recently demonstrated a solution using two of its standard products.

Multiple algal cultures were diluted to low concentrations of chlorophyll. Cultures were evenly distributed into 25-mm-diameter glass test tubes and placed in a room-temp environment near a window for exposure to natural light. Growth was monitored using Turner Designs' C-FLUOR chlorophyll probe with C-FLUOR in-line adaptor. Daily measurements were made and test tubes were returned to their original location near the window for continued natural light exposure. These measurements were repeated until each C-FLUOR probe's response saturated.

C-FLUOR probes output a voltage response proportional to the fluorescence detected. The C-FLUOR in-vivo chlorophyll blue excitation probe was used to measure the algal test tube cultures. Turner Designs Databank handheld data logger was used to display voltage. Maximum concentrations detected ranged from 90 to 183 µg/L and

were plotted for five of the 12 cultures monitored.

Growth data can help determine ideal conditions for growth, calculate growth rates, or monitor densities for feeding experiments. Other sensors from the C-FLUOR product line can also be used to monitor for pigments such as phycocyanin or phycoerythrin, which may indicate contamination of algal cultures.

Wave Sensor to Monitor Great Lakes

At the confluence of Lakes Michigan and Huron, strong and ever-changing currents produce intense wave-current interactions, coupled with complex wave fields approaching from both lakes. SeaView's multidimensional SVS-603 wave sensor is ideal in this environment.

Michigan Tech's Great Lakes Research Center (MTU-GLRC) operates four data buoys in the Great Lakes and uses the SVS-603. At the end of the 2019 season, SVS-603 SD card data were collected to determine if there are more optimal sensor settings to achieve improved wave statistics.

For the 2019 season, the low-frequency noise filter employed by GLRC's SVS-603 sensors was the widely accepted Lang filter. However, an unidentified low-frequency noise source still produced anomalous spikes in the significant wave height and period data of the Straits Buoy. SeaView took the acceleration data saved on board the sensor and honed in on the best sensor settings to recommend to GLRC for future deployments.

Tracking Fishing Gear Pollution in Europe

In European waters, more than a third of plastic pollution comes from fishing equipment.

As part of the European Connected Ocean initiatives to map and digitize seas, CLS, supported by IFREMER and CNES, is launching a groundbreaking program to track fishing gear by satellite in partnership with a fishing association specializing in the circular economy and recycling. **ST**

Davit Systems for French Navy

Boat-handling systems supplier Vestdavit has won a tender from Chantiers de l'Atlantique to supply davit systems for four new logistic support ships due for delivery to the French Navy under the FLOTLOG (Flotte Logistique) program. The modern, double-hulled vessels will ultimately replace the Navy's current, single-hulled LSSs and will be deployed to support France's blue-sea combat fleet commitment to OCCAR (Organisation for Joint Armament Cooperation).

Vestdavit will supply two PLD-6000 A-frame davits for interception craft and a single PL-3600R davit for fast rescue per ship to ensure safety and crew comfort in missions worldwide in unforgiving seas. With the first vessel to be handed over by the end of 2022, deliveries will be completed by 2029.

Electrical Fitout for Mexican Navy Patrol

Alewijnse Marine has completed the electrical fitout of the Mexican Navy's latest vessel, the Long Range Ocean Patrol (POLA) ARM *Reformador*. Built with Damen Shipyards and its suppliers, the vessel was constructed as five separate modules; three in Mexico and two in the Netherlands, before final assembly in Mexico.

The electrical workscope included engineering, supply and installation of equipment, project coordination and supervision, and commissioning.

Naval Assurance for Type 31 Frigate

Lloyd's Register (LR) has been selected to provide naval assurance services for the U.K. Ministry of Defence's (MoD) Type 31 General Purpose Frigate program. The five new vessels will be designed and constructed to LR's Naval Ship Rules. During the first phase of the program, LR will provide design assessment and support, which will result in formal appraisal of the Type 31 design in 2020. During the later phases, LR will assist Babcock to ensure it is fully integrated with the shipyard's digital acceptance systems and that supply chains effectively implement project requirements for equipment certification. The first Type 31 frigate is scheduled to be in the water in 2023. The Type 31 frigates will replace some of the Type 23 frigates in the U.K. Royal Navy's fleet.

EvoLogics Approved for US Navy Divers

EvoLogics underwater acoustic modems were recently listed as Authorized for Navy Use (ANU), following a lengthy period of testing and technical evaluation by Naval Sea Systems Command (NAVSEA) and the Emergency Ship Salvage Material (ESSM) System. The ANU Program provides a list of selected diving equipment, tools and accessories that have undergone design safety reviews, testing and evaluation to ensure diver safety and acceptability. EvoLogics' USBL positioning system was investigated for potential use in locating fuel tanks on the wreck of the *Prinz Eugen*, a German battleship sunk in 1946 at Bikini Atoll.

General Atomics to Support Ford-Class Carriers

General Atomics Electromagnetic Systems (GA-EMS) has been awarded a contract for ongoing engineering and logistics sustainment of *Gerald R. Ford*-class Electromagnetic Aircraft Launch Systems (EMALS) and Advanced Arresting Gear (AAG) systems by the Naval Air Systems Command, Patuxent, Maryland. GA-EMS will provide critical engineering, technical, configuration management and program support.

Forum ROV Trials in Vietnam

Forum Energy Technologies' Perry XLX-C ROV has successfully completed harbor trials in Vietnam. It is a compact, heavy-duty, work-class hydraulic ROV with a depth rating of 4,000 m.

Working with customer Submarine Manufacturing & Products (SMP) and the Vietnam Navy, the trials followed an extensive commissioning period and factory acceptance test that took place at Forum's test tank in Kirbymoorside, Yorkshire, U.K.

L3Harris to Provide DC Switchboards For South Korea Navy

L3Harris Technologies has been awarded a contract to manufacture and deliver DC switchboards for the Republic of Korea's Navy submarines.

L3Harris will supply direct current (DC) switchboards that provide 900-volt DC power from the ship's generators and batteries to the propulsion motor and other vital ship service loads.

This award is a fully funded contract, with the final delivery scheduled for June 2022. **ST**

contracts

RTsys', Caudan, France, RUBHY Buoy has been chosen to execute measurements on radiated noise emitted by ships for advanced design studies and R&D. Undisclosed.

Teledyne CARIS, Fredericton, Canada, has been selected to provide CARIS BASE Editor for generalization of bathymetric data in nautical charts. Swedish Maritime Administration.

Alfa Laval, Lund, Sweden, will help resolve steam balance and redundancy issues connected to sulphur-compliant fuels with an integrated steam boiler plant comprising oil-fired steam production, waste heat recovery, advanced control and connectivity. It will be implemented on eight Seaspan-owned large container ships. Seaspan Ship Management.

Lloyd's Register (LR), London, England, has signed an agreement to approve a Machinery Planned Maintenance and Condition Monitoring Scheme (MPMS(CM)) via remote audit for 25 LR-classed vessels. This will be performed in accordance with LR's recently updated Shi-

pRight procedures for Machinery Planned Maintenance and Condition Monitoring, helping optimize maintenance schemes. Euronav.

Planet Ocean Ltd., Camberley, England, has signed an exclusive representation agreement for undersea situational awareness equipment, including high-definition cameras, electric pan and/or tilt positioner systems, underwater lighting and projection lasers. SIDUS Solutions LLC.

Dave Perham, Geraldton, Australia, of Australia's western rock lobster fishery has taken delivery of a new lobster boat with much lower fuel consumption than comparable vessels. Dongara Marine.

Ashtead Technology, Houston, Texas, will provide subsea survey and ROV equipment across the CARICOM region to support offshore drilling, field development, IRM and decommissioning projects. Reliance Subsea Services Ltd.

Korean Register, Busan, South Korea, has signed a memorandum of understanding to conduct a joint study on "Ship Cyber Security Network Construction and Design Safety Evaluation" at the Marine Engineering Research Center of SHI. Samsung Heavy Industries.

GeoSpectrum Technologies, Dartmouth, Canada, will deliver its Long-Range Acoustic Messaging (LRAM) system to another Western customer. This follows a recent successful delivery of LRAM equipment to the Canadian government. Undisclosed.

OceanPact Geociências, Rio de Janeiro, Brazil, has chosen deepwater positioning technology to support its geophysical, geotechnical and environmental research operations across the region. Sonardyne Brasil Ltda.

Kawasaki Heavy Industries, Tokyo, Japan, has ordered the first commercial unit of a new high-density, lithium-ion capacitor energy storage system (ESS). Corvus Energy.

HR Wallingford, Wallingford, England, will establish a suite of numerical hydraulic models for the entire Suez Canal system, as well the port approaches in the Mediterranean Sea and Gulf of Suez. It will also supply a bespoke wave generation system for the flume in SCA's research center. Suez Canal Authority.

Aker BP, Lysaker, Norway, has signed an agreement for the MARESS cloud-based software solution to get detailed insight into fuel consumption and emissions from its fleet of offshore vessels operating on the Norwegian Shelf. Yxney Maritime.

ABB, Zürich-Oerlikon, Switzerland, will provide hybrid-electric propulsion and energy storage systems for the newest additions to the Washington State Ferry fleet, setting the largest U.S. ferry system on course for zero-emission operations. Vigor Fab LLC. **ST**

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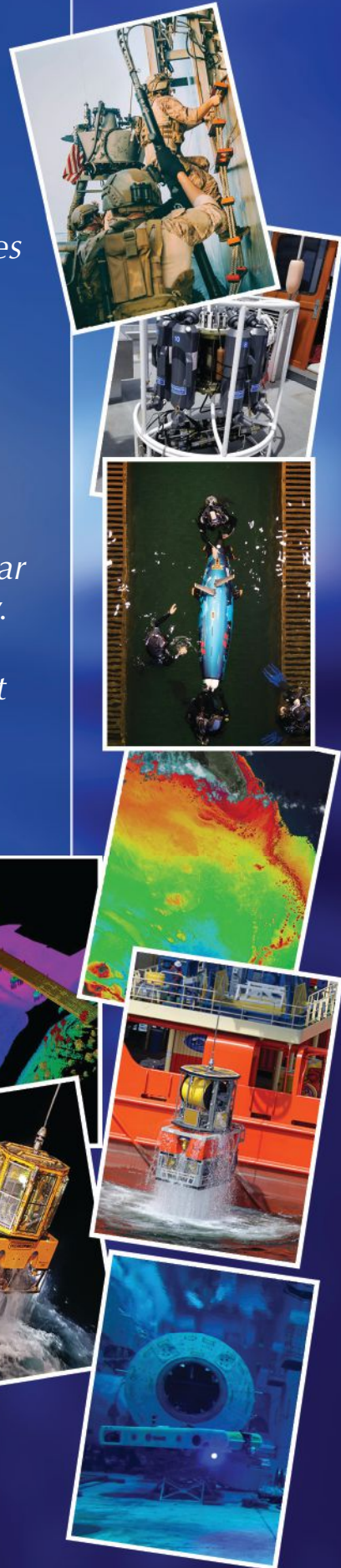
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meetings

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

AUGUST

August 4-6—Technology, Systems & Ships, Arlington, Virginia. www.navalengineers.org/Symposia/Tech-nology-Systems-and-Ships-2020.

August 11-14—Oceans 2020 Singapore, Singapore. info@oceans2020singapore.org or <https://singapore20.oceansconference.org>.

August 18-21—International Partnering Forum on Offshore Wind, Providence, Rhode Island. www.offshorewindus.org/2020ipf.

August 26-28—INAMARINE (Indonesia International Shipbuilding, Offshore, Marine Equipment, Machinery and Services Exhibition), Jakarta, Indonesia. +62 21 5435 8118, santi@gem-indonesia.com or www.gem-indonesia.net.

SEPTEMBER

September 7-9—Oceanology International Middle East, Abu Dhabi, United Arab Emirates. +971 2 491 7615, firas.abultaif@reedexpo.ae or www.oceanologyinternationalmiddleeast.com/en-gb.html.

September 9-11—Noia Oil & Gas Conference & Exhibition, St. John's, Canada. kmorrissey@noia.ca or www.noia.ca.

September 14-17—Fleet Maintenance and Modernization Symposium, Virginia Beach, Virginia. www.navalengineers.org/Symposia/Fleet-Maintenance-and-Modernization-Symposium-2020.

September 21-25—NMEA/RTCM Conference & Expo, Orlando, Florida. 410-975-9425 or www.nmea.org.

September 23-24—Oil Spill India, Mumbai, India. +91-8287955348,

kamna@itenmedia.in or www.oilspillindia.org.

September 23-24—Remote Hydrography Conference, Southampton, England. tinyurl.com/y7v95eeg.

September 27-October 2—Underwater Mining Conference, St. Petersburg, Florida. 727-631-9579, lazevedo@immsoc.org or www.underwatermining.org.

September 28-October 2—SNAME Maritime Convention, Houston, Texas. 703-997-6701 or www.sname.org.

September 29-30—Teledyne Marine Canadian Users Conference, Halifax, Canada. www.teledynemarine.com/events/Teledyne-Marine-Users-Conference-Canada.

September 29-October 1—National Coastal and Estuarine Virtual Summit. <https://estuaries.org/summit>.

OCTOBER

October 5-8—AUUSI XPO-NENTIAL, Dallas, Texas. meetings@auusi.org or www.xponential.org.

October 6-8—World Conference on Floating Solutions, Rotterdam, Netherlands. admin@pavingthewaves.blue or www.pavingthewaves.org.

October 11-16—SEG, Houston, Texas. exhibits@seg.org or <https://seg.org/AM/2020>.

October 12-14—Climate Risk Summit, London, England. +44 (0)20 7576 8118, events@economist.com or <https://events.economist.com/events-conferences/emea/climate-risk-summit-2020>.

October 14-15—OilComm, Houston, Texas. www.oilcomm.com.

October 14-15—World Ocean Tech and Innovation Summit, Halifax, Canada. oceanspeakers@economist.com.

October 19-22—OCEANS 2020

Gulf Coast, Biloxi, Mississippi. www.oceansconference.org/gulf-coast-2020.

October 20-23—EURONAVAL, Paris Le Bourget, France. www.euronaval.fr.

October 26-28—Offshore Energy, Amsterdam, Netherlands. +31 (0) 10 209 2600, service@offshore-energy.biz or offshore-energy.biz.

NOVEMBER

November 2-4—MAST Asia, Tokyo, Japan. <https://mastconfex.com/asia2020>.

November 3-5—Marine Renewables Canada Conference, Halifax, Canada. amanda@marinerenewables.ca.

November 10-12—Marine Autonomy & Technology Showcase, Southampton, England. dcook@noc.ac.uk or <https://noc-events.co.uk/mats-showcase-2020>.

November 16-20—BlueTech Week, San Diego, California. www.tmbaluetech.org/bluetech-week.

DECEMBER

December 1-3—Oceanology International London, London, England. +44 (0)1202 669244, j.riegal@saltwater-stone.com or www.oceanologyinternational.com.

December 1-3—Pacific Marine Expo, Seattle, Washington. www.PacificMarineExpo.com.

December 2-3—LNG Latin America & the Caribbean, Buenos Aires, Argentina. <http://LNGlatinamerica.com>.

December 8-10—UDT, Rotterdam, Netherlands. Charlotte.Aldrich@clarionevents.com or www.udt-global.com.

December 16-17—West Coast Defense Contracting Summit, San Diego, California. 202-552-0179 or marketing@defenseleadershipforum.org.

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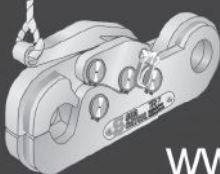
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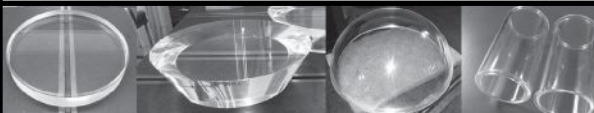
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Graham Hawkes is a pioneering ocean engineer who is responsible for designing and building more than 60 manned submersibles, ranging from atmospheric dive suits to flying subs. As a test pilot, he held the deepest solo dive record for more than 20 years. He founded HAWX Open Ocean LLC to design and build revolutionary marine technologies that enable undersea access for all.



We live in a disruptive time. The coronavirus pandemic is forcing us to rethink daily life, and this process is accelerated by advanced technologies. The affordable mobile communications tools that we now rely on even more heavily are based on disruptive technologies. Disruptive technology was defined for me by John Sculley, former head of Apple, as when a market is overturned by new technology costing 1/10 or less of the old.

My latest company, HAWX Open Ocean LLC, is about to lower the cost to see and conduct baseline surveys in the deep ocean for less than 1/100 of the old costs of doing work with manned submersibles or ROVs; well beyond disruptive.

Such dramatic reduction is possible, in part, because of ultrahigh costs of the last century, when there was little deep-sea access, so the few pioneers had to develop their own early-stage, one-of-a-kind technologies that were extremely costly. The focus then was on solutions to access the ocean and set records. The sea change now goes beyond pioneering solutions and records to expanding access to the ocean from the few to the many.

I was part of the early days of deep-ocean access with manned submersibles and the big push—the media dubbed “the race to the bottom”—to dive Challenger Deep in the Mariana Trench, the deepest

part of the ocean, with DeepFlight Challenger, the elegant manned submersible I built for Steve Fossett. At the time, the original work rationale for manned subs had already been lost to unmanned work-class ROVs, leaving only manned depth records and an argument for physical “eyes in the deep” to justify the high cost of manned submersibles. The high cost was also due to the required mothership. This meant that such costly vehicles were only for the wealthy few.

On March 26, 2012, James Cameron heroically won the race to the bottom. Later, Cameron admitted that he preferred to look at video monitors rather than through view ports, striking a blow to the argument for putting humans physically in the deep. Now, smaller cameras have replaced humans.

So, with records set and technological advances achieved, what’s the next step for humankind in the ocean? The race to the deep belongs to the last century, clearing the decks for the next leap forward: democratizing ocean access.

Today, the costly tethered ROV is challenged by mini-ROVs branded to appeal to the mass consumer market as underwater drones. Today’s drones seem like toys, but they should not be discounted because they are rapidly improving. Beyond ROVs, we have the promise of AUVs and surface drones to potentially eliminate the cost of surface ships.

Enabling ocean access for all is the frontier of the 21st century. Affordable and easy-to-use unmanned vehicles and simple access to and management of the data they collect are driving innovations. This is what many participants at the 2018 All Hands on Deck National Ocean Exploration Forum and others are now calling “democratization of the ocean.” Importantly, the leading edge of this movement is enabling coastal communities to see, survey

and manage their own Exclusive Economic Zones (EEZs), deemed sovereign territory under the international Law of the Sea Treaty. Polynesian peoples in particular are looking to manage their portion of the Pacific Ocean that is under increased pressure from mining, fishing, development and tourism.

So far in my lifetime, we have barely moved the needle on exploring the ocean; only 2 to 5 percent has been explored (depending on your source). My company is pushing hard to lower the costs of seeing into the deep with a simple lander accessible to anyone. The opportunity to empower everyone to see, for the first time, roughly two-thirds of our ocean planet is what’s behind my newbuild. The hand-launched lander can see into and recover data from the seafloor by taking advantage of next-generation miniature recording cameras and sensors that enable basic survey and management at any depth, from any boat.

Sea Rocket is a low-cost, easy-to-use, autonomous, touch-and-go lander with the potential to move humankind forward in exploring the deep, while achieving my original goal of creating the “best eyes in the deep.”

All that’s required is to attach a small, pressure-protected, off-the-shelf 4K camera (including automatic controls, power supplies and recording systems), a dive light and other sensors, such as a CTD, onto Sea Rocket and dive to the seafloor. This lander can be hand-launched from any boat at a fraction of the cost of the last century’s constrained ROVs or free-diving manned submersibles. This technology will enable anyone to see, survey and manage the deep ocean. The tetherless lander costs less than 1/1,000 of Cameron’s record manned dive and turns almost any boat into a ship of opportunity—disruptive tech that is the next step forward for humankind. **ST**

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The logo features a stylized globe icon composed of white curved lines on the left. To its right, the text "SEG20" is in a large, bold, white sans-serif font. Below "SEG20", the text "HOUSTON, TX" and "11-16 OCT 2020" are in a smaller, white sans-serif font. At the bottom of the logo, the text "INTERNATIONAL EXHIBITION" and "90TH ANNUAL MEETING" are in an even smaller, white sans-serif font.

SEG20
HOUSTON, TX
11-16 OCT 2020
INTERNATIONAL EXHIBITION
90TH ANNUAL MEETING

CELEBRATING 90 YEARS

**SHIFTING GEARS IN
THE DIGITAL SPEEDWAY**

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- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions available

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

UNDERWATER ACOUSTIC MODEMS

reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, the HS high-speed modems, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m

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ULTRA-COMPACT
"TINY" MODEMS



S2C M (left) and the new S2C T "tiny" modem - 20% smaller and lighter