September 2019

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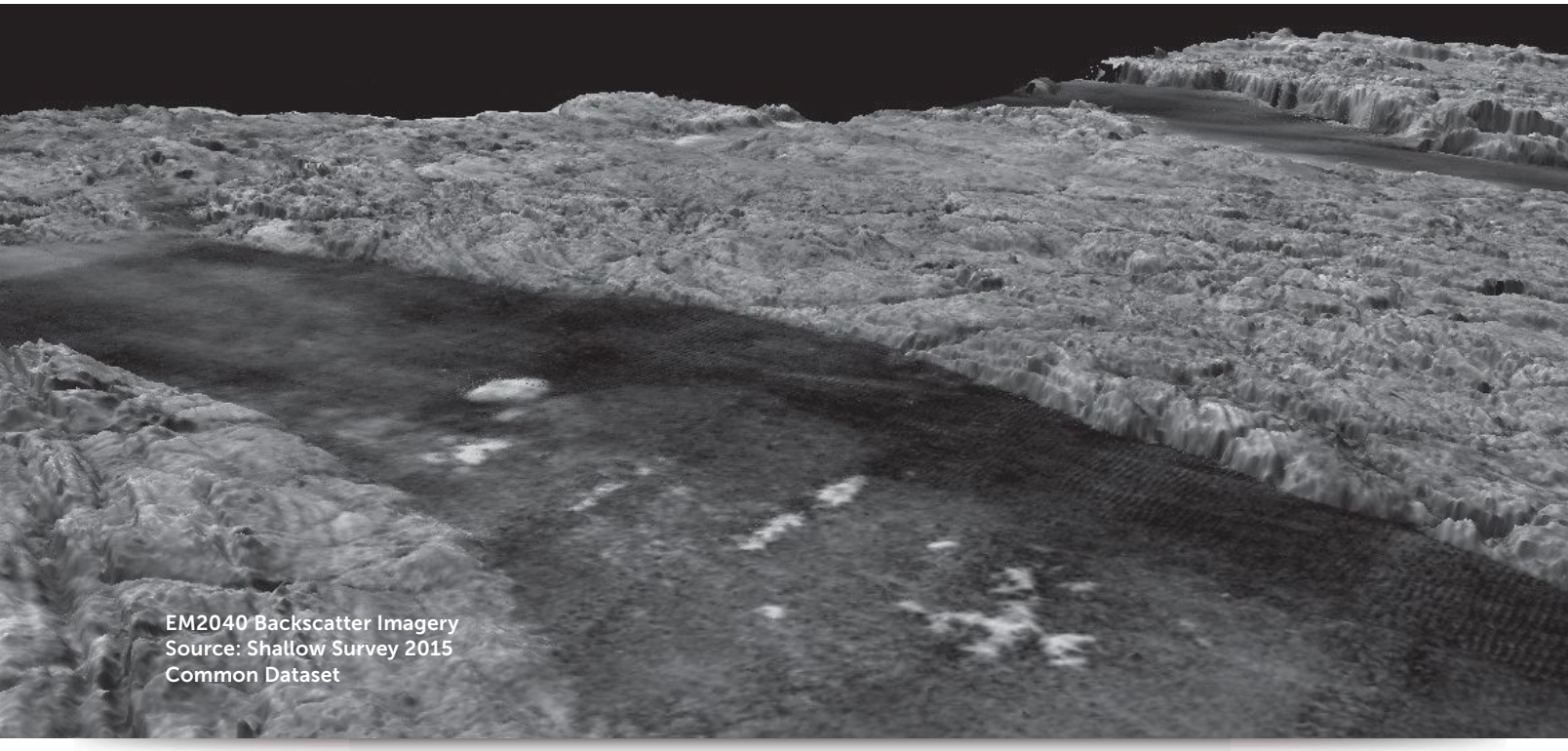

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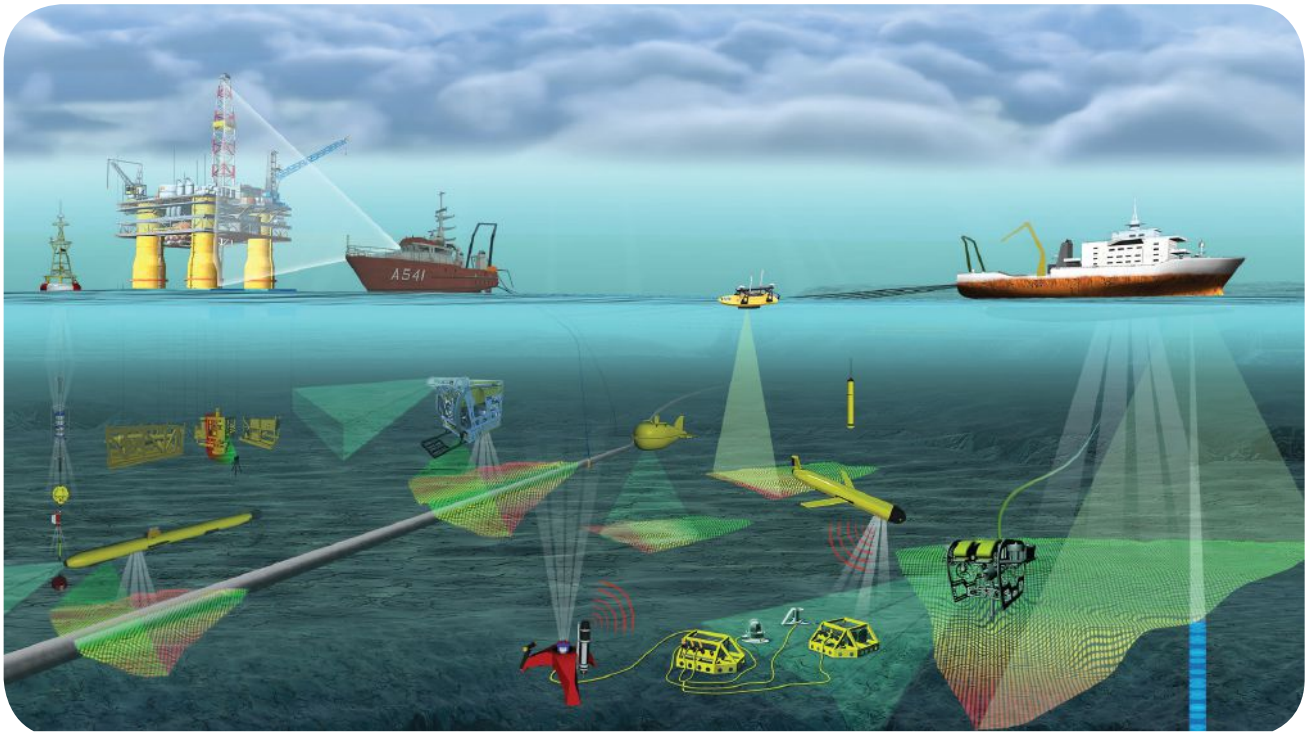

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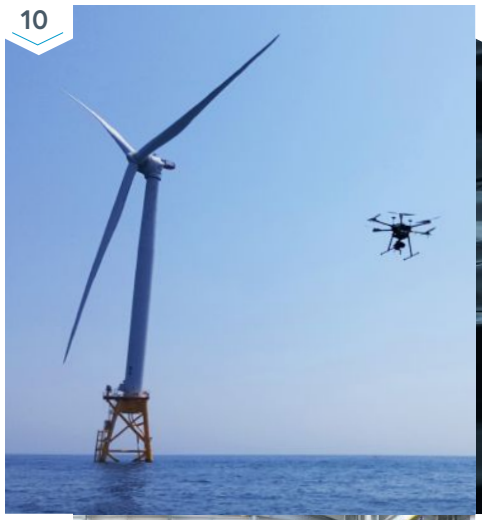

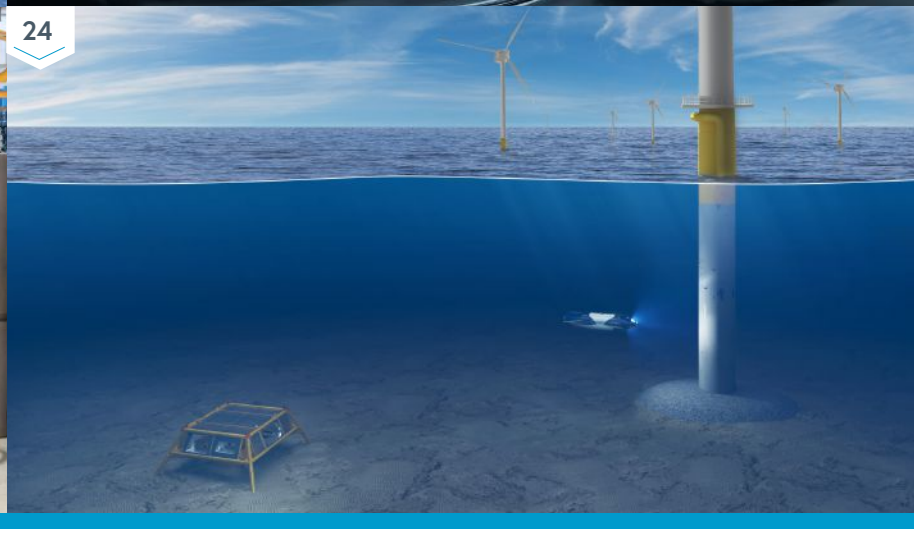

FEATURES

DEPARTMENTS

IN EVERY ISSUE

ON THE COVER:

Windpark Noordoostpolder in Flevoland, the Netherlands. The wind farm's owner-operators are members of the Koepel Windenergie Noordoostpolder, a partnership of more than 100 agricultural entrepreneurs from the North East Polder, and Innogy, a subsidiary of RWE.

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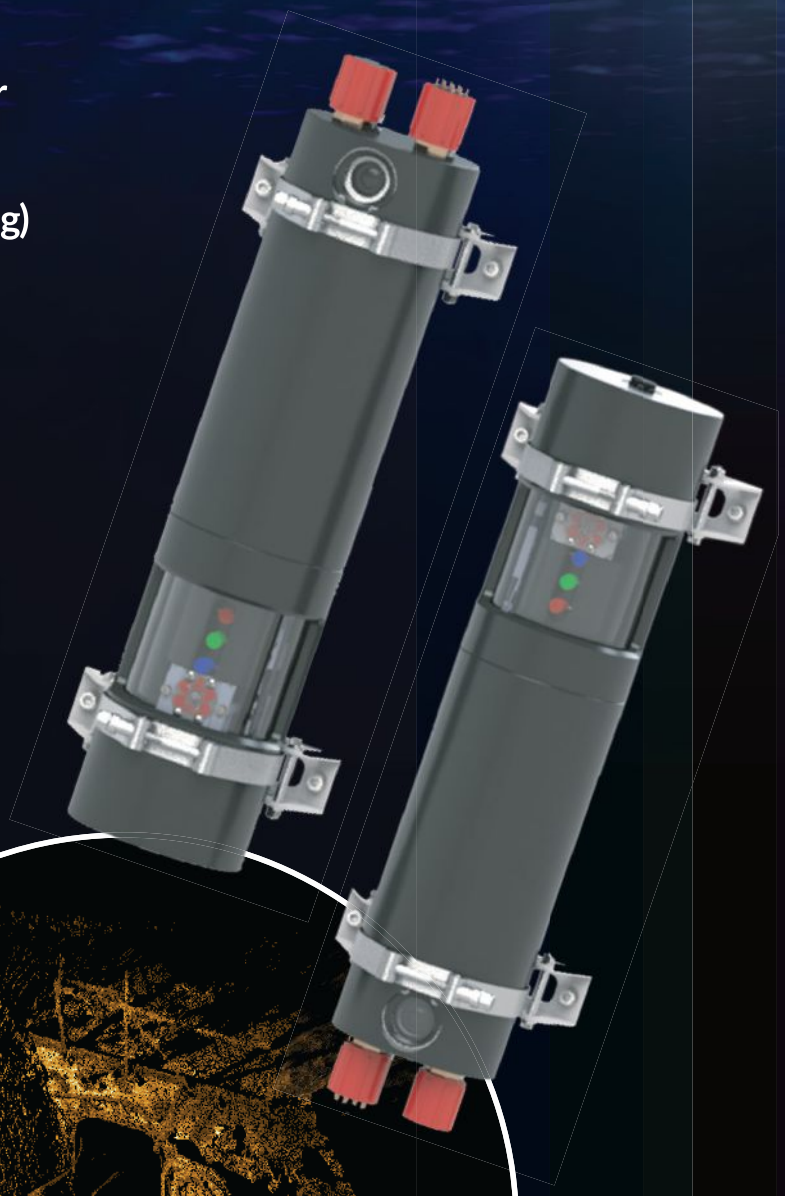

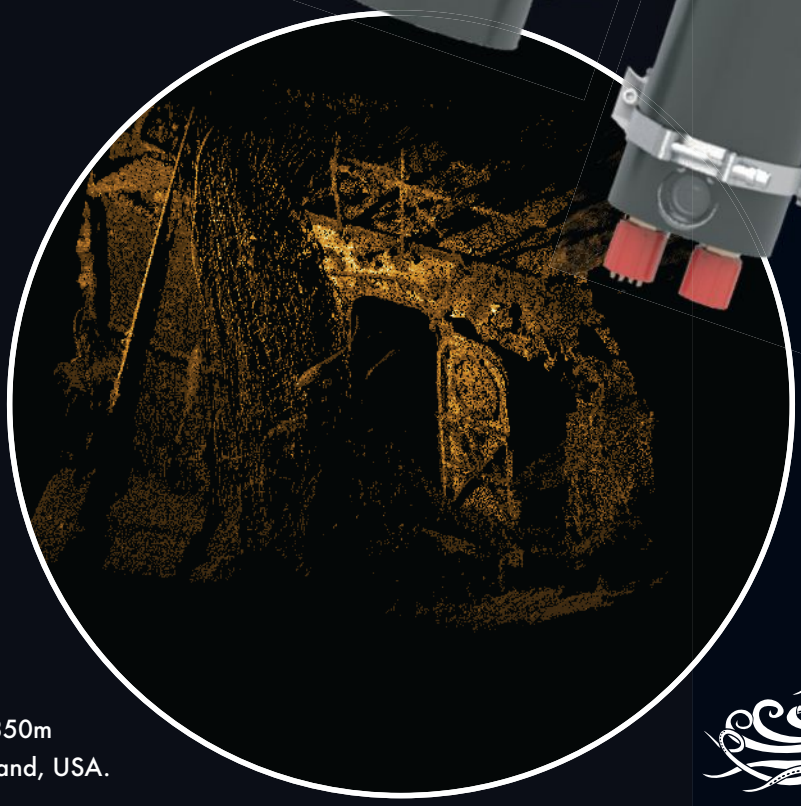

SeaVision® scan of
USS Baldwin shipwreck in 350m
water depth near Rhode Island, USA.

KRAKEN

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MARINE RENEWABLE ENERGY: CONTRIBUTING TO CANADA'S LOW-CARBON FUTURE

ELISA OBERMANN,
Executive Director,
Marine Renewables Canada

As the world increasingly moves towards building a low carbon economy, our oceans and rivers present new opportunities. Energy from tides, waves, wind, and river currents are yet to be mainstream in the electricity mix, but their potential to power the grid and create new economic opportunities is significant.

In Canada, ocean waves and tides span our coastlines and rivers flow through every province. The tidal energy resource alone is estimated to be 40,000 MW with over 200 sites across the country. Adding wave and river current, the potential soars to over 340 GW.

Marine renewable energy is still an emerging sector, but over the past decade Canada has taken many actions to advance the technology and build a new industry. On the east coast, the development of tidal energy in the Bay of Fundy has been supported through provincial and federal government policies, funding, and initiatives, including Nova Scotia's feed-in tariff (FIT) program and shared infrastructure through the Fundy Ocean Research Center for Energy (FORCE). Approximately 25 MW of renewable electricity has been approved under the FIT. The success of policy and other supports is evident with FORCE and Nova Scotia attracting the interest of developers from around the world. DP Energy, Sustainable Marine Energy, Minas Tidal, Jupiter Hydro, and Big Moon Power have received permits for development in the province and are all working towards deployments in the next 1-2 years. The Government of Canada has also had a huge impact in supporting these projects and most recently awarded DP Energy $29.7 million under its Emerging Renewable Power Program (ERPP) for the 9 MW Uisce Tapa project being developed at FORCE.

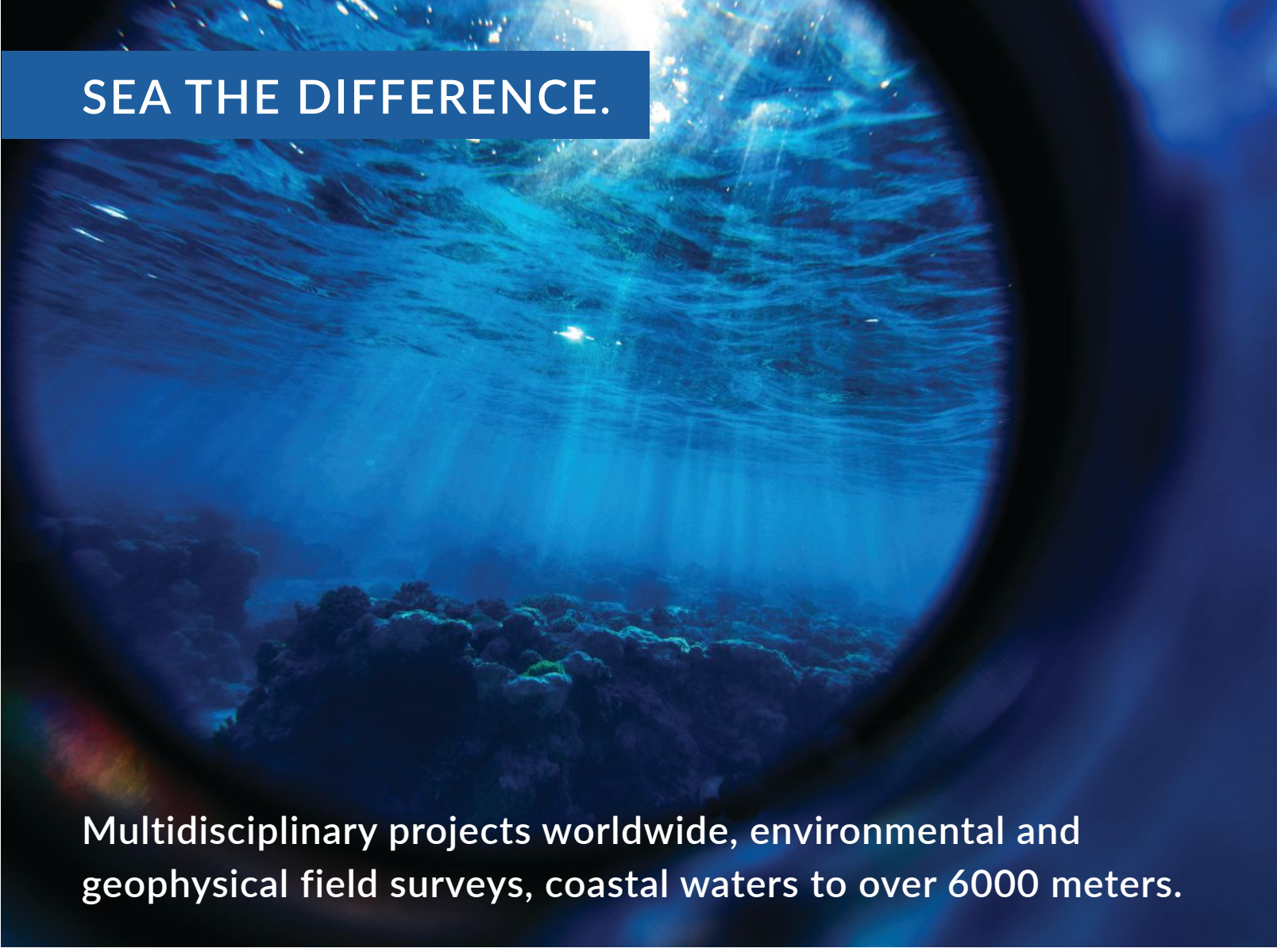
Other regions of Canada are also making progress in tidal, wave, and river current energy – many with a focus on providing clean electricity to remote communities. Wave energy development is being supported on the west coast through enabling R&D led by the University of Victoria's West Coast Wave Initiative. And on the east coast, the College of the North Atlantic's Wave Environment Research Centre (WERC) has six fully permitted mooring sites available and has been working with wave energy developers to demonstrate various technologies.

Canada is also home to the Canadian Hydrokinetic Turbine Test Centre (CHTTC), a test center for river current (hydrokinetic) energy turbines. Since 2013, CHTTC has carried out over ten deployments with several device developers assisting in future commercialization of river current energy technologies.

Canada has positioned itself to lead and benefit from development of marine renewable energy. Foundational research has grown knowledge of environmental effects and refined technical approaches. Businesses that have gotten involved early are now part of a growing supply chain of service providers who have gained experience that can be applied in Canada and internationally. While challenges lie ahead to fully realize the potential of our ocean and river resources, they also present a prime opportunity to innovate, create new economic opportunities, and ultimately contribute to a low-carbon future.

Marine Renewables Canada is a national association with a mandate to support and advance Canada's tidal, wave, river current, and offshore wind sector.

www.marinerenewables.ca



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» *ULC provides high-quality visual and sensor assessments to help manage assets—such as offshore wind turbines—in ways that were previously unattainable. Photo credit: ULC Robotics.*

PURPOSE-BUILT UAVs REVOLUTIONIZE OFFSHORE ASSET INSPECTION

ULC ROBOTICS TALKS SAFETY, COST-SAVINGS, AND FULL-SERVICE AERIAL INSPECTIONS

ULC Robotics is a leader in product development and engineering services for the energy industry. Among their core services, ULC maintains and operates a fleet of professional and commercial-level UAVs. Using FAA-certified pilots, as well as program managers and engineers, ULC provides high-quality visual and sensor assessments to help manage assets—such as offshore wind turbines—in ways that were previously unattainable. ON&T sat down with ULC's Tom Barracca to discuss some of the company's offshore wind inspection capabilities.

[Q] The vertical take-off and landing (VTOL) fixed-wing unmanned aerial vehicle (UAV) is huge, with a 10-foot wingspan. How is something that large powered?

The prototype aircraft initially used batteries for its all-electric propulsion system, but in order to maximize the flight time for our customers we switched to a hybrid arrangement. The hybrid system uses batteries to power electric motors for vertical takeoff and landing and a small gasoline engine for forward flight. That gives you maximum range and efficiency.

[Q] In terms of using ULC inspection drones for offshore wind structures, what are some of the advantages?

Two key drivers for the wind developers are improving safety and saving money. People are working at heights, above rough seas, and in other conditions where unmanned aerial vehicles would be helpful to not only reduce costs but increase safety.

[Q] What other jobs can these drones complete?

When we're looking at a particular problem that can be solved by UAVs in an industry like offshore wind, we tailor the solution with a specific purpose, which sometimes means coming up with new technology from scratch. We start with the problem, determine the right aircraft and sensors, and then try to match the technology we have to provide a fast response. Sometimes we need to develop new tools, but our customers are generally open to this.

For some jobs a helicopter or a large boat makes sense, but for other jobs drones are the best option. For example, our VTOL aircraft can fly long distances, so they can fly from the shore rather than taking off from a vessel, which is an obvious cost reduction and opens up a whole new set of possibilities to the industry.

We also build multirotor aircraft, which is of interest to the industry because it can inspect ports, cable landings, and intertidal areas which are not far from the shore but can be difficult to inspect, especially given the size of the offshore wind assets. We have spoken with companies in the supply chain who are putting people on 80-foot lifts on a barge or a platform to inspect wind components. A hexacopter is a perfect fit for a detailed inspection in these cases, because it removes people from high-risk environments while performing the inspection faster.

[Q] Is the data from the onboard camera stored on the vehicle until it returns to shore?

The aircraft will capture a 360° view of the asset during the inspection process and, upon landing, will provide data that is then downloaded onto a laptop or uploaded to the cloud. Keep in mind, every pixel of every image captured is geotagged, and all onboard data, like wind speed, is recorded, and we often fly missions with additional LiDAR or thermal sensors. While the data is not delivered in real time, we get better clarity on a computer than you would transmitting data live.

There are companies flying off-the-shelf drones, but our business model is to develop the software and hardware for custom aircraft built to suit the needs of our clients. We find it useful to provide the robotics as a service, and deliver the data as the customer wants.

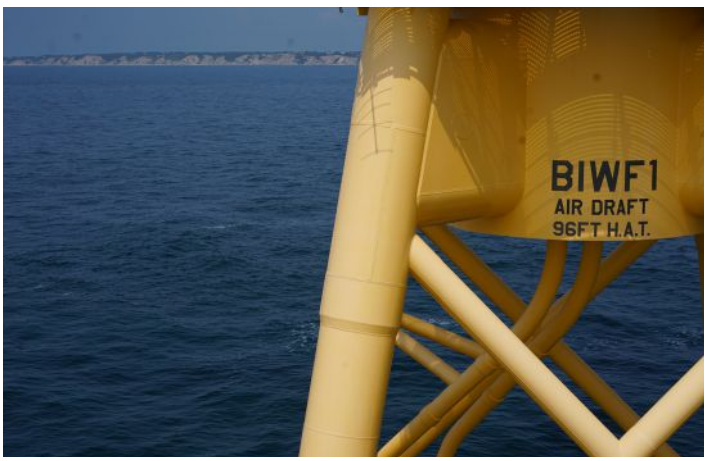
For example, a customer could have an engineer who has been looking at a certain type of corrosion for 20 years, and they would want the raw data for analysis. The other end of the spectrum is when a company requires an inspection report, but doesn't have an SME in-house. This is when we would analyze the data and deliver the report directly. Of course there are other options, but the bottom line is that we work with the customer to provide the data to their individual specifications.

[Q] So, your clients don't have to purchase, store, and maintain a drone; they don't need a subject matter expert; and they don't need a pilot. ULC can provide all of that. Correct?

» *Upon landing, the UAV provides data that is then downloaded onto a laptop or uploaded to the cloud. Photo credit: ULC Robotics.*

» *The aircraft captures a 360° view of the asset during the inspection process. Photo credit: ULC Robotics.*

» *Every pixel of every image captured is geotagged, and all onboard data, like wind speed, is recorded, and ULC often flies missions with additional LiDAR or thermal sensors. Photo credit: ULC Robotics.*



» *Images captured via UAV could be risky or impossible for a human inspector to capture. Photo credit: ULC Robotics.*

Correct. Our pilots are FAA-certified, and while others can get this certification, you really want a pilot to go well beyond the basics. As a responsible commercial operator, we require our pilots to log a significant number of hours on each aircraft within our fleet of UAVs. Our pilots are also certified to fly manned aircraft, which makes communications with regulators, like the FAA, much easier and we are able to readily obtain the waivers required to fly in certain airspace.

We've been flying in the traditional utility space for years, and there are many safety standards and operating procedures that translate to the renewable energy industry, specifically offshore wind. Our deep understanding of these standards is strengthened by the fact that a lot of our employees come from the utility, defense, and aerospace industries. While there is risk in the domain, safety is so well integrated into everything that we do that we are careful to work closely with our clients to mitigate that risk as much as possible.

[Q] Can you tell me about an example where a client benefited from your services?

We worked with Deepwater Wind, who have since been acquired by Ørsted, to perform an annual visual inspection of the turbine foundations at Block Island Windfarm. Traditionally, an employee of Keystone Engineering, the company that built the foundations, would physically climb each 80-foot foundation to complete a visual inspection based off of a checklist of criteria.

We had used one of our UAVs to complete a thorough, point-by-point inspection of the foundations. The aircraft was outfitted with a high-resolution DSLR camera to capture detailed images of the support structure and welds. One advantage was that the UAV could capture images at angles that could not be captured by an inspector climbing the foundations. As a result, Keystone's engineers were provided a more complete data set and were able to deliver to Deepwater Wind a total assessment with unprecedented accuracy and expediency.

We had captured 2000 photos during the inspection, which needed to be manually analyzed. After the inspection, we decided to revisit the project to streamline the analysis with the help of our resident AI scientist, who had developed a Machine Learning algorithm to interpret the data. The algorithm is capable of classifying all welding joints, and helped demonstrate our ability to further automate the inspection process.

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UNDERWATER STONE AGE BOAT BUILDING SITE DISCOVERED

» *Garry Momber tagging structure. Photo credit: NOC.*

The Maritime Archaeological Trust has discovered a new 8,000-year old structure next to what is believed to be the oldest boat building site in the world on the Isle of Wight.

"This new discovery is particularly important as the wooden platform is part of a site that doubles the amount of worked wood found in the UK from a period that lasted 5,500 years," said the Trust's Director, Garry Momber.

The site lies east of Yarmouth, and the new platform is the most intact, wooden Middle Stone Age structure ever found in the UK. The site is now 11 meters below sea level and during the period there was human activity on the site, it was dry land with lush vegetation. Importantly, it was at a time before the North Sea was fully formed and the Isle of Wight was still connected to mainland Europe.

The site was discovered in 2005, but its structures were difficult to interpret until the Maritime Archaeological Trust used state of the art photogrammetry techniques to record the remains. During the late spring a new structure was spotted eroding from within the drowned forest. The first task was to create a 3D digital model of the landscape so it could be experienced by non-divers. It was then excavated by the Trust during the summer and has revealed a cohesive platform consisting of split timbers, several layers thick, resting on horizontally laid round-wood foundations.

Garry continued, "The site contains a wealth of evidence for technological skills that were not thought to have been developed for a further couple of thousand years, such as advanced wood working . . . Yet, being underwater, there are no regulations that can protect it. Therefore, it is down to our charity, with the help of our donors, to save it before it is lost forever."

The Maritime Archaeological Trust is working with the National Oceanography Centre (NOC) to record and study, reconstruct and display the collection of timbers. Many of the wooden artefacts are being stored in the British Ocean Sediment Core Research facility (BOSCORF), operated by the National Oceanography Centre.

As with sediment cores, ancient wood will degrade more quickly if it is not kept in a dark, wet and cold setting. While being kept cold, dark and wet, the aim is to remove salt from within wood cells of the timber, allowing it to be analyzed and recorded. This is important because archaeological information, such as cut marks or engravings, are most often found on the surface of the wood and are lost quickly when timber degrades. Once the timbers have been recorded and have desalinated, the wood can be conserved for display.

This material, coupled with advanced wood working skills and finely crafted tools suggests a European, Neolithic influence. The problem is that sections of the ancient land surface are being eroded by up to half a meter per year and the archaeological evidence is disappearing.

ALL-IN-ONE: NEW MICROBE DEGRADES OIL TO GAS

The tiny organisms cling to oil droplets and perform a great feat: as a single organism, they may produce methane from oil by a process called alkane disproportionation. Previously this was only known from symbioses between bacteria and archaea. Scientists from the Max Planck Institute for Marine Microbiology have now found cells of this microbe called Methanoliparia in oil reservoirs worldwide.

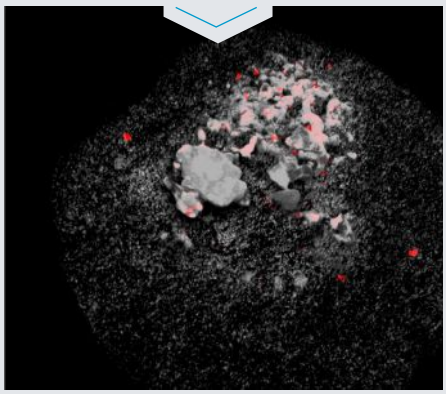
Crude oil and gas naturally escape from the seabed in many places known as "seeps". There, hydrocarbons move up from source rocks through fractures and sediments towards the surface, where they leak out of the ground and sustain a diversity of densely populated habitats in the dark ocean. A large part of the hydrocarbons, primarily alkanes, is already degraded before it reaches the sediment surface. Even deep down in the sediment, where no oxygen exists, it provides an important energy source for subsurface microorganisms, amongst them some of the so-called archaea.

Now, a study led by scientists from the Max Planck Institute for Marine Microbiology in Bremen, Germany, and the MARUM, Centre for Marine Environmental Sciences, provides environmental information, genomes and first images of a microbe that has the potential to transform long-chain hydrocarbons to methane. Their results are published in the journal *mBio*.

Splitting Oil Into Methane And Carbon Dioxide

This microbe, an archaeon named Methanoliparia, transforms the hydrocarbons by a process called alkane disproportionation: It splits the oil into methane (CH_4) and carbon dioxide (CO_2). Previously, this transformation was thought to require a complex partnership between two kinds of organisms, archaea and bacteria. Here the team from Max Planck Institute for Marine Microbiology and MARUM presents evidence for a different solution.

"This is the first time we get to see a microbe that has the potential to degrade oil to methane all by itself," author Rafael Laso-Pérez explains.



Epifluorescence microscopy picture of Methanoliparia cells attached to a droplet of oil. The white scale bar represents a length of 10 micrometers. Photo credit: Max Planck Institute for Marine Microbiology.

During a cruise in the Gulf of Mexico, the scientists collected sediment samples from the Chapopote Knoll, an oil and gas seep, 3000 m deep. Genomic analyses revealed that Methanoliparia is equipped with novel enzymes to use the quite unreactive oil without having oxygen at hand.

"The new organism, Methanoliparia, is kind of a composite being," says Gunter Wegener, the senior author of this study. "Some of its relatives are multi-carbon hydrocarbon-degrading archaea, others are the long-known methanogens that form methane as metabolic product."

With the combined enzymatic tools of both relatives, Methanoliparia activates and degrades the oil but forms methane as a final product. Moreover, the visualization of the organisms supports the proposed mechanism.

"Microscopy shows that Methanoliparia cells attach to oil droplets. We did not find any hints that it requires bacteria or other archaea as partners," Wegener continued.

"We scanned DNA-libraries and found that Methanoliparia is frequently detected in oil reservoirs – and only in oil reservoirs – all over the oceans. Thus, this organism could be a key agent in the transformation of long-chain hydrocarbons to methane," says Laso-Pérez.

The next step, according to Wegener is growing Methanoliparia in the lab, which he says will enable further investigations, such as ". . . whether it is possible to reverse the process, which would ultimately allow us to transform a greenhouse gas into fuel.

OSIL'S GIANT PISTON CORER SYSTEM IN THE SOUTH CHINA SEA

OSIL have successfully completed sea acceptance tests aboard the MV Xue Long 2 on an OSIL 22m Giant Piston Corer system in the South China Sea, proving the system with excellent sample recovery rates and ease of handling. The system was installed and operated over a 10 day period with 2 OSIL engineers on board to provide training to local scientists.

The 22m system is installed into and deployed using a MacGregor Triplex handling system. The corer was successfully deployed in deep water collecting over 85% sample recovery on its first deployment. With further system tuning, scientists are looking towards 95% plus recovery rates which are possible using the OSIL corer. The unique piston design provides a more complete, longer and less disturbed sample than traditional gravity coring systems.

The Giant Piston Corer will be used by the Polar Research Institute of China (PRIC) for marine sediment studies. The system is modular and easily assembled for rapid deployment in all conditions. Due to its modular nature systems up to 60m in length are available from OSIL for use in soft sediments.

For more information, visit
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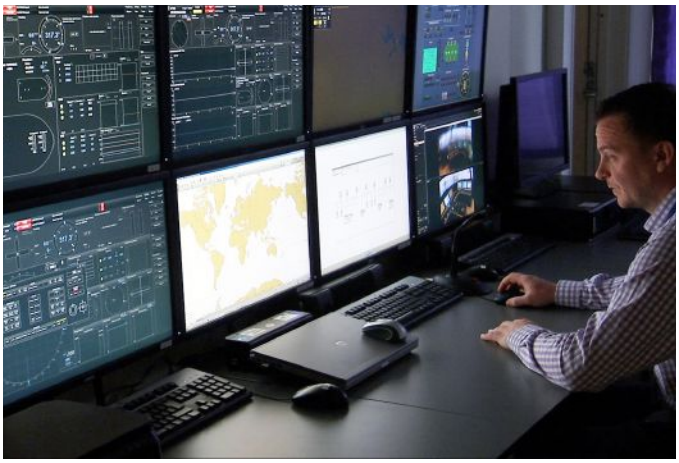


» *Advanced K-Sim Navigation technology will facilitate testing of new autonomous vessel technologies at the research center in South Korea.*

KONGSBERG DIGITAL TECHNOLOGY FOR NEW AUTONOMOUS SHIP CENTER IN SOUTH KOREA

UIPA, the South Korean Information and Communication Technology Promotion Agency has awarded Kongsberg Digital the contract to supply a fully-featured bridge simulator for a new, state-of-the-art autonomous ship research facility in Ulsan, South Korea. The Korean government has committed to invest US$110 million in the project over the next three years, with a goal of starting operations in 2023. The simulation contract is being delivered through maritime ICT convergence specialists eMARINE Global.

The simulator will be used primarily for research and development of navigational equipment and display systems, and will facilitate testing of autonomous vessel technologies in a safe virtual environment before trials in a designated autonomous ship test bed. Based on Kongsberg Digital's industry-proven K-Sim Navigation platform, the new system will deliver high-fidelity visual and physical simulation, a radar signal interface function and software for navigation analysis, equipment test and evaluation.

The high-fidelity simulator is due for installation in November this year. The delivery will, in addition to K-Sim Navigation, include development of new software to integrate external inputs such as GPS and wave sensors, as well as an API interface to permit simulation data transfer to other systems. Kongsberg Digital will also supply an area database for the virtual 'Ulsan Port', and a modelling tool enabling new simulator vessel models to be built from the ground up.

Kongsberg Digital is recognized as the technology leader in simulators for crew training and a driving force behind the growing use of digital twins in maritime applications. The company's flexibility to deliver a customized service including research-focused software development for the new autonomous ship research facility in Ulsan reflects its central role as an enabler of new safety and performance enhancing technologies for both manned and unmanned vessel operations.

ℹ *www.kongsberg.com/en/kongsberg-digital*

MSI INSTALLS WAVE BUOYS FOR INDIAN OCEAN ISLANDS

As part of the Monitoring for Environment and Security in Africa (MESA) program, funded by the European Union and implemented by Mauritius Oceanography Institute (MOI), Metocean Services International (MSI) was awarded a contract for the installation of AXYS TRIAXYS directional wave buoys in Comores, Seychelles and Madagascar.

These buoys will contribute to increasing the decision making and planning capacity of institutions mandated for marine and coastal management and the data will be used to, inter alia, allow monitoring and mitigation of oceanographic risks such as sea level rise, swells and storm surges that may lead to coastal hazards.

Each of the 3 buoys deployed, in water depths ranging from 32 m to 90 m, is fitted with GSM, radio and satellite telemetry enabling MSI to receive the data in real-time for display on a website, local display on a PC and monitoring of buoy position / status respectively. Deployment of the buoys was facilitated in Seychelles by the Seychelles Meteorological Authority, in Comores by the Agence Nationale de L'aviation Civile et de la Meteorologie and in Madagascar by the Direction Regionale de L'environnement, de L'ecologie et des Forets.

ℹ *www.metoceanservices.com*

NEW ROPELESS FISHING SYSTEM UTILIZING ACOUSTIC RELEASE TECHNOLOGY

EdgeTech has introduced a new Ropeless Fishing System with embedded acoustic release technology, which was developed to eliminate vertical lines connecting a surface buoy to bottom fishing gear. The system was designed from the ground up with the input of fishers with the intent of alleviating possible whale entanglement and other negative effects of seafloor-to-surface fishing and trap lines.

The EdgeTech Ropeless Fishing System was designed for the rough and tumble handling of shallow water and small boat operations. Expanding the extensive line of reliable acoustic release products and utilizing the same proven Push-off Release Transponder (PORT) technology, the EdgeTech system is perfectly suited for those applications that require a robust, yet shallow water, acoustic release enabled ropeless fishing package.

The unit can be deployed in water depths down to 500 meters and handle a load of 500 pounds while remaining underwater for up to one year (two years on lithium batteries). With its unique nickel aluminium bronze alloy construction, it can withstand even the harshest shallow water environments providing corrosion resistance like none other.

The system, when communicating with a fishing-vessel-installed acoustic deck box, will provide shipboard operators information such as position, battery life and tilt status, release confirmation and temperature. The EdgeTech Trap Tracker application for Android and IOS platforms records all data, plots the trap and trawl locations on a marine chart and uploads the positions real-time to a Cloud data base so that other fishers can see where trawls are located to avoid setting over another fishers trawls.

The system will tolerate harsh handling on the vessel and unfavourable conditions under the water. The acoustic coding structure allows for over 1 billion unique codes making it the most secure acoustic release ever produced. The EdgeTech Ropeless Fishing System will enable fishing operations in areas and conditions probative without such technology.

For more information, visit
WWW.EDGETECH.COM

SAAB SEAEYE'S FALCON SUPPORTING OCEAN OBSERVATORIES RESEARCH

A Saab Seaeye Falcon electric underwater robotic vehicle is to help support a network of oceanographic and atmospheric sensors that are part of the Ocean Observatories Initiative (OOI) transforming ocean research.

Funded by the National Science Foundation, the overall OOI program is managed by Massachusetts-based Woods Hole Oceanographic Institution (WHOI). The moored, mobile autonomous, and cabled sensors provide real-time data access to address critical issues such as climate change, ecosystem variability, ocean acidification, and carbon cycling. The observatory consists of:

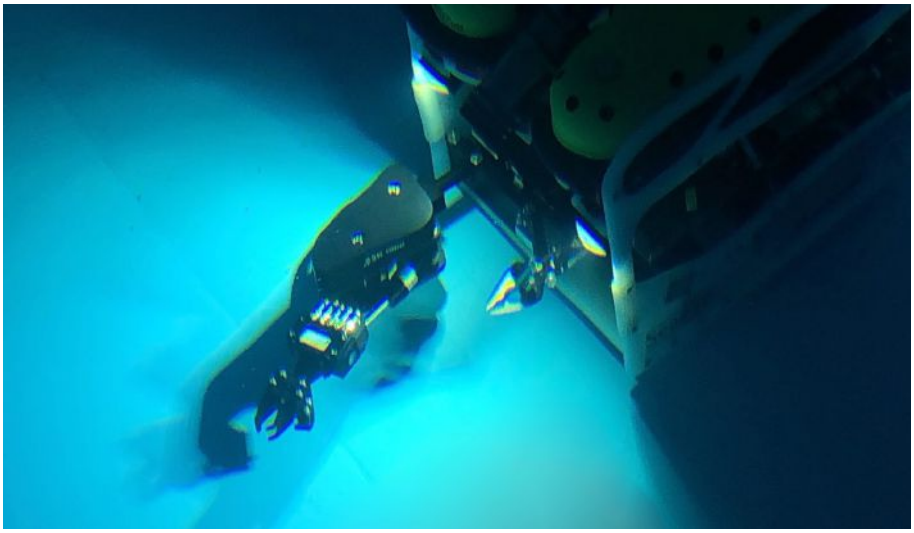
- The Coastal & Global Scale Nodes (CGSN) which include sensor arrays moored off the coast of Massachusetts, Alaska, and Greenland, operated by WHOI
- The Endurance Array (EA) off the coast of Oregon and Washington, operated by Oregon State University
- The Regional Cabled Array (RCA), a submarine cable network of sensors and instruments, operated and managed by the University of Washington
- As well as the Cyber infrastructure, managed by Rutgers, The State University of New Jersey.

After deploying a third-party ROV for several years, it was concluded that a dedicated underwater robotic vehicle could be a significant addition to the suite of tools available to the program and provide operational flexibility, as well as scheduling and budget optimization.

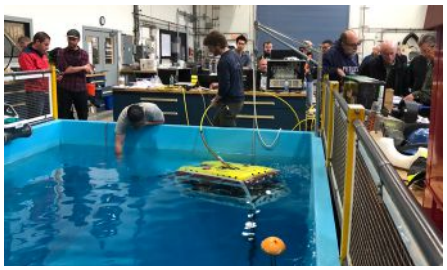
The Falcon won a competitive contract against multiple vendors. It met the general requirements for a vehicle that can operate in 450 m of water, with a 1000 m option, has a multi-function manipulator arm and navigation system, and can work from either a dynamic positioning, or non-dynamic positioning vessel. A 1100 m umbilical cable run will not only allow the Falcon to operate from a non-dynamic positioning vessel, but allows multiple re-termination before needing replacement.

The Falcon will conduct operations in support of mooring deployments and recoveries. This would include inspections of instruments and mooring systems, as well as attaching rigging or unfouling instruments to allow recovery of assets.

At-sea training was completed in March 2019, along with verification of mobilization and de-mobilization requirements, integration of navigational systems, and included operating the vehicle in currents and performing test recoveries of CGSN anchor types.



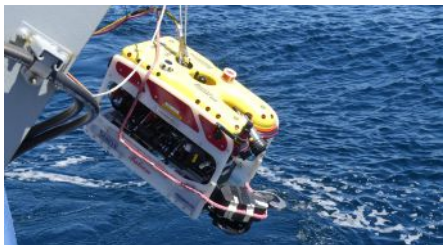
» *Falcon fitted with multi-function manipulator in test tank. Photo credit: Collin Dobson, WHOI.*



» *Falcon during training at WHOI's test tank facility in Woods Hole, Mass. Photo credit: Derek Buffitt, WHOI.*

First project deployment of the Falcon was in April onboard the RV Neil Armstrong. During the multi-leg 21-day cruise, the CGSN team performed mooring inspections and anchor recoveries. Future operations could take place in water depths of up to 450 m and will include surveying mooring locations, locating existing anchors, and engaging hooks and lines for recovery of anchors. The next planned deployment is on the Endurance Array for Oregon State University. The Falcon will be mobilized on the RV Elakha and will support shallow water anchor inspections and recoveries.

The Falcon packs five thrusters and an intelligent distributed control system into a small, easily handled vehicle. Systems on board include front and rear cameras, a Kongsberg HDTV camera, Imagenex sonar, five-function manipulator and single function manipulator with rope cutter.



» *Falcon deployed on a recent service cruise to the Ocean Observatories Initiative Pioneer Array. Photo credit: Rebecca Travis, WHOI.*

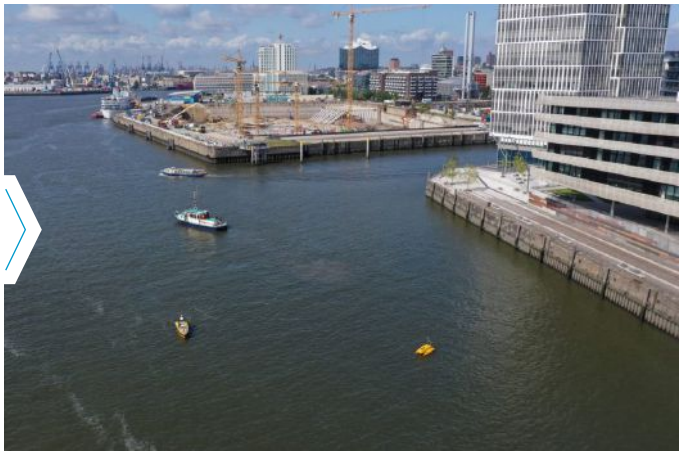
» *Successful anchor recovery at the OOI Pioneer Array aided by the Falcon. Photo credit: Rebecca Travis, WHOI.*

L3HARRIS DEMONSTRATE ASV **TECHNOLOGY** IN A PORT ENVIRONMENT

In August 2019, L3Harris Unmanned Maritime Systems (UMS) demonstrated its industry-leading Autonomous Surface Vehicle (ASV) technology at a workshop in the Port of Hamburg.

The workshop, in collaboration with Hamburg Port Authority, MacArtney Germany, and HafenCity University, successfully showcased the C-Cat 3's and C-Worker 5's abilities to autonomously navigate and scan a port environment.

The ASVs were operated using L3Harris' proprietary ASView Control System, including COLREG aware collision avoidance capability. Integrated with the C-Worker 5 was a SeaBat T50-P multibeam for mapping the seabed, and a Polaris TLS LiDAR to scan the harbor walls and surrounding features. The C-Cat 3 aided this operation by measuring the topography of the seafloor. High quality data was then fed back to the audience during the live demonstration on screens in the dockside presentation area.



For more information, visit
WWW.ASVGLOBAL.COM

| FEATURE |

ACCELERATING BLUE TECHNOLOGY VIA SUBSEA ELECTRIFICATION WITH LITHIUM-ION BATTERY INNOVATION

By Leon D. Adams, VP, Southwest Electronic Energy

Monitoring the health of the oceans, producing hydrocarbons from a subsea well, and ensuring subsea defense all require safe sustainable power. Traditional hydraulic-powered systems are fraught with environmental and reliability challenges, but advanced subsea battery solutions safely enable such activities.

Data collected about ocean thermal streams, pollutants and other aspects of the ocean can be wirelessly communicated, therefore, using a reliable advanced subsea battery solution can untether the data acquisition and monitoring equipment.

Smarter and more reliable hydrocarbon drilling and production requires battery power for subsea control systems, subsea intervention, autonomous underwater vehicles, and powerful electric motors. Offshore operations have long relied on environmentally-challenged hydraulic fluid based systems, but need to evolve to smart, clean, efficient electric control and actuated systems, enabled by advanced subsea battery solutions.

Subsea defense and security is increasingly critical in our stealth and cyber-oriented world with competing global powers. Leveraging Blue Technology enables NATO Navies to improve anti-submarine warfare and more safely execute mine countermeasures, which demand more autonomous surface and subsea vehicles with longer mission endurance. Advanced subsea battery solutions provide capability for naval subsea intelligence, surveillance, reconnaissance, undersea warfare, and deception.

The common thread among these innovative subsea applications is safe, reliable, long lasting, and easy to use subsea battery solutions.

Subsea Electric Power

A pressure tolerant lithium-ion polymer battery is ideal for subsea use, compared to traditional lead acid batteries. In 2013, Southwest Electronic Energy (SWE) launched its first commercial pressure tolerant lithium-ion polymer subsea battery pack, SWE SeaSafe, a major breakthrough in subsea power operations. SWE collaborated with Woods Hole Oceanographic Institution on the design, which is radically lighter and smaller than traditional lead acid batteries.

These batteries are easier to install than lead acid batteries, while they don't require a pressure vessel, they can require a pressure balanced oil-filled container, since contacts are not sea-ready. SWE SeaSafe batteries provide cycle lives that are eight times longer than their lead acid counterparts. The SWE SeaSafe line of batteries also performs six times better at low temperatures than standard lead acid batteries.

In 2017, SWE introduced the SeaSafe II® and SeaSafe Direct®, which incorporated lessons learned, reliability improvements and American Bureau of Shipping (ABS) certification. The SWE SeaSafe Direct can be placed directly into the water without a pressure vessel. Its ease-of-use convenience is becoming a growing trend in the industry.

SeaSafe II and SeaSafe Direct batteries have been used in short-duration, high-power demand applications and long-duration low-power demand situations. Applications include autonomous underwater vehicles for propulsion, control, and instrumentation; in remotely located infrastructure equipment for valve control and pipe shearing; and in oceanography sensing set-ups such as those for monitoring the salinity and temperature of ocean water over a period of time.

The SWE SeaSafe batteries are rated to 6,000 meters water depth and deliver 30V and 28Ah, with other sizes available. A series of battery modules can be linked together to meet specific increased voltage needs and in parallel to meet specific increased power and capacity needs with the capability of taking thousands of charges.

Advanced Safety

These smart batteries can track and report the status of the batteries for condition-based monitoring, which is crucial for reliable and safe operations. The integrated Battery Management System (BMS) automatically manages and tracks the safety, reliability, charge and discharge of the batteries and reports technical information on demand.

A built-in user-friendly BMS, patented by SWE, embeds advanced safety and reliability features into each smart module battery.

Safety features are configurable to the application. The BMS is designed to detect and prevent over-and-under voltage conditions and excessive charge and discharge scenarios. It can monitor the charge and discharge temperature while detecting and preventing short circuits and features redundant short circuit fuse protection.

The BMS makes it possible to autonomously control the charge level within each battery module. It gauges load voltage, rate of current and remaining battery capacity. A patented algorithm assesses the state of health and preventive maintenance forecast for the pack. The SeaSafe Observer GUI displays battery state of health and charge status.

Put Them To The Test!

The SWE SeaSafe II and SeaSafe Direct batteries have passed a host of tests to ensure they are safe for subsea use. SWE conducted exhaustive functional and pressure testing at Southwest Research Institute on the batteries for years.

ABS issued a design approval on the batteries in 2017, which included review and approval of more than fifty SWE engineering design, test and product documents. In one particular test, the SeaSafe II and SeaSafe Direct battery module cases were immersed in fire to verify that the case was inflammable.

SWE SeaSafe II and SeaSafe Direct passed the International Standard IEC 62619:2017 Safety Requirements test for non-propagation of forced thermal runaway. For the intentional overcharged cell-induced thermal runaway test, SeaSafe Direct module was manufactured to allow direct overcharging of Cell 4 in order to bypass the built-in BMS safety system. All cells were fully charged before testing. Three SeaSafe Direct modules were placed side-by-side with a modified module in the middle, in oil, inside a stainless-steel enclosure.

Cell 4 in the modified module was overcharged 150% normal charge voltage directly at 6 V at near 150 Amps, bypassing BMS cutoff control. After 30 minutes into the intentional overcharge, the cell went into thermal runaway. The potting split as designed, allowing the cell to vent into the oil as designed. There was no flame and the two adjacent battery modules in the case did not show any damage. There was no thermal runaway propagation from module-to-module.

Other tests SeaSafe II and SeaSafe Direct passed include UL 1642:2012, IEC 62619:2017, IEC 61000-4-2:2008, IEC 61000-4-3:2010, IEC 61000-4-6:2013, IEC 61000-4-4:2012, CISPR 16-2:2016 and UN 38.3:6th Edition.

SWE SeaSafe II and SeaSafe Direct have also been certified to UN38.3 on transport safety. Tests included altitude simulation, thermal, vibration, shock, external short circuit, and overcharge. The tests found that the battery modules comply with UN38.3.

The design and creation of SWE SeaSafe II and SeaSafe Direct brings Blue Technology in to the 21st century.

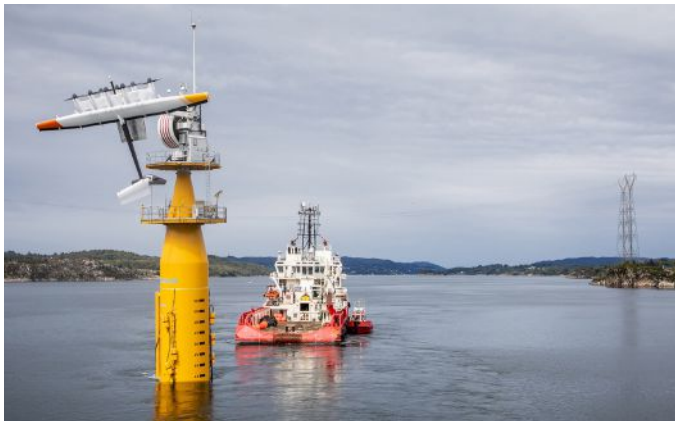
About the Author

Leon Adams is the vice president of sales in lithium and lithium-ion battery solutions, product definition and technical customer support at Southwest Electronic Energy Corp. He is a member of the Marine Technology Society, Society for Underwater Technology and Institute of Electrical and Electronics Engineers. Adams holds an M.B.A. and B.S. in Engineering Physics.

CHECK THE TECH:

FLYING TURBINES HARVEST OFFSHORE WIND

Makani's New Energy Kites Could Compete With Floating Turbines



» *The Makani airborne wind power system being transported to a successful offshore demonstration 2019. Photo credit: Makani.*

Offshore wind can power the world, but there are serious challenges in harvesting this resource. For one, the strongest most reliable winds blow high above the ocean surface (up to 500 meters). Also, some of the strongest winds blow in places where the water is prohibitively deep, or remote, or the conditions are especially harsh. Of course, some of the world's most innovative companies are developing floating platforms for offshore wind turbines, but a more affordable solution would be welcome, especially for small island nations. That's why Makani, a subsidiary of Alphabet Inc., is developing energy kites in partnership with Royal Dutch Shell Plc.

Makani kites use a wing tethered to a ground station to efficiently harness energy from the wind, generating electricity at utility-scale. As the kite flies autonomously in loops, rotors on the wing spin as the wind moves through them, generating electricity that is sent down the tether to the grid.

The Makani energy kite system integrates advances in aerospace engineering, materials science, and autonomous controls to create a lightweight design that is easy to transport and install. A suite of simulation tools have guided the design and development. Computational models of kite aerodynamics, structural loads, and the g-forces of flight have informed the design of the 26-meter carbon fiber wing and high-strength tether.

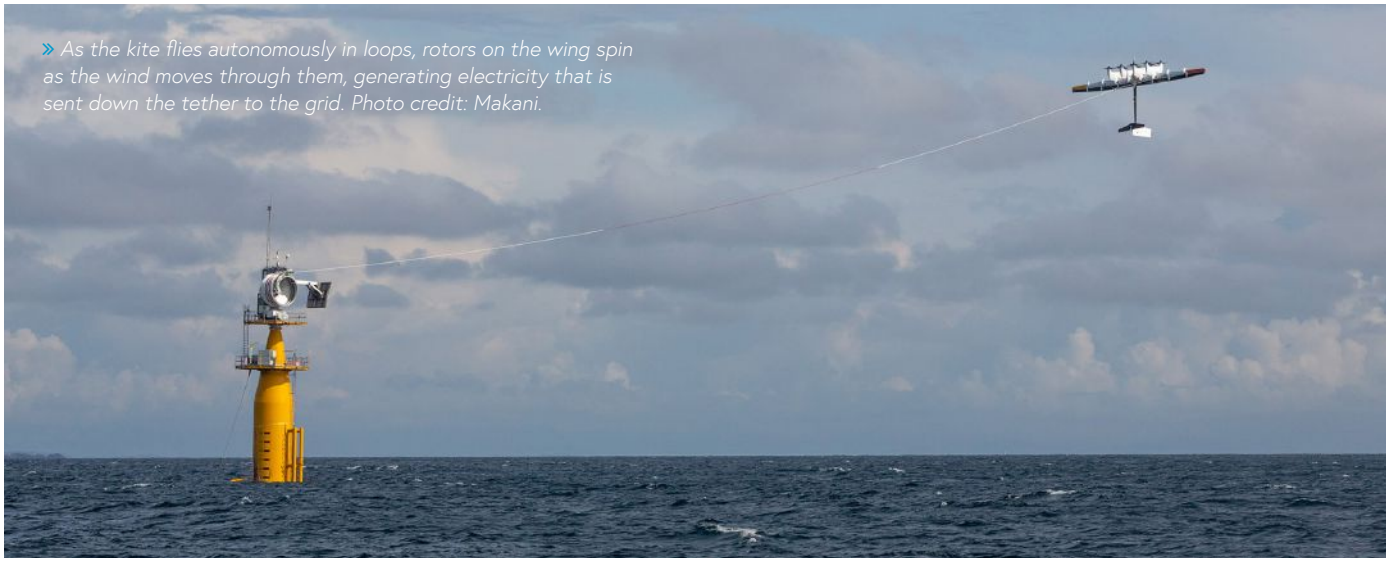
Makani has over a decade of experience designing, building, and testing energy kites. In 2015 they began testing their current prototype which is designed to transfer up to 600 kilowatts of electrical power—enough to power about 300 homes. Makani successfully demonstrated their airborne wind power system offshore in 2019. The demo was completed about ten kilometers off the coast of Norway in the North Sea, in waters 220 meters deep.

How it Works

When sited on land, the kite rests on a base station atop a concrete foundation. Offshore, the base station is bolted to a steel spar buoy. The kite's flight path is controlled by onboard computers running custom flight controller software. Data from GPS and other sensors help the software steer the kite.

The kite positions itself downwind and climbs to an altitude dictated by the flight controller, with the hybrid motor/generators initially consuming a small amount of energy. The kite then transitions into crosswind: flying autonomously in a circular path optimized for maximum power generation by the flight controller. As the kite flies, wind spins the rotors. This drives onboard generators to produce electricity which is transferred down the tether and to the grid.

The low mass of Makani's system unlocks wind energy resources in areas offshore that are not economically viable for existing technologies. Harnessing energy from the wind in new places means more people around the world will have access to clean, affordable wind power. *www.makanipower.com*



» *As the kite flies autonomously in loops, rotors on the wing spin as the wind moves through them, generating electricity that is sent down the tether to the grid. Photo credit: Makani.*

INTERMOOR'S IM-RELEASE: THE QUICK RELEASE CONNECTOR THAT SAVES TIME AND MONEY

The IM-Release is a game-changing acoustic quick release mooring connector that is available to moored vessel operators who are looking to save valuable time and money not only in the case of weather or emergency avoidance (blowout, icebergs, hurricanes…) but also in the context of operational optimization.

The IM-Release was designed using a proven mooring connector and its secondary actuated release system, with an advanced control system. The control system uses high-fidelity acoustic modems, and implements domain key authorization, unique addressing, network relay and frequency hopping techniques, ensuring the mooring connectors are not affected by obstructions or noise. These features eliminate the possibility of an inadvertent release and allows for the connector to be actuated individually, in clusters, or even sequenced in any order.

More importantly, the new connector weighs a quarter of the weight of other connectors yet can disengage at 100% of its rated break strength; a massive 900t compared to less than half of that in older products. Being four times lighter and smaller than other existing devices, it is easier and safer to install, saving an average of seven hours per rig. These new features have been implemented while improving battery life from eighteen months to five years.

The acoustically operated mooring connector is based on two components, all field tested and with a strong track record:

» The SRP Rocksteady subsea connector (DNV and ABS verified), which is the world's leading renewable connector and has been used on all major wave and tidal projects around the world

» Teledyne's acoustic modem, which has been used for underwater location beacons, ROVs, seismic technology etc.

As offshore industries continue to adapt to market conditions, there is an ongoing need to make offshore operations both more cost efficient and less risky. There is a benefit for moored vessels which must move off location for maintenance (such as offshore floating wind vessels) or for vessels which move from location to location (such as mobile offshore drilling rigs) to utilize the IM-Release.

The IM-Release provides a significantly safer way to disconnect a vessel from a mooring. Utilizing an IM-Release can reduce risk by allowing the vessel to move off location quickly in the case of severe weather or other emergencies. The IM-Release can also be used to optimize efficiency by allowing faster disconnections, allowing vessels to move off location quickly and move more efficiently from one location to another.

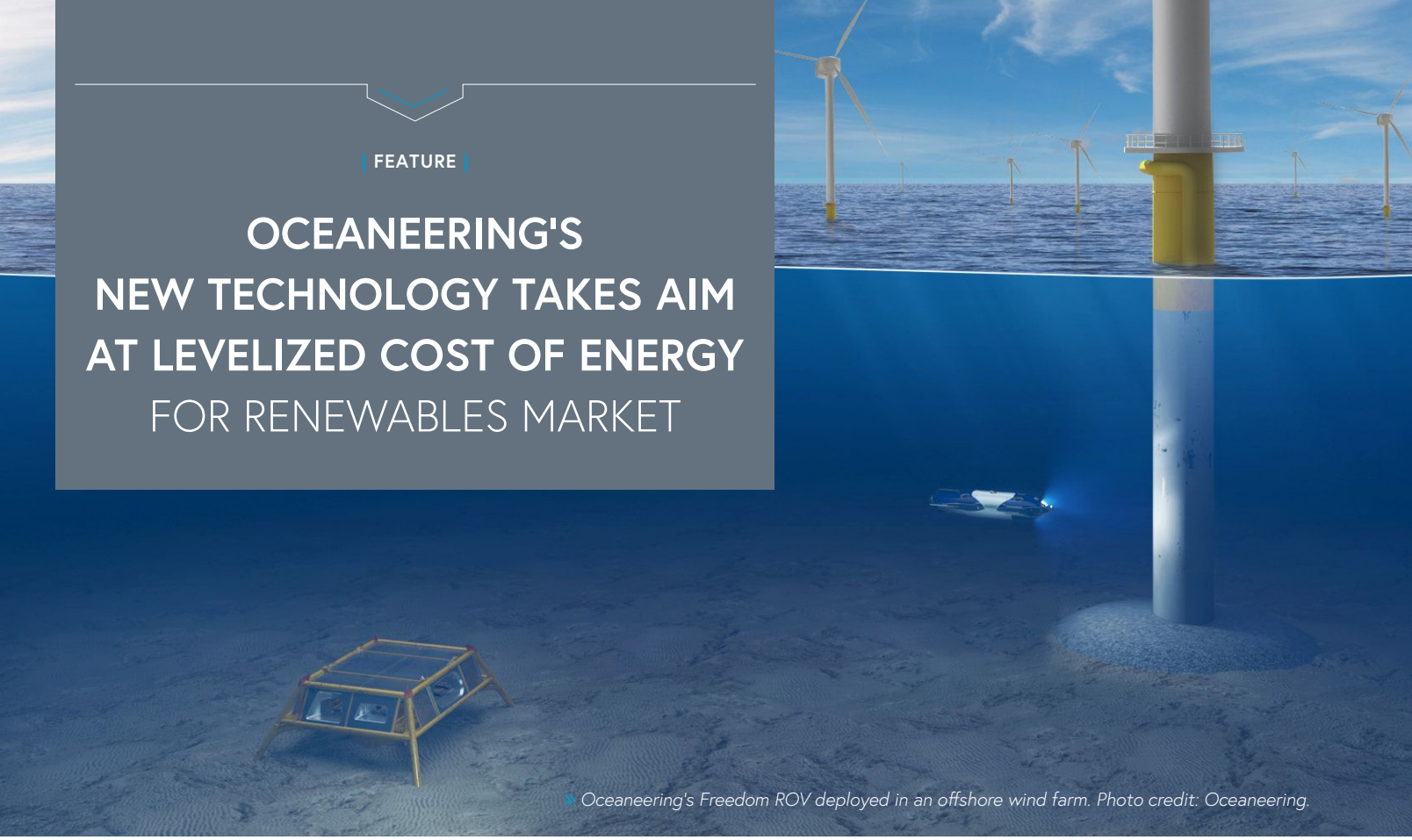
» IM-Release has cost and risk reduction benefits for moored vessels which must move off location for maintenance (such as offshore floating wind vessels) or for vessels which move from location to location (such as mobile offshore drilling rigs). Photo credit: InterMoor.

» The new connector weighs a quarter of the weight of other connectors yet can disengage at 100% of its rated break strength. Photo credit: InterMoor.

To find out more about InterMoor, visit WWW.INTERMOOR.COM

| FEATURE |

OCEANEERING'S NEW TECHNOLOGY TAKES AIM AT LEVELIZED COST OF ENERGY FOR RENEWABLES MARKET



» *Oceaneering's Freedom ROV deployed in an offshore wind farm. Photo credit: Oceaneering.*

While Oceaneering is a known provider of remotely operated vehicles (ROVs), the subsea engineering firm, which has over 15 years of experience serving the renewables industry, is set to launch several new vehicles designed to meet the challenges faced by the renewables industry.

Oceaneering recently embarked on a joint project with a university in Scotland to identify methods to enhance route preparation and cable burial. The study involves performing scale-model laboratory tests focused on the dynamics of the ploughing process, improving tool design, and enhancing soil management. Plough system design improvements are expected to boost performance in challenging soil conditions and enable Oceaneering to meet strict guidelines in highly-regulated areas offshore the U.S.'s eastern coastline.

> *"The advantages of our systems in the U.S. are significant," said Simon Miller, Business Development Manager at Oceaneering. "Not only will plough enhancements enable us to meet Dredge Act requirements, but they will lower the potential risk of violation to contractors who may not fully understand them. This solution aims to enable non-U.S. flagged heavy vessels used for cable lay activities to focus on their core tasks, while burial is addressed off the critical path with our assets."*

Miller said that Oceaneering's main goal is to work with the relevant regulatory agencies and their clients to ensure compliance in any region in which the company works.

"We aim to provide a complete system for route preparation and cable protection as well as turnkey solutions," he said.

The Fully Modular Ocean Manta

The Ocean Manta, a shallow-water jet trenching vehicle, is capable of completing post-lay burial, from the beach to offshore, in water depths up to 55 m (180 ft). The system can accommodate deeper water depths up to 100 m, dependent on burial requirements and soil classification.

The Ocean Manta is a fully modular system that offers easy mobilization. It is lighter than heritage deepwater machines and doesn't require deck space for dedicated launch and recovery systems. This means the Ocean Manta can be flexibly deployed via a crane on a light construction vessel, a shallow water barge with suitably rated crawler crane, or directly from the beach for splash zone.

Careful consideration was taken with the design of the Ocean Manta. The system generates far less noise pollution than conventional jetting machines, due to its surface-fed electro/hydraulic power packs. The subsea noise profile is equal to a typical 175HP work class ROV. This minimizes risk to developers undertaking projects in areas sensitive to marine mammals.

The system also includes a patented energy containment system (ECS) – a weighted covering that is deployed during jetting operations

» *Ocean Manta increases operational efficiency. Photo credit: Oceaneering.*

to significantly dampen the sediment plume in the water column. The ECS assists in ensuring energy loss within the trench (via sediment plumes) is minimized by capping the open top of the trench during burial operations. With the ECS deployed and trailing the jetting machine, fluidized soils within the capped trench are kept suspended longer, allowing the product more time to sink under its weight and greatly lowering the risk of not achieving target depth of burial.

Increasing Operating Windows With Isurus™ ROV

The industry is continually looking for methods to increase efficiency, reduce risk, and lower the overall carbon footprint. Oceaneering has embraced these objectives and integrated features into one of the newest additions to its fleet, the Isurus ROV.

The Isurus is a flexible, fast, fully work-class-capable ROV that is specifically designed for the severe current conditions faced by many renewables installations.

"We identified a gap in the market and realized we needed to create a solution," said Darren Shannon, ROV Senior Operations Manager, Oceaneering. "The vehicle ultimately combines the core components of our field-proven Magnum™ Plus ROV with optimized hydraulic and propulsion packages and a new, hydrodynamic design."

Scheduled for its first job in October, Isurus overcomes the challenges ROVs traditionally encounter while operating in conditions exceeding 2 knots. Capable of operating at up to 5 knots, Isurus increases the operational window and reduces cost attributable to delays from bad weather conditions. Because Isurus can function in higher currents, work can be completed more efficiently, on-time, and cost-effectively.

» *Isurus completes monopile weld inspection. Photo credit: Oceaneering.*

The Isurus vehicle's high speed and station keeping capabilities allow it to increase cable lay efficiency. Its work class capabilities help decrease the time required to perform pre- and post-lay cable survey runs for cable messenger wire hook up. The vehicle is also capable of holding position in the water column to assist during touch down monitoring.

Isurus can also be used to complete other renewables applications including anode cage hook up and structural inspections such as deploying robotic crawlers for subsea weld inspection at wind farm assets.

The Next-Gen Resident Vehicle: The Freedom™ ROV

The Freedom™ ROV, Oceaneering's next-generation resident vehicle, pushes subsea robotics and autonomy to the next level while delivering cost savings, reduced risk, and lowered carbon emissions.

Freedom delivers a modular, hydrodynamic vehicle capable of residing subsea, maintenance-free, for durations up to six months. Freedom is supported by docking stations for deployment and recovery subsequent to operations, such as initial wind farm site mapping and investigation surveys. These docking stations eliminate the requirement for a surface vessel. When considering routine wind farm surveys, maintenance and inspection, this has significant financial and environmental benefits.

"Our customers need a viable alternative to conventional deployment of vessels and ROVs in situations where the work may be lengthy in duration, such as surveys or operations and maintenance tasks (O&M), for example. They also want a flexible system that can be used for routine inspection and light intervention. Freedom fits all of these briefs," Miller said.

"With substantial range and our on-board battery technology, we are pushing the boundaries to undertake complete wind farm site surveys in the development stages of projects. Data capture and quality are our guarantees to our clients to ensure conventional, vessel-based geophysical surveys can be replaced in the near future," he said.

With an ability to dock, receive mission instructions, undertake tasks, and return to docking for a recharge and upload of data before moving onto the next wind farm assignment, Miller believes wind farm operators will see a benefit from using Freedom during the O&M life cycle.

"In the UK, and along the U.S. East coast, there is a real opportunity for asset sharing across projects to help drive the levelized cost of energy down," Miller said.

Freedom's design has been optimized to include functionality found on survey AUVs (long range, sensors, cameras), observation class ROVs (hovering capabilities), and work class ROVs (tooling and tethering). Freedom's ability to not only complete work, but its role collecting data during higher-speed surveys highlights another pivotal development.

Having reliable data and communications is key to advancing subsea vehicles, such as Freedom. Oceaneering launched the Satellite Agnostic Intelligent Link (SAIL) solution in 2018, which is a rapid-deployment, stabilized VSAT/LTE communications package, capable of supporting high-throughput bandwidth globally via a diverse portfolio of satellite constellations.

The SAIL solution has proven to operate work class ROVs through a fail-safe satellite connection, enabling faster real-time data transfer from offshore to shore, which is necessary for completing digital inspections, remote piloting, and bulk operational technology uploads.

Pushing The Boundaries

With decades of engineering experience, Oceaneering continues to push the boundaries of currently available technology to enable a lower carbon future for the offshore energy industry.

WWW.OCEANEERING.COM

RHODE ISLAND OFFSHORE WIND DEVELOPMENT UPDATE

ON&T chats with Hilary Fagan, Executive Vice President of Business Development for the Rhode Island Commerce Corporation

By now, most people have heard that Rhode Island is home to the first U.S. offshore wind farm. The capabilities, partnerships, and best practices they have developed should continue to benefit the development of offshore wind in New England and the Mid-Atlantic states for decades to come.

One of the key challenges for offshore wind in the U.S. is the development of a supply chain, a skilled workforce, and industry-specific capabilities. Rhode Island is well-positioned to solve these challenges. For example, the state connects companies through its Supply Rhode Island initiative and its dedicated Offshore Wind Supply Chain Database. It's no surprise that a place called the Ocean State succeeds at bringing new industries together. Rhode Island has long been home to a wide range of maritime industries, including boat building and servicing; development of advanced materials; ocean sciences and engineering; and the development of unmanned underwater vehicles. For example, it's easy to imagine how the expertise developed by companies working with the Naval Undersea Warfare Center in Newport, in testing both undersea systems and unmanned vehicles, can translate to our expertise in offshore wind inspection and survey. ON&T chatted with Hilary Fagan of the Rhode Island Commerce Corporation about the next steps for offshore wind in her state.

ON&T: What is the Rhode Island Commerce Corporation doing to ensure that your state has the technical workforce to remain at the forefront of this industry?

Fagan: The Rhode Island Department of Labor and Training has provided the resources for us to build and specially train our offshore-wind talent pool. We are also utilizing a number of grants and initiatives—for example, Real Jobs Rhode Island, which offers certificate programs in our high schools. Made possible by an initial $100,000 grant through Real Jobs Rhode Island, the Wind Win RI program offers courses on everything from marine safety to engineering, with the goal of getting students to graduate with an offshore wind energy certificate equivalent to nine college credits. The class of 2020 will be the first to graduate with the energy certification, which will include special licenses, marine safety certification, first aid and more. Then, students can pursue a trade out of high school, or continue on to college for further education in wind energy.

The University of Rhode Island and Community College of Rhode Island are also part of a consortium of education partners helping with the curriculum and course work needed to develop offshore wind talent in Rhode Island.

ON&T: How is Rhode Island partnering with other states to advance our nation's offshore renewable energy portfolio?

Fagan: The demand from New England states for offshore wind energy is strong and growing, so the entire region will benefit from the growth of this industry. One way we're interested in coordinating is through our port infrastructure. We want to further explore ways we can collaborate to successfully develop offshore wind opportunities off the New England coastline.

ON&T: In the fall of 2018, Deepwater Wind was acquired by Ørsted. What did this mean for its existing projects (like the Block Island Wind Farm) and future projects in the region?

Fagan: We're hugely supportive of Deepwater Wind, now Ørsted. What is exciting is that Ørsted is an industry leader, so its acquisition of Deepwater Wind brings additional in-depth and technical knowledge into our state, especially since it named Providence its U.S. co-headquarters. This relationship with Ørsted benefits our supply chain, mostly recently with GEV Wind Power, which recently made Rhode Island the home of its U.S. headquarters, and strengthens our renewable energy supply chain and will enable Rhode Islanders to further access clean energy careers. This is the latest announcement that is putting Rhode Island at the forefront of the U.S. offshore wind industry.

ON&T: In June, General Dynamics' Electric Boat broke ground on a $792 million expansion of its submarine-building facilities in North Kingstown, Rhode Island. What attracted General Dynamics to North Kingstown, and what is your office doing to bring more maritime construction to your state?

Fagan: We've worked very closely with Electric Boat to help it train the talent and develop the workforce it needs in our state. In anticipation of the thousands of jobs it will create here in the next decade, we partnered Electric Boat with six of our career and technical schools, which are now training Rhode Island high school students in advanced welding and shipfitting. The program begins in a student's freshman year and grows more advanced each year, ultimately leading to paid internships during senior year and to the possibility of a well-paying job at Electric Boat after graduation.

To ensure that Rhode Islanders of all stages are being trained to fill the Electric Boat jobs, 500-plus people of all ages will also be hired and then trained through the company's partnership with the Community College of Rhode Island and the New England Institute of Technology. An additional $2 million has been allotted to the new Job-ready Workplace Learning Program, which provides refundable job training tax credits on a competitive basis to support job training.

Our Real Jobs Rhode Island initiative has now trained hundreds of Rhode Islanders to fill maritime manufacturing jobs at Quonset Business Park, which 200 companies call home.

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A DEEPER DIVE INTO OFFSHORE ENERGY CONNECTIVITY CHALLENGES

By Stewart Kantor
President and CFO at Ondas Networks

The offshore renewable energy industry, which encompasses wind generation and tidal energy, has grown steadily over the last decade. This growth is expected to continue, with recent reports from the Global Industry Analysis claiming that one of the primary offshore energy sources, wind capacity, is forecast to grow by over 80 gigawatts (GW) through 2024.

This growth comes with challenges, however, as more wind turbines and new technologies require secure, reliable and highly available mission-critical data connectivity. The networks for these operations must be able to provide continuous connectivity in challenging RF environments including wireless communications over seawater which absorbs radio frequencies (RF) and limits range with increased capacity requirements to handle the numerous dispersed MC-IoT technologies.

More Capacity and Quality at Sea

Historically, offshore energy operations have relied heavily on satellite communications for connectivity. These networks can be costly with many limitations for mission-critical connectivity including capacity and quality of service constraints (e.g. latency). Furthermore, the ongoing need to implement and maintain security has added to these data requirements and is driving offshore energy to enhance its networks for the Mission-Critical Internet of Things (MC-IoT).

Other alternatives include cellular service providers and private wireless network solutions. Cellular operators are rarely an option given their networks focus almost exclusively on land-based operations which are driven by large consumer subscriber bases. Private wireless networks for shore to offshore communications have been constrained by both their proprietary wireless protocols and by capacity. Unlicensed wireless solutions have limited range and quality of service issues (e.g. WiFi based).

A New Standard Emerges for Licensed Private Wireless Networks

In 2017, a new standards-based option emerged from IEEE which has helped address concerns around network capacity, reliability and security — IEEE 802.16s. The IEEE 802.16s

standard was a grassroots effort launched by the Institute of Electrical and Electronics Engineers (IEEE). The standard provides a higher degree of security, reliability and capacity by leveraging existing licensed frequencies that are readily available to mission-critical entities and offshore energy operators. The standard was designed specifically for mission-critical entities and allows for higher throughput, including multi-megabit data rates, and greater quality of service as compared to legacy narrowband technologies.

The protocol supports very long transmission ranges (up to 50 miles from a base station) which serves to minimize the amount of infrastructure and helps reach offshore technologies. Additionally, it uses Time Division Duplexing which is a highly efficient protocol for asymmetric data networks as found in energy generation applications. The network can be built to ensure bandwidth availability to support data flow and speeds, establishing a framework for operators to access technologies that work in a broader range of available, licensed channel sizes to support capacity and bandwidth needs.

Looking Ahead

The incorporation of MC-IoT and private wireless networks imposes an ambitious precedent for offshore applications. By establishing the ultimate goal of a secure, multi-vendor eco-system across global critical infrastructure end markets, mission-critical infrastructure will be able to establish the private, reliable secure networks needed to create safer and smarter offshore operations.

For more information, visit WWW.ONDAS.COM

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COMPANY SPOTLIGHT

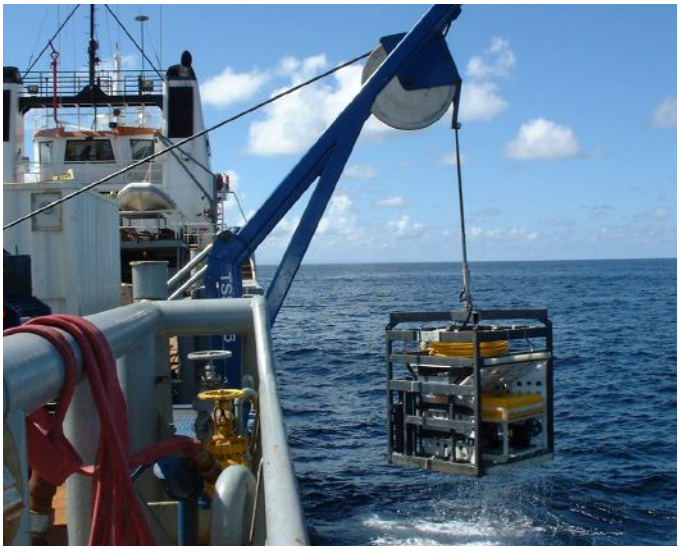
MARINE VENTURES

FROM DEFENSE TO INFRASTRUCTURE AND ENERGY: MVI SERVES EVOLVING OCEAN INDUSTRIES

Marine Ventures International, Inc. (MVI) has come a long way since its founding in 2009. Initially, MVI's focus was providing offshore scientific and operational personnel for large-scale sampling and surveying efforts, including staffing of the natural resource damage assessment program following the 2010 Deepwater Horizon oil spill. More recently, MVI has responded to the evolving needs of the industry, with a particular focus on governmental projects relating to undersea surveillance and environmental assessments — both in terms of national defense and the potential environmental impacts of offshore wind development and nearshore dredging projects. Today, MVI is considered an industry-leading provider of ocean engineering, environmental consultancy, and program management services, and is fully equipped to partner with private sector clients and government agencies alike on subsea development, marine construction, and defense projects.

A Unique set of Specialist Service Lines

Over the last decade, MVI has expanded its talented team of maritime professionals to develop an exclusive set of specialist units, known as Service Lines. One leading Service Line is Government Projects, which, in 2018, joined a group of undersea and maritime technology members as part of the Undersea Technology Innovation Consortium (UTIC), an organization formed to promote the development, prototyping, and commercial application of innovative undersea technologies and services.



UTIC is funded by the Naval Undersea Warfare Center (NUWC) which awards companies like MVI to bolster the cross-utilization of emerging and creative ideas and technologies contributing to the defense of US and international waters. This year, MVI joined Applied Research Associates' Expeditionary Warfare Team to support the Naval Surface Warfare Center (NSWC) and the Navy's expeditionary needs. These opportunities allow MVI to join with other non-traditional companies and work collaboratively with the US Government to develop new technologies and services.

Another of MVI's most prominent Service Lines is Protected Species Observation, a hub of international BOEM/BSEE certified Protected Species Observers (PSOs) and Marine Mammal Observers (MMOs) qualified to meet the mandates set by permit conditions and requirements for mitigating impacts to marine animals during industrial operations. MVI has deployed consultants in the Gulf of Mexico, the Caribbean Sea, off the shores of South America, and in the Mediterranean Sea for a range of corporate clients and governmental entities. As a provider of Passive Acoustic Monitoring (PAM), MVI also offers cost-effective, rapid deployment of PAM equipment shipped directly from our office in Stuart, Florida.

The Subject Matter Expert (SME) Service Line, launched in 2017, is also thriving. The team, headed up by Dr. Alan Hart, features leading experts from the fields of ecotoxicology, health, safety and environment (HSE), organic chemistry, and physical oceanography. Past projects range from the development of HSE documentation to evaluating the risk of potential environmental impacts from methanol produced in water discharges from offshore platforms.

Other MVI Service Lines include Submarine Cable Projects, Technical and Engineering Services, Marine Environmental Consulting, and wildlife monitoring during marine construction projects. Technical services include vessel mobilization/demobilization and logistics support, deck equipment operations, sampling and oceanographic equipment operations, and offshore survey operations. MVI's substantial project management and marine engineering experience includes the development and deployment of subsea communications networks, including subsea nodes, oceanographic instrumentation, and offshore buoys for power and communication purposes.

For more information, visit
WWW.MARINEVENTURES.COM

OPEX GROUP SECURES NORTH SEA CONTRACT WITH CNOOC FOR DIGITAL SERVICES

An Aberdeen-based provider of predictive analysis services has secured a new multi-million-pound contract with CNOOC Petroleum Europe Limited, a wholly-owned subsidiary of CNOOC Limited, for digital services across the company's UKCS assets.

The three-year contract, with extension options, will see OPEX Group roll out its X-PAS™ predictive analysis service on the Buzzard, Golden Eagle and Scott platforms, supporting operations across all topside oil, gas, water and power systems. OPEX has delivered digital services for CNOOC Petroleum Europe Limited for the past seven years through its previous contract with the company.

The X-PAS™ service has been developed by OPEX to support oil and gas operators improve the predictability of offshore operations. Combining oil and gas and data science expertise with a range of predictive technologies, the service helps operators to maximise the value of operational data. OPEX collaborates closely with oil and gas facilities' support teams to capitalize on this existing data and expertise in a way that enables them to act

proactively in order to improve production uptime, solve complex problem areas and help reduce maintenance costs.

For more information, visit
WWW.OPEX-GROUP.COM

HEEREMA'S HEAVY LIFT VEHICLES SUPPORT OFFSHORE WIND PROJECTS

Participates In Largest US Offshore Wind Project

Dutch offshore contractor Heerema has been assigned to help build the first and largest commercial offshore wind farm in the United States. The prestigious 'Vineyard Wind LLC' project is the nation's first utility-scale offshore wind energy project. Situated 14 miles off the coast of Massachusetts, this project will generate clean, renewable, cost-competitive energy for over 400,000 homes and businesses, while reducing carbon emissions by over 1.6 million tons per year.

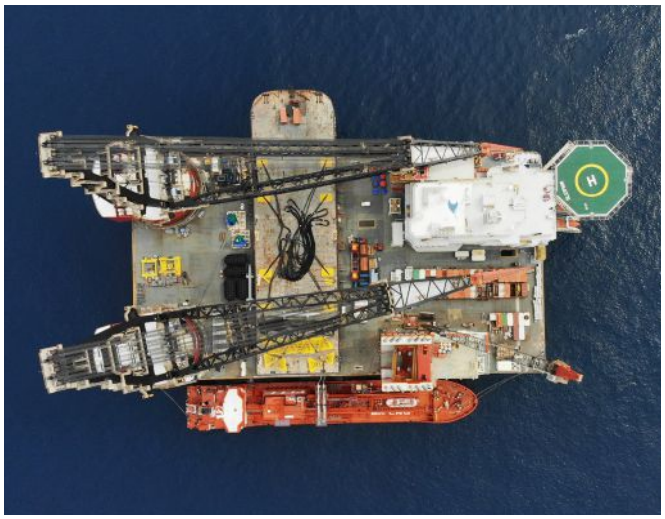
The contract for Heerema is comprised of the (offshore) transport and installation (T&I) of 84 foundations consisting of monopiles and transition pieces and appurtenant ESP platforms in the Northeast of the US near the island of Martha's Vineyard.

CEO Koos-Jan van Brouwershaven is excited: "We are extremely proud to be part of the first and largest commercial offshore wind project in the United States. This project fits perfectly into Heerema's agenda to participate in innovative and sustainable projects. Our vessels are ideally suited to install specific infrastructure in complex conditions. As an experienced offshore contractor, Heerema is continuously seeking opportunities to further strengthen our position in the international offshore market through innovation, proactivity and reliability. We expect that more of these exciting projects will follow in the near future".

The construction is expected to start next year and the wind farm is scheduled to be operational in 2021.

First Wind Project In Taiwan

Heerema Marine Contractors has signed a new contract to support the construction of a wind farm project, this time in Taiwan. Assigned by the Taiwan branch of Jan de Nul, Heerema will take on the installation of 21 jacket foundations (4 legged) for the Changhua project.



The Changhua Windfarm Phase 1 project is situated in Taiwanese waters and is a project of the Taiwan Power Company (TPC) and executed by a consortium of Jan de Nul and Hitachi. The installation will take place 8 km off the coast of Changhua county, at a water depth of 18 to 28 meters.

The installation will be done by Heerema's fast sailing heavy lift vessel *Aegir*. *Aegir* is capable of executing challenging projects such as these and is perfectly suited to install the 21 foundations in the harsh conditions in which this project takes place. The foundations must be able to withstand extreme Taiwanese circumstances such as earthquakes, typhoons and high waves.

Koos-Jan van Brouwershaven, CEO of Heerema Marine Contractors is excited: "This is our first contract in Taiwan, thus another major milestone. This Changhua project re-emphasizes Heerema's commitment to operate in wind projects all over the world and strengthen our position in the Asian offshore wind market".

Van Brouwershaven praises the hands-on mentality of both Jan de Nul and Heerema contract teams. "The willingness to constantly seek cooperation between partners is what drives this team and Heerema as a company. With such a mindset we can jointly achieve anything".

For Heerema, the offshore phase of this project will start in March 2020 with planned completion in early June 2020.

Maiden Voyage For World's Most Sustainable Crane Vessel

In July 2019, Heerema's newest vessel left upon her maiden voyage. *Sleipnir*, the world's largest and strongest semi-submersible crane vessel (SSCV) was built in Singapore and will set course for Spain. The trip will take about 45 days and is schedule to wrap up in late August.

Sleipnir is designed to work on large offshore projects such as installing and removing jackets, topsides, deep-water foundations, moorings and other offshore structures, such as windmills. This unique vessel is the largest crane vessel yet

built. It has the strongest pair of revolving cranes and also is the world's first crane vessel with dual-fuel engines running on MGO and LNG, dramatically reducing harmful emissions.

The last two days bunkering of LNG took place 12 miles off the coast of Indonesia. Since LNG is not yet obtainable worldwide, Heerema is the first to perform an LNG bunkering in this area of the world. Heerema has selected Dutch company Titan LNG to help in this undertaking. Titan LNG has chartered a ship commercially managed by Anthony Veder, also Dutch, thus resulting in a unique Dutch cooperation.

Koos-Jan van Brouwershaven, CEO Heerema: "Not only is *Sleipnir* the world's largest and strongest vessel, it is also first of its kind as far as sustainability goes. We are making offshore history. No other vessel has such numerous features. Our LED lights and shore power electricity are only a few examples of Heerema's ambition in this area. Sustainability is an integral part of HMC's identity, embedded in our daily work practices. But we intend to do far more than that. *Sleipnirs*' design clearly showcases Heerema's dedication to sustainability beyond simply compliance. It shows that we act sustainably because we want to, not because we have to. This specific project of bunkering LNG is proof of this ambition. We are very pleased to work together with Dutch Company Titan LNG, since it provided us with good solutions for bunkering, in Singapore as well as in Spain. The involvement of a second Dutch company, Anthony Veder, makes this maiden voyage extra special."

"I'm extremely proud of the Titan team that has successfully completed the largest LNG bunkering in the World," said Niels den Nijs, CEO Titan LNG. "It was a complex project to supply this eight-legged innovative crane vessel, the *Sleipnir*. I'd like to thank Pavilion Gas and SLNG for the support in Singapore and Anthony Veder, our shipping partners, that completed this Dutch-Singaporean project. Titan LNG looks forward to supplying Heerema with more LNG in the future to fulfil our mission of lowering harmful emissions of the marine and industrial sector."

Jan Valkier, CEO of Anthony Veder says: "We are excited by serving Heerema's *Sleipnir* with this LNG bunkering operation, in cooperation with Titan LNG, and look forward to many more. Shortly after adding Coral Fraseri to our fleet we have already mobilized her in the small-scale LNG market, which underlines our strong position and commitment in supplying the maritime industry worldwide sustainable solutions for LNG as marine fuel."

In its trip to Spain, *Sleipnir* will round South Africa's Cape of Good Hope. In the Mediterranean, Titan LNG will again supply the *Sleipnir* using the *Coral Fraseri* that will pass through the Suez Canal.

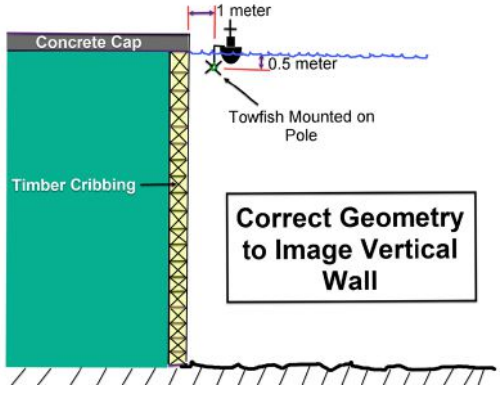
VERTICAL WALL INSPECTION USING SIDE SCAN SONAR

By Garry Kozak, GK Consulting

Harbors, Ports, Bridge Supports and Canal Systems have many vertical wall structures which need to be periodically inspected for integrity and possible degradation. Common methods for inspection are the use of divers or ROVs with cameras for visual inspection. These methods work well in water that has some visibility, but in black water, the methods are handicapped. Sonar is an alternative way to get high resolution images which is not limited by visibility and the process of inspection is quicker than by divers or ROV. This article presents the methodology for successfully inspecting vertical walls using side scan sonar.

An engineering firm in the Great Lakes was doing work on a length of harbor wall and needed a method to quickly inspect the crib wall structures. In the past, sector scan sonars have been used to inspect wall structures. This is a good technique for small areas, however if the requirement is for a long section of wall structure, it takes many independent sector scans and this is a time consuming process. Then to get a continuous image post processing must be done to match and blend the individual sector scan images into a mosaic. The sector scan tile matching is typically done manually in Photoshop since there is no software that automatically creates mosaics. The engineering firm requested a trial to see if standard off-the-shelf side scan sonar could be used to produce data of sufficient resolution for inspection of the vertical wall structures. A survey was performed with an EdgeTech 4125 side scan system operating at 1600 kHz. The 1600 kHz frequency was selected to image the crib walls because of its extremely high-resolution capability.

With the proper survey technique, side scan sonar can produce a continuous image of an entire long vertical wall at a very high resolution. The resulting data is geo-referenced and can be processed automatically in software like SonarWiz Map. This is a very efficient technique requiring minimal acquisition and post processing time. The success of inspecting a vertical structure with side scan sonar is dependent on understanding and controlling the geometry of the scan. The correct technique is to place the sidescan sonar towfish about 1 to 2 meters from the wall to be inspected and only about .5 to 1 meter in depth (Image 1).



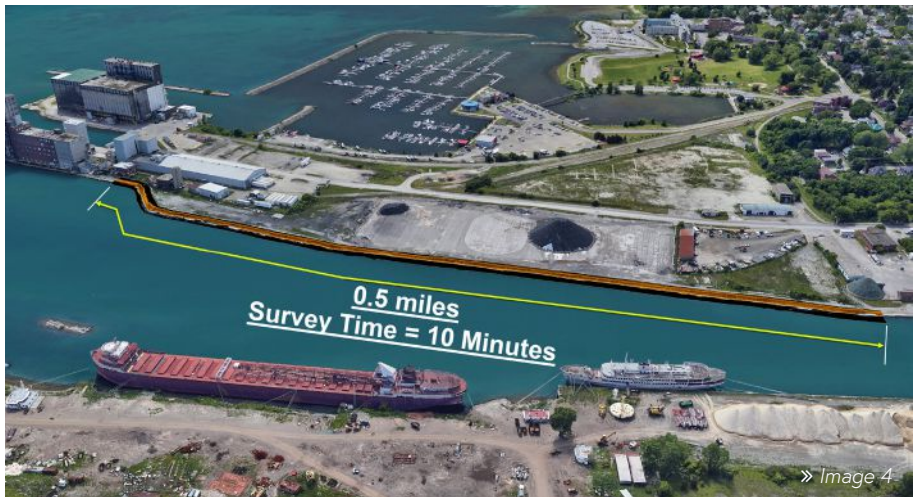
» Image 1

» Image 2

Pole mounting of the side scan sonar and rotating the fish in the pole mount bracket to position the transducer at an optimum angle for imaging the wall would be a perfect setup. However, since the small boat (Image 2) we collected the data out of had no pole mount, the towfish was simply hung on a rope off one side of the boat, 1 meter in depth and towed. No rotation was done to the towfish transducer. Since the sidescan sonar vertical beam is so wide, not rotating the transducer in practice had no negative effects on the quality of data collected.

The EdgeTech 4125 system (Image 3) is a lightweight, portable system which was setup and operational in 10 minutes onboard the small boat of opportunity that was provided for the survey. The sonar was operated on a 15 meter range scale to maximize the ping rate for optimum resolution data.

» Image 3



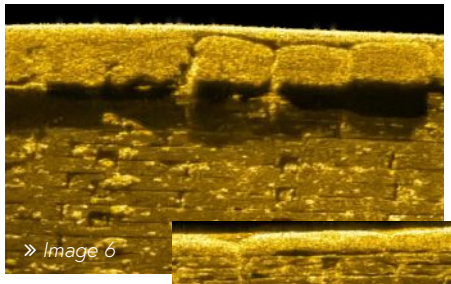
» Image 4

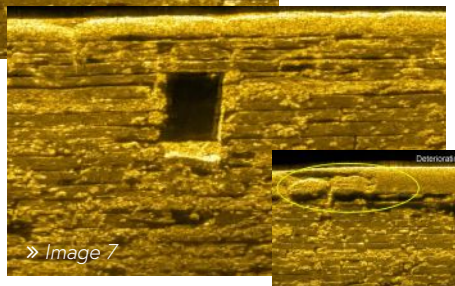
A single survey track was made in front of the wall maintaining the towfish about 1 to 2 meters from the wall face. The length of wall that was required to be inspected was 0.5 miles and the scan was completed in 10 minutes (Image 4).


» Image 5

Cribbing walls are constructed of timbers that are layered and secured with tie in timbers to prevent collapsing. An example of cribbing wall construction is shown in Image 5.

The resulting sonar imagery was of very high resolution allowing the viewing of every timber, seam, missing timbers, concrete cap deterioration (Image 6), outflow openings (Image 7), undercutting or areas of non-support of cribbing wall (Image 8), etc. The results exceeded all expectations of the engineering company and met all their inspection requirements. This trial conclusively showed that with the right field data collection technique, side scan sonar is a very effective tool for vertical wall inspections.


» Image 6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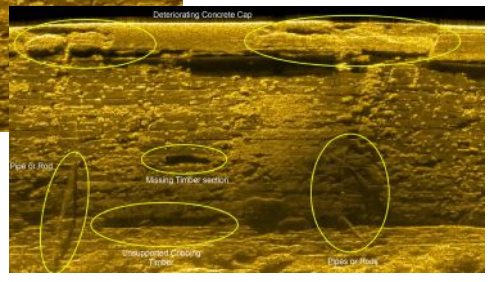


» Image 8

SMD UNVEILS NEW GREEN, SUPER CAPABLE WORK CLASS ROV

SMD unveiled their electric Work Class ROV at Offshore Europe. Their new Quantum/EV ROV introduces electric drive technology to the subsea sector in an optimized, modular package which brings their Work Class ROV performance and capability to a new level.

The high capability Quantum/EV is SMD's environmentally responsible solution designed around five key principles covering performance, reliability, flexibility, ease of use and compact form factor. The prototype, showcased at OE19, is equipped with a range of cutting-edge technologies including the completely new 25kW high power electric thrust system, a new long-distance DC transmission solution and locally managed DC power system. Quantum/EV has a 20% increase in performance and is twice as efficient when compared to SMD's current Work Class ROVs. The new platform also features advanced flight processing for super stability, battery compatibility for tetherless operations and is future proofed to accept AI command technology.

SMD has been subjecting the newly developed technologies and the new vehicle to a thorough testing program that will continue over the coming months. First deliveries are expected to begin in 9-12 months.

Mark Collins, SMD's Director for Remote and Autonomous Technologies has been involved throughout the development process said, "The technology will support our client's ambitions and is suitable for traditional vessel, Unmanned Vessel and resident applications. One of the novel things about the EV technology is its modular flexibility. We've created future-ready, component-based, modular architecture which can be extrapolated for different uses; easily transferred for use in AUVs and USVs."

WWW.SMD.CO.UK

CYGNUS FLOODED MEMBER DETECTION TOOLS OFFER OPERATIONAL FLEXIBILITY AND POTENTIAL SAVINGS

Flooded Member Detection is an inspection regime designed to screen subsea platform structural members for defects. A cracked weld, for example, can allow the ingress of sea water into the member which may create a point of failure for the structure. Operators therefore inspect these members on a regular basis to gain confidence that there has been no sea water ingress.

Techniques

There are two recognised non-destructive testing techniques that allow for Flooded Member Inspection; the use of a radioactive source (commonly referred to as the Gamma Technique), or using Ultrasound. Inspection using a radioactive source is effective and can be fast – as the source does not need to physically touch the Member and therefore no cleaning or surface preparation is required. But Cygnus Instruments has embarked on a full development and trials cycle because the UK-based ultrasonic specialist believes that a fully developed, professional UT system can now play a much greater role in FMD in the future.

This is because while some degree of surface preparation is needed for Ultrasonic Testing (UT) of Members, that perceived disadvantage can very often be outweighed by two distinct advantages: operational flexibility and cost savings. Because the Gamma Technique uses a radioactive source, the equipment is almost always provided as a service by a third-party contractor. To operate the equipment one, or often two, specialist technicians must come with the equipment – and they will then take up precious bed-spaces offshore. The Cygnus UT equipment is extremely easy to understand and simple to operate; therefore, existing personnel from the diving or ROV team will perform the inspection work themselves – creating a good cost saving for the operator.

In addition, as the Cygnus system is able to sit on a vessel without incurring personnel costs, it means that an operator and its inspection contractor can perform small packets of FMD inspection work as and when it is convenient; a vessel is not tied to meeting a third-party inspection service provider offshore at a certain time in a certain place. With the Cygnus system, work can be done as and when it suits.

CYGNUS EQUIPMENT

The Cygnus UT FMD system is the only system available to buy that is designed by dedicated ultrasonic non-destructive testing specialist. To that end, when the Cygnus system presents a Flooded / Not Flooded result, that result is backed up with a true UT A-Scan. This allows for more interpretation of a result and that the technician is properly informed.

For more information, visit
WWW.CYGNUS-INSTRUMENTS.COM

AIRBORNE OIL & GAS AWARDED MAJOR TCP FLOWLINES CONTRACT

Airborne Oil & Gas B.V. has been awarded a large contract from a supermajor through Oceaneering International Inc to supply Thermoplastic Composite Pipe (TCP) flowlines for deployment in West Africa. It is believed to be the first TCP solution of this type utilized in the region and expected to save the operator up to 40% on total installation costs.

The contract builds on a long-standing relationship between Airborne Oil & Gas and the E&P business on the qualification and deployment of TCP and marks a significant milestone for Airborne Oil & Gas in supplying TCP for permanent subsea applications. TCP as a non-metallic, composite pipe which delivers high levels of corrosion and fatigue resistance and therefore a significantly extended service life.

Under the contract in West Africa, the world's leading manufacturer of TCP will provide the supermajor with a 4km, 7.1-inch ID, 160 bar design pressure TCP Flowline for water injection replacing existing corroded flowlines in the field. The total installed cost of TCP has proved to offer significant benefits to the operator's pipeline replacement projects, particularly for water injection lines which often suffer from corrosion.

WWW.AIRBORNEOILANDGAS.COM

N-SEA ADVANCES UXO MANAGEMENT TECH

Between 600,000 to 1,000,000 naval mines were dropped in the North Sea during the second world war. Despite post-war clear up campaigns, thousands of unexploded ordnances (UXO) are still left on seabeds around Europe. These UXOs put a high risk on operations and the vessels used during the construction of wind farms, especially when laying cables, pilling foundations and jack-up vessels. Before work begins, it is crucial that they are removed as effectively and efficiently as possible.

Developed by N-Sea in collaboration with EIVA, MagSense is a vertical gradiometer array system which gathers and records high resolution information in magnetically noisy subsea environments and hostile conditions. Many North Sea UXOs are deeply embedded into the sea floor, making detection and recovery difficult, but MagSense's vertical gradiometry makes identification far easier, reducting the excavations required, as well as time and cost.

MagSense excels in tempestuous environment, specifically the North Sea, with one particular project taking half the time to complete compared to previous campaigns. Designed to lead on wide seabed surveys, as well as collect high density data in shallow waters, MagSense technology can be towed through water when used alongside the EIVA 3D Scanfish, meaning that the most problematic areas can be accurately surveyed. Moreover, infill is not required; 3D steering is built into the design and extra sensors enhance control. Risk to personnel is also lessened though the unique launch-and-recovery system (LARS) feature which keeps manual handling to a minimum.

The nearshore environment is also challenging for UXO clearance, but in 2018, N-Sea BODAC UXO BV launched the remotely operated dredge (ROD), which comprises a dual-ended rotatable tool with gradiometers, assisted by the implementation of strategic artificial intelligence and machine learning technology with a 12-inch dredge tooling at one end and a grab removal tool at the other. ROD has provided unprecedented nearshore UXO clearance productivity on projects in the German and Polish sectors. Deployed from a shallow draft spud pontoon, ROD is able to operate down to zero water depths round the clock. The tool utilizes real-time kinematic for accurate positioning, incorporating altimeter, acoustic and optical imaging as well as an extremely powerful dredge pump to safely excavate and identify targets. Operators can control ROD remotely from a control room allowing work to continue after conventional ROV or diver methods have been shut down by weather or excessive currents.

» *Siem Vessel N-Sea.*

WFS TECHNOLOGIES' SEATOOTH® PIPELOGGER FOR MAJOR SUBSEA PIPELINE PROJECT

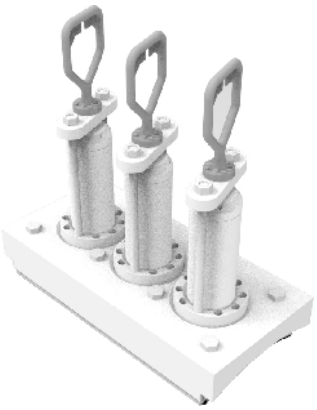
Allseas chosen WFS Technologies' new Seatooth® Pipelogger for the real time measurement of process temperature on a subsea pipeline system which they installed recently. The pipeline system is designed to have a total gas throughput capacity of 31.5 billion cubic meters per year.

WFS Technologies' Pipelogger is a real-time, wireless technology which requires little to no maintenance, and can operate at depths of up to 2,000 m without the need for periodic and costly ROV inspection - contributing significantly towards reducing the operating cost while monitoring process condition to optimize gas delivery parameters.

The new Mark III generation of Pipeloggers feature a hot-swappable sensor configuration as well as the capability to create subsea cloud networks for real-time analytics at the edge.

WFS Technologies is an industry pioneer of the Subsea Internet of Things (SIoT) devices.

Moray Melhuish, Commercial Director at WFS Technologies, said, "By combining our proven Seatooth technology with the ability to hot-swap components, we are able to future proof the installation by enabling the simple addition of capability as the requirement emerges. This can include ultrasonic flow, vibration, cathodic protection status, ultrasonic thickness and metocean conditions, as well as the initial requirement – in this case, the monitoring of process temperature."



The Seatooth® PipeLogger is a smart, wireless, subsea internet of things device designed to deploy multiple sensors and devices on subsea pipelines, trees, risers and manifolds. It is a cost-effective alternative to hard wired systems for production, flow and asset integrity monitoring and calibration. WFS' patented Seatooth technology supports two-way communications through seawater, seabed, concrete coating, ice and the splash zone.

ASHTEAD TECHNOLOGY EXPANDS IMR SERVICES WITH NEW ACQUISITION

Ashtead Technology has further expanded its inspection, maintenance and repair (IMR) and decommissioning capabilities with the acquisition of Underwater Cutting Solutions (UCS) for an undisclosed sum. This is the fifth deal completed by the international subsea equipment and solutions specialist since the firm was acquired by Buckthorn Partners and APICORP in April 2016.

Founded in 2004, UCS is a market leader in the North Sea, providing mechanical cutting, dredging and coating removal equipment and services. Over the past 15 years, it has developed and successfully deployed a suite of purpose designed tools and techniques for the cutting of subsea and topside pipelines and structures.

The addition of UCS to Ashtead's portfolio follows recent growth announcements in key geographic regions, most notably investments in a new Houston facility and the expansion of its Singapore base.

WWW. ASHTEAD-TECHNOLOGY.COM

| FEATURE |

MITIGATING DIGITAL RISKS IN THE OFFSHORE REALM

ON&T editor Greg Leatherman sat down with Justin Gratto, Senior Security Consultant at Secure State Cyber, to capture his insights into securing digital security for companies working in the offshore industries. His answers proved both informative and eye-opening

1. What are some of the common vulnerabilities that exist for ocean industry companies moving into digitalized assets?

I do not have the data across all verticals in the maritime industry, but based on the clients we have been exposed to my answer may surprise you. The most common vulnerabilities that exist in ocean industry companies are not technical, they're human. The top three threats are:

I. Ransomware – A ransomware encryptor (e.g., Gandcrab) relies on phishing as the vector of attack, not unlike other common encryptors such as Wannacry, could rely on vulnerable open SMB V1, RDP or Remote Desktop Protocol for their attack. Ransomware share one thing in common; encrypt files that don't belong to them and charge a fee to decrypt the files. Gandcrab has been most successful in proving long-term relevance by way of the attack vector not being something easily patched (the user) and adaptability to detection by antivirus engines (being updated).

II. Phishing in General – There is a real trend in successful phishing campaigns being a real problem in maritime industry companies, but it is not a problem that is uniquely maritime.

III. Access Control Policy – Yes, you heard me right, lack of policy or failure to enforce an access control policy with regards to local and domain administrator accounts is in my top three threats to the maritime industry.

It's vital that companies educate users on risks and how to spot a phish, as well as implementing strict control of admin accounts. They should also limit or deny using open remote desktop protocol and replace it with a more secure alternative.

There is a website to help victims of ransomware retrieve their encrypted data. It has a listing of every decryptor available to recover ransomed files without having to pay the criminals. (see Resources on page 41).

2. What about 5G, blockchain, and emerging tech? Are companies prepared?

Being an early technology adopter could be compared to eating a chocolate covered coffee bean: sweet on the outside, bitter on the inside, and capable of keeping you up at night, but it will give you a huge boost in the short term.

The overall risks of introducing any new technology to a company or being an early adopter of any new technology are the "unknown unknowns" (unexpected or unforeseeable risks). In such cases, the earlier you adopt a new tech, the higher the assumed risk. We assume high risk, because there is nothing to compare it to. There are no metrics yet.

3. Who is equipped to mitigate cyber vulnerabilities?

Cyber attacks are HSSE threats and the responsibility is everyone's.

First, senior management must understand what the most valuable assets to the company are, define requirements for protecting those assets, and draft a budget that funds enough security to not only ensure the business is protected in terms of prevention, but also continuity during and recovery after incidents.

Secondly, every member of the crew and those supporting the business back on shore must be educated about risks, how to spot a phish and what to do when a threat is discovered. Those best-equipped are an educated and cyber-vigilant workforce.

4. Much offshore digitalization is happening incrementally. How does Secure State Cyber approach incremental change?

When a top-down approach is not applicable, then one must use a bottom-up approach. Each incremental change must include disaster recovery and business continuity plans. Ask yourself, if we implement this new incremental change, how will it impact these plans? Does it disrupt the availability of any other

systems? Are redundant systems in place?

We look at security from the perspective of assuming your preventative measures will eventually fail. Someone will inevitably drop the ball; we like to be prepared to catch it.

5. How can operators secure platform control and safety networks, while still allowing the real-time reporting of data to business, vendor, regulatory and cloud systems?

There should be clear network segmentation or segregation in the form of three VLANs or virtual local area networks. One VLAN for platform control and safety systems that included operational technology, one VLAN for the IT systems that performs administrative or business functions such as reporting and a last VLAN for guest or crew network providing morale internet services. Equipment and devices should not be able to be used on any network except the one intended. The laptop that you use to connect to the uncontrolled guest Wi-Fi should never be the same laptop you use to access either other VLAN. This also goes for USB removable media between those devices.

6. How does your company identify cyber risks when it comes to something like operational systems?

Operational systems are like IT systems in that threats can be categorized at the high level into three categories:

1. Insider threat, a malicious, accidental or negligent threat that belongs to the organization.
2. External threat, a malicious, accidental or negligent threat that does not belong to the organization.
3. Natural Disasters, these things happen and you have no control over them..

Of course, IT systems process and transmit data, while OT systems control physical machines and often have a high safety impact. Therefore, controlling and limiting physical access to OT systems is a concern, and providing physical and logical airgaps can be a useful strategy. Network segmentation and establishing and enforcing trust zones is necessary for security in an OT environment; so is controlling and clearly documenting who has administrator privileges.

Timing is key. Controls or functions that lag processes can cause disruption or even system failure, which is critical when zero downtime is a requirement. Therefore, redundancies or backup systems, as well as a high fault tolerance, are required. Such systems have low compatibility parameters and/or are proprietary protocol dependent. We also see resource inflexibility—*just enough* resources to perform designed functions. And of course, the Chief Engineer is often responsible for procurement.

7. What role does training play?

Training empowers employees, crew, and passengers to be the first line of defense in a cyber risk mitigation strategy. It can prevent needless downtime and loss of operating cost. A user is already being paid by the organization, we see training them to do their job well and to prevent security incidents as the most effective use of a security budget. What's more, educating your users can help prevent burnout and stress-related injuries in your IT department.

There is one caveat: in order to be effective, security training must be conducted in a way that the users are interested or at the very least won't hate. Professionally written and delivered training that uses methods for captivating an audience is key.

8. What about geopolitical factors?

Geopolitical factors can and do impact some larger nation-state threat actors or those sponsored by nation-states. Secure State Cyber suggests having your security department stay on top of cyber threat intelligence reports and try and share information with similar company's security departments in a joint intelligence sharing platform. This helps your company stay on top of trends and shine a light in dark places for your security teams. There are paid products and services being offered for cyber threat intelligence (see Resources, below).

9. What does Secure State Cyber's average project lifecycle look like?

An average project for Secure State Cyber starts with an assessment/security review accompanied with a Risk Treatment Plan as the deliverable. Throughout the whole process there is frequent communication with the customer. Following the initial assessment/security review, we work with the customer to make a selection of which cyber risks to mitigate, a definition of scope and the project start date. Depending on the risk levels and what the customer wants to achieve, it could take 2-6 months.

RECOMMENDED RESOURCES:

Find Secure Alternatives from AlternativeTo: https://alternativeto.net/software/remote-desktop-connection

Download Decryption Tools from NoMoreRansom: https://www.nomoreransom.org/en/decryption-tools.html

Gain insights into products and services offered for cyber threat intelligence via Gartner: www.gartner.com/reviews/market/security-threat-intelligence-services

Educate and empower digital technology users via Beauceron: https://www.beauceronsecurity.com

The Future of Maritime Cyber Security: https://securestatecyber.com/cyberbloggen-en/the-future-of-maritime-cybersecurity/

DEME COMPLETES ELIA'S MODULAR OFFSHORE GRID SUBSEA EXPORT CABLE INSTALLATION

DEME successfully completed the installation of 85 km of subsea export cable for Elia's Modular Offshore Grid, deploying the state-of-the-art cable installation vessel 'Living Stone'. The cable connects Elia's Offshore Switch Yard to the shore station Stevin at Zeebrugge, as well as the Rentel wind farm Offshore Substation.

'Living Stone' collected the cable at the manufacturer Hellenic Cable in Greece, transported it to the site in Belgium and performed a flawless cable installation, offshore jointing and four pull-ins. According to DEME, works have been completed in record time and well ahead of schedule. The unique dual-lane cable installation system, consisting of two cable highways, can install one cable while the next cable can be simultaneously prepared on deck, including the installation of the cable protection system (CPS).

"This is again a very successful job executed by the 'Living Stone'. It was great to see all plans worked out without any set back," says Marco Kanaar, Project Director at DEME Offshore. "Usually with a new, complex vessel such as the 'Living Stone' you might expect some teething problems, however it was great to see that our crew had already ironed out any potential issues beforehand. Definitely the great team spirit between our marine crew and project team and certainly the constructive approach from our client Elia have been instrumental to the success."

"The MOG plays an essential role in the transition towards more renewable energy. We are especially proud that Elia can act as a pioneer in this regard," says Tom Pietercil, Project Director at Elia. "The project has been completed in record time: the first agreements were made with the authorities in March 2016, and the MOG will be operational this September. This is the result of good cooperation between all partners in the project."

"It is a great pleasure to confirm the safe and fast completion of another project ahead of schedule," says Hugo Bouvy, Managing Director of DEME Offshore. "The offshore crew of the 'Living Stone' as well as our dedicated project team have provided high quality services and workmanship. This significant achievement once again demonstrates DEME Offshore's expertise in engineering and execution of cable lay projects. It definitely marks our continued growth in what DEME Offshore recognizes as a crucial market for the world's future energy needs."

The Belgian Modular Offshore Grid submarine power cable project was awarded in August 2017. DEME also deployed the newest trailing suction hopper dredger 'Bonny River' on the project to backfill 45 km of trenches.

Source: *www.deme-group.com*.

BUSINESS NETWORK FOR OFFSHORE WIND AND SUBCABLEWORLD TO HOST CONFERENCE ON OFFSHORE WIND CABLES IN OCTOBER

SubCableWorld (SCW), the preferred information resource of the submarine telecom industry, and the Business Network for Offshore Wind (The Network), a non-profit organization dedicated to establishing an offshore wind supply chain in the United States, have announced that they will hold the first conference focusing specifically on offshore wind cable supply chain issues in the United States.

The one-day event, entitled "Subsea Cables: A Critical Connection," will be held on October 10, 2019, at the Houston Aquarium in Houston, Texas.

The conference will cover issues related to the development of the US cable supply chain, insurance and risk management, technological advances in cable designs, installation and maintenance and other topics. In addition, SCW will present its demand forecast for the US offshore wind market. Additional details about the agenda will be released soon.

"Cables are a critical component for offshore wind farms, but in the past they have not always received the attention they deserve," said John Manock, editor of SubCableWorld. "This conference will put offshore wind cables front and center in the conversation and will present an opportunity for the industry to recognize the importance of developing a domestic cable supply chain."

Liz Burdock, CEO & President of The Network, said, "Cable damage accounts for as much as 80% of insurance claims at offshore wind farms. Our goal for this event is to focus on the US offshore wind cable supply, best practice installation methods and technological innovations so we start the US industry off right, helping to reduce failures and keeping costs low."

About SubCableWorld

SubCableWorld (SCW) is the preferred information resource of the submarine telecom industry. It includes a website, industry reports, forecasts and analysis, and the daily SCW NewsFeed, which delivers the top news and information impacting the marine markets, including updates on cable contract awards, in-depth industry analysis, new project announcements and cable system upgrades.

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Email: Contact@subcableworld.com
Website: www.subcableworld.com

About the Business Network for Offshore Wind

The Business Network for Offshore Wind is a 501(c)(3) organization dedicated to establishing an offshore wind supply chain in the United States. The Network is focused on delivering education, creating partnerships and advancing the industry. All membership and event proceeds are invested back into supporting the industry by helping the Network continue programmatic education and develop the tools and networks necessary to create a U.S. offshore wind supply chain. The Network hosts the annual International Offshore Wind Partnering Forum (IPF), the leading technical conference for offshore wind in the United States dedicated to moving the industry forward.

Contact:
Ross Tyler
Phone: +1 (443) 652-3242
Website: www.offshorewindus.org

| DEFENSE |

WHY UNMANNED SYSTEMS ARE THE GO-TO OPTION FOR GRAY ZONE OPS IN THE GULF

By Heiko Borchet, via the Center for International Maritime Security (CIMSEC)

» *The UK's Maritime Autonomy Surface Testbed (MAST), an unmanned surface vessel (USV) based on the BLADERUNNER hull shape, undergoes trials in the Tidal Thames. Photo credit: Owen Cooban via Wikimedia Commons.*

INTRODUCTION

Current incidents in the Arabian Gulf should be seized as an opportunity to advance naval conceptual thinking about unmanned maritime systems in gray zone operations. Gray zone activities are an astute object for concept development, as they "creep up on their goals gradually," rather than involving decisive moves, as Michael Mazarr has argued. In response, Mazarr contends, gray zone operations will "call for a greater emphasis on innovation" as these operations take different forms and intensities and thus require varied responses. This coincides with the general need to devote more attention to concepts development that drive the use of new naval technologies such as unmanned systems.

APPLYING UNMANNED SYSTEMS TO GULF SECURITY

Maritime stability in the Arabian Sea has deteriorated significantly over the past couple of weeks. In response to the Iranian seizure of the Stena Imperio, a Swedish oil tanker under British flag, London reached out to different European capitals in view of establishing a maritime protection mission escorting commercial vessels through the Strait of Hormuz.

This incident and prior events in the Arabian Sea such as harassing commercial vessels with speedboats and assaults on commercial vessels are a perfect illustration of so-called gray zone activities. Located between war and peace, gray zone activities involve "coercive actions to change the status quo below a threshold that, in most cases, would prompt a conventional military response," as Lyle J. Morris and others have suggested.

These activities raise an obvious question: How best to respond? Staying out of the region for an interim period, as the British government has advised U.K. shipping, has been interpreted as a watershed moment "when the UK admits it can no longer protect its merchant vessels." But even if political support for the maritime protection mission matured, the question would remain if there were enough adequate platforms to do the job.

Deploying big capital ships or surface combatants to escort merchant vessels might send a strong message of resolve to Iran, but doubts remain if this approach is adequate. Past experiences in the Arabian Sea have made it clear that naval vessels remain vulnerable to speedboats operating at a high tempo in distributed maneuver operations. While this is certainly only one method of attack, it is most important for strategic communication. Small boats successfully attacking or deterring prestigious naval ships delivers a message that all gray zone actors want to convey.

It is time to supply navies with an additional option using unmanned systems. Unmanned maritime systems (UMS) have been developed and used for quite some time, but right now, the majority of unmanned maritime systems are used for mine countermeasures. There is an obvious operational need to do the job, concepts of operations are in place, and technology is mature. This makes a perfect fit, but more can be done.

Unlike gray zone activities in the South China Sea that involve the building of artificial islands to underline sovereignty claims and the use of naval militia and the coast guard to intimidate neighbors, Iran's actions are of a different quality. In the Arabian Sea, mosaic defense emphasizes mass, speed, and surprise. Unmanned maritime systems would be ideal to respond because they can be built to be lost. This levels out current asymmetries between speed boats and big capital ships and denies the adversary the offensive on strategic communications. This attrition-like role is only one mission UMS could play in future maritime

protection missions. Overall, the mission envelope could be much broader.

First, assuming that a maritime protection mission depends on persistent situational awareness and understanding, unmanned systems can be used to collect intelligence and provide reconnaissance. For this mission the emphasis should be on closing the sensor chain from seabed activities through the undersea world to the sea surface into airspace and space. In all of these domains unmanned systems are already in use, but more needs to be done to fuse data to augment the existing Recognized Maritime Pictures (RMP), for example to detect anomalies stemming from adversarial behavior at sea.

Second, unmanned systems at sea can push the defense perimeter out. Forward deployed unmanned surface vehicles (USV) could be used to intimidate an adversary's embarking speed boat fleet thus delaying the launch of operations and creating "noise" that would send alarms to the RMP. A more wicked though not yet technically mature option would focus on very small, mine-like unmanned underwater vehicles (UUV). These assets could be deployed covertly by submarines or by air assets. These UUV could turn into a sort of adhesive explosives that stick to boats running over them, thus rendering them dysfunctional.

Third, unmanned maritime systems could be used for deception operations. A swarm of USV could enter a theater of operation disguised as a big capital ship on the adversary's sensors. As the adversary prepares to counter the ship the USV swarm would disperse into many different smaller platforms thus out tricking the adversarial defense posture. A similar mission can be envisaged for the underwater domain where UUV are already used to imitate the signature of submarines.

Fourth, USVs could constitute the outer ring of maritime protection missions. Robust platforms could be equipped with remote-controlled weapon stations, like the Protector USV developed by Rafael Advanced Systems, to engage incoming speed boats or flying platforms. In addition, USV could be used to deploy electronic counter-measures, for example, to jam adversarial sensors and take out communications between unmanned aerial assets and the respective control units.

CONCLUSION

While some of these ideas are closer to reality than others, what matters most is that concepts and operational requirements need to drive the use of unmanned maritime systems in gray zone operations. So far, the discussion about UMS mainly focuses on providing solutions to meet the needs that emerge in naval warfare areas such as mine countermeasures, anti-submarine warfare, or anti-surface warfare. However, gray zone activities cut across all of these tasks. Adequate responses need to adopt a more horizontal approach, as well looking at the technological building blocks that can be used for all missions. Here, the most recent decision of Belgium and the Netherlands to develop a toolbox of unmanned systems for mine-countermeasures shows the way to the future. This approach could be turned into a holistic concept to deal with UMS for maritime gray zone activities.

Putting extra emphasis on innovation and concepts development also opens up avenues for fruitful cooperation with the Gulf states that step up efforts to expand their own naval capabilities while at the same time ramping up efforts to establish a local naval industrial base. Involving them from the start would make sure that specific regional requirements could be adequately addressed while at the same time contributing toward building up local technology expertise in important areas and incentivizing the establishment of local capabilities and concepts. In the long run this joint approach could help shoulder the burden to provide maritime stability in one of the world's most pivotal regions.

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EDITOR'S NOTE:

Ocean News & Technology is partnering with the Center for International Maritime Security (CIMSEC) to increase awareness of defense technology topics. ON&T reprints this article, which first appeared on the CIMSEC website, with permission. CIMSEC is a 501(c)3 non-partisan think tank with over 800 members in more than 30 countries. CIMSEC does not take organizational positions and encourages a diversity of views in the belief that a broad range of perspectives strengthens our understanding of the challenges and opportunities in the maritime domain.

To learn more, visit *www.cimsec.org*

VIDEORAY AWARDED CONTRACT WITH U.S. NAVY FOR EOD RESPONSE ROV

» *The bottom of the Defender pictured showing a payload of an Oculus 750D multibeam sonar, Inuktun rotating manipulator and a Nortek DVL used for autonomous control such as station keeping and waypoint following. Photo courtesy of VideRay.*

VideoRay has announced its second multimillion-dollar award with the U.S. Navy to develop, define, and deploy new technology for Explosive Ordnance Disposal (EOD) operations. This contract follows the successful completion of an earlier prototype facilitated by the Defense Innovation Unit in 2018. The platform for both contracts is the highly-regarded VideoRay Mission Specialist Series (MSS) Defender ROV, which has been delivered for military and commercial uses to several demanding customers worldwide.

The Defender vehicle, based on VideoRay's Mission Specialist technology, is becoming the technology of choice for a wide variety of challenging missions. It is chosen by Navies, Coast Guards, First Responders, Offshore Oil and Gas Producers, and Offshore Renewable installation companies for many reasons:

Powerful – the Defender has the best thrust to weight ratio in the industry and the ability to lift more than 20 pounds while flying level.

Portable – the Defender can be shipped as checked luggage on commercial airlines and is deployable with just one person.

Open Architecture – the Defender can accept a wide range of accessories, though open software, and multiple power and communications options.

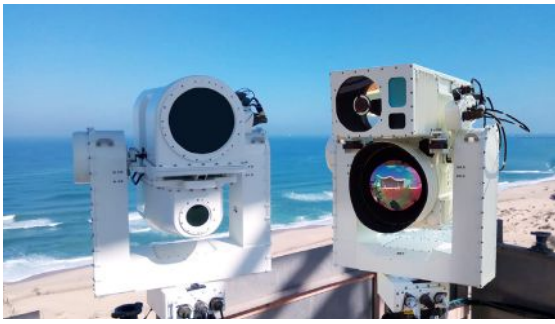
Greensea Integrated Control and Navigation – the Defender includes Greensea's EOD Workspace software for sophisticated supervised autonomy and precise maneuvering. Greensea supports the U.S. Navy with a Cooperative Research and Development contract for software development on this project.

Customer Support – VideoRay is one of the largest and best-established companies in the observation class ROV industry, now celebrating 20 years in business. It has the largest installed fleet of vehicles.

Innovation – with VideoRay's Cooperative Research and Development Agreement (CRADA) with the U.S. Navy helped develop and fine-tune new options and capabilities to meet underwater missions and objectives.

For more information, visit WWW.VIDEORAY.COM

CONTROP'S COMPLETE SOLUTION FOR COASTAL AND MARITIME SURVEILLANCE



CONTROP Precision Technologies Ltd. - a company specializing in the field of Electro-Optics (EO) and InfraRed (IR) Defense and Homeland Security solutions – presents a unique EO suite comprising the TORNADO-ER and the SPEED-ER systems.

The TORNADO-ER provides a panoramic InfraRed (IR) image, automatic detection of moving maritime targets as well as multi-target tracking capability, covering dense maritime areas and detecting swimmers at short ranges and vessels up to 12km. The SPEED-ER is a long-range observation system that is cued to those targets which have been detected by the TORNADO-ER, enabling users to explore the targets and their contents, and providing highly accurate locational details. The two solutions are controlled by a dedicated C2 system, a man-machine interface (MMI) which includes intuitive panoramic imagery, maps, enlarged images, and observation videos. The user-friendly MMI presents targets on the map and on the panoramic image, providing all required information upon request.

The TORNADO-ER includes two mid-wave infrared (MWIR) cameras. The live videos from these cameras are "stitched together" to provide one panoramic stream. The system scans at a rate of 3 seconds for 360°.

The SPEED-ER has an extended long-range camera and highly stabilized optics, featuring CONTROP's unique technologies. The sensors include MWIR, Short Wave InfraRed (SWIR), Daylight Channels, Laser Range Finder (LRF) and an optional Laser Pointer.

For more information, visit
WWW.CONTROP.COM

CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF AUGUST 26, 2019

Oil prices were down in the past month. Prices closed on August 26 at $55.50 per barrel, continuing a downward trend from a summer high close of $59.02 in July. The Wall Street Journal reported that the low price of oil is hitting the Saudi Arabian economy hard and could impact a planned Aramco IPO. In spite of Saudi efforts to cut production to bring prices up, a Reuters August 30 poll of industry analysts showed lower expectations WTI crude prices than a month earlier, due to the U.S.-China trade war and slowing growth in global economies.

Natural gas prices dropped to a 10-year low level in mid-August before rebounding a bit at the end of the month, finishing at $2.27 per million BTU, down $0.20 from a month earlier. Bloomberg noted the impact of a supply glut in Europe, while an EIA report in late August pointed to continued high inventories in the US. As of press time, the impact of Hurricane Dorian was unknown, but some Yahoo Finance and other sources expected a rise in natural gas prices from the storm.

WEEKLY WTI CRUDE & NATURAL GAS SPOT PRICES

Last 52 Weeks

WTI Spot Price

$55.31

$59.02 previous month

TRENDING DOWN

Henry Hub Spot Price

$2.27

$2.47 previous month

TRENDING DOWN

KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF SEPTEMBER 2, 2019

THE DOW JONES INDUSTRIAL AVERAGE AND S&P 500
have fallen significantly in the past month

Equity indexes have be highly volatile in the past month with large losses from concerns over the US-China trade war and recession fears. The Dow Jones fell from record highs in July and on September 2 closed more than 1,000 point lower. The S&P 500 similarly fell from record levels and ended the same period down just over 100 points.

The Philadelphia Oil Service Sector Index (OSX) down again in the past month to 61.97 points. The index has been trending downward most of the year. From one year ago, the OSX is down 78.06 points, or 55%, from its September 10, 2018 close of 140.03.

SELECTED EQUITY INDEXES

CUMULATIVE PERCENTAGE CHANGE

Last 52 Weeks

26,118.02

Up **1,036.18** from previous month

TRENDING DOWN

DJIA

61.97

Up **17.17** from previous month

TRENDING DOWN

OSX

2,906.27

Down **108.30** from previous month

TRENDING DOWN

S&P 500

Coming this winter!

NEW! 2019 UPPER DECK Equipment Guide

UPPER DECK is proud to announce an expanded, all new digital deck equipment guide to be published in Q4 of 2019!

This comprehensive, must-have guide for marine and related industries contains comparative product information for Winches, A-Frames, Cranes and, Buoys and be distributed through ON&Ts' over 20,000 subscribers. In addition, the deck equipment guide will:

- ☑ Contain contact information of manufacturers and rental companies
- ☑ Will have additional global distribution via its availability on ON&T's website for all of 2020 (under "Buyers' Guide")
- ☑ Will be promoted heavily on social media

Don't miss out on this opportunity to reach and connect with industry leaders and professionals!

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ENERGY COMMODITY MARKETS ARE TOTALLY FOCUSED ON DEMAND FACTORS

BY G. ALLEN BROOKS | Author, *Musings From the Oil Patch* | www.energymusings.com

Natural Gas

September ushers in the "shoulder months" for natural gas demand. Temperatures and humidity moderate when fall weather arrives. The market is also exposed to demand drops associated with tropical storms/hurricanes that can cut power needs when they make landfall. If a storm crosses the Gulf of Mexico, natural gas output will be cut as producers shut down platforms and wells and remove staff in order to protect assets and human life. Forecasting storms before they form is impossible, let alone trying to project their routes. The only thing we can confidently predict is that there will be storms and if they arrive on U.S. shores, gas demand will fall, but supply may or may not decline. As hurricane season is a constant — only the intensity and targets are unknown — producers target storage facilities to manage any temporary gas surplus.

Current gas storage continues tracking slightly below the 5-year average, but it is not helping natural gas prices. Almost every week for the past two months, gas storage injections have exceeded the 5-year average. They have also exceeded 2018 weekly injections, which were below the 5-year weekly averages. This weekly injection performance comes as the gas industry reports outsized weekly exports to Mexico and Canada via pipelines, and in liquefied form to global gas markets. Without this significant export demand, the U.S. gas market would be swamped with gas prices sharply lower. As it is, gas prices are sitting close to record lows, well below a year-ago levels, but fighting the pressure to drop below $2 per thousand cubic feet. Winter can't come soon enough.

Global gas prices are mirroring U.S. prices. While global gas supply continues growing, demand has been less robust than previously expected. In Asia, the restarting of nuclear power plants in Japan is cutting that country's gas use, one of the largest gas importers in the world. The Japan Korea Marker (price index for Asia) has fallen close to $4/Mcf, down from $11 a year ago. In Europe, rapidly filling gas storage facilities have cut the European gas price marker by two-thirds to $3/Mcf from $9/Mcf over the past 12 months. An offset may be the earlier closing of the huge Netherlands' Groningen gas field that supplies substantial volumes throughout Europe. While the target closure date is moving forward from 2030, the new date has not yet been disclosed. What we do know is that its output is being slashed by 20% starting in October.

What the world is experiencing is an unintended consequence from the success of the American shale revolution that promoted the U.S. LNG export business. It was predicated on capturing the arbitrage spread between low U.S. gas prices and high-priced international gas, which has disappeared. Gas producers may now be ruing living in the world of "be careful what you wish for."

Crude Oil

Oil prices are see-sawing daily based on the rhetoric surrounding trade tariffs. Whenever "more" precedes tariffs, oil prices sink, fearing further weakening of global economic demand. If the adjective is "fewer" or "delayed," oil prices rise. The degree prices move often reflects the news about other factors such as OPEC's and Russia's solidarity in sustaining production cuts, global economic forecasts, the health of the U.S. dollar, or predictions about U.S. oil output, as well as the weekly U.S. oil inventory data. Potential geopolitical events will also move oil prices – in most cases, higher. Unfortunately, one cannot predict them, as they are almost always a "surprise."

Readers of this column are familiar with our chart showing WTI crude oil futures prices since the start of October 2018 to the latest available data plotted against prices from November 2014 through the end of February 2016. What we have marveled about has been the parallel performance of the recent period's oil prices until early August when the Iranian tanker confrontations began. That tension lifted oil prices by nearly $5 per barrel, or close to 10%. Since then, crude oil prices have fluctuated in a fairly narrow range depending upon daily trade war news. In the past few weeks, all the primary global energy forecasters – IEA, EIA and OPEC – have reduced their oil demand forecasts for the balance of 2019 and for 2020, which has contributed to the downward slope of oil prices in August. The reduction magnitudes vary, but private forecasters are now following with reduced demand expectations, although theirs tend to be larger cuts.

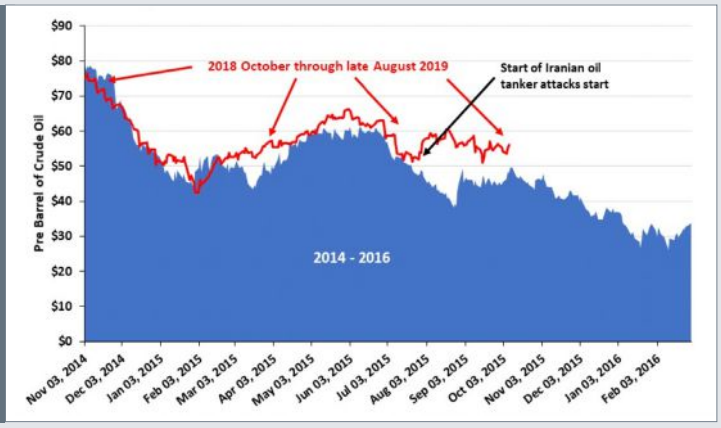
Increased investor pressure on oil companies to cut back their drilling and production activity has impacted the U.S. oil drilling rig count, which will translate into lower future oil output, but no one knows exactly when that will materialize. With OPEC and Russia having cut their output levels well below their maximum productive capacity, and Canada recently announcing it will extend its crude oil production limits through 2020, the world is clearly oversupplied.

Prospects for limited oil demand growth in 2020 and the world in an oil glut, it is hard to argue for higher oil prices later this year or in 2020, unless global tensions ratchet higher. Oil market

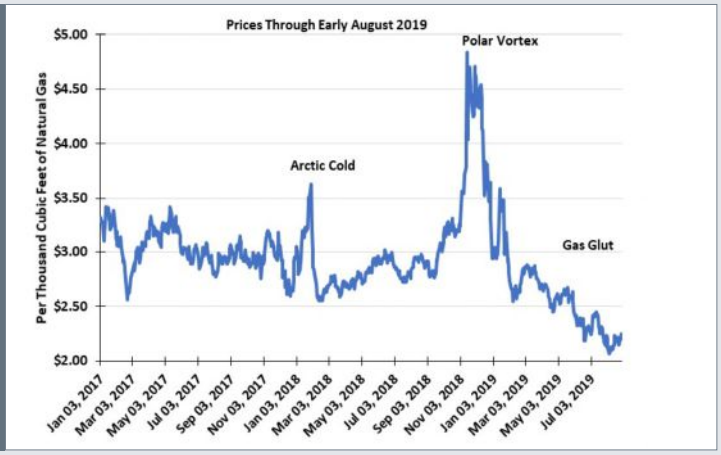
fundamentals suggest that absent geopolitical tensions, prices would be closer to $50 a barrel than the current mid-$50s price. Some observers suggest that absent geopolitical tension, oil prices are heading into the high $40s.

An oil price decline below $50 a barrel would send shock waves throughout the industry. Producers struggling to regain profitability would be at risk once again and forced to cut activity. OPEC producers, facing lower revenues, would likely step up exports hoping to generate additional income. A significant oil price drop would stimulate global economic growth, but wildcards such as trade tariffs and the Iranian and Venezuelan sanctions could upset an oil price rebound.

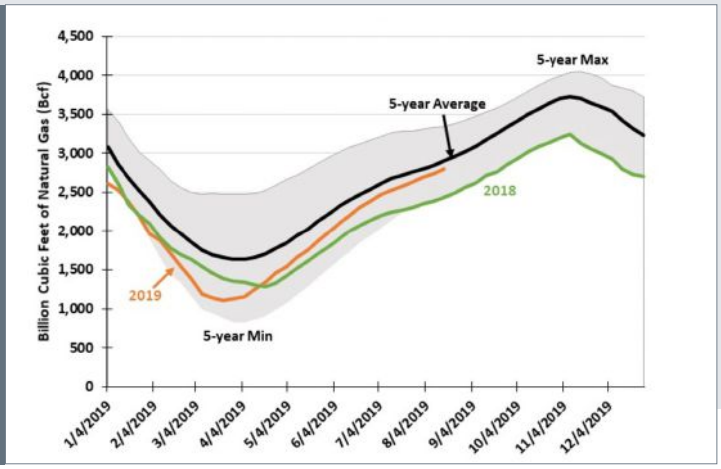
Are Geopolitical Events Helping To Support Oil Prices At Higher Level Than Fundamentals Would Indicate?



2019 Natural Gas Prices: From Promising To Disappointing



Low Natural Gas Prices Helping Rebuild Storage





AMERICAS

Teledyne Marine Tech Workshop
San Diego, CA » October 6-9
www.teledynemarine.com/events/TMTW2019

LAGCOE
New Orleans, LA » October 9-11
www.lagcoe.com/home-expo

MTS Dynamic Positioning
Houston, TX » October 15-16
www.dynamic-positioning.com

AWEA Offshore WINDPOWER
Boston, MA » October 22-23
engage.awea.org/Events

OCEANS'19
Seattle, WA » October 28-31
www.seattle19.oceansconference.org

OTC Brazil
Rio de Janeiro, Brazil » October 29-31
www.otcbrasil.org

GIPEX
Georgetown, Guyana » November 6-8
www.guyanaoilexpo.com

BlueTech Week
San Diego, CA » November 18-22
www.bluetechweek.org

Workboat
New Orleans, LA » December 4-6
www.workboatshow.com

Blue Innovation Symposium
Newport, RI » January 14-16, 2020
www.blueinnovationsymposium.com

EUROPE

Ocean Energy Europe
Dublin, Ireland » Sept. 30 - Oct. 1
www.oceanenergy-europe.eu/annual-event/oee2019

Offshore Energy
Amsterdam, The Netherlands » October 8-9
www.offshore-energy.biz

Green Shipping
Rotterdam, The Netherlands » October 8-9
www.gssummit.org

WindEurope Offshore
Copenhagen, Denmark » November 26-28
www.windeurope.org/offshore2019

Green & Smart Shipping Summit
Rotterdam, The Netherlands » October 8-9
www.gssummit.org

Mediterranean Offshore Conference
Alexandria, Egypt » October 15-17
www.moc-egypt.com

Euromaritime
Marseille, France » February 4-6, 2020
www.euromaritime.fr

OTHER REGIONS

Telecoms World Middle East
Dubai » September 24-25
www.terrapinn.com/conference/telecoms-world-middle-east

Bahrain Int'l Defense Conference
Manama, Bahrain » October 28-30
www.bahraindefence.com

IAMU Annual Assembly
Tokyo, Japan » October 30 – Nov 1
aga20.iamu-edu.org

East Africa Oil & Gas
Dar-es-Salaam, Tanzania » November 7-9
www.expogr.com/tanzania/oilgas

ADIPEC
Abu Dhabi » November 11-14
www.adipec.com

Oceanology International China
Shanghai » November 13-15
www.oichina.com.cn/en/home

Asia-Pacific Deep Sea Mining Summit
December 4-5 » Singapore
www.asia.deepsea-mining-summit.com

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AUGUST		
» Submersibles (AUV, ROV, UUV)	Cranes, Winches, LARS & Control Systems; Sensor, Profilers, Measurement; Thrusters; Umbilical, Tether, Cables, and Connectors	SPE Offshore Europe » September 3-6 Teledyne Marine Tech Workshop » October 6-9
SEPTEMBER		
» Renewables » Offshore Energy Installation & Maintenance	Energy Storage Devices; Inspection Drones; Current Meters	Ocean Energy Europe » Sept. 30 - Oct. 1 Offshore Energy » October 8-9 AWEA Offshore WINDPOWER » Oct. 22-23 WindEurope Offshore » November 26-28
OCTOBER		
» Ocean Science & Technology	Acoustic Modems; Acoustic Releases, Transponders, Command & Control Systems; Technical Schools, Training Programs	OCEANS » October 28-31 BlueTech Week » November 18-22
NOVEMBER		
» Oil Spill Prevention & Response » Ocean Archaeology & Salvage » Executive Profile	Buoyancy Materials; Pressure/ Watertight Housing; Well Control Equipment	Blue Innovation Symposium » January 14-16
DECEMBER		
» Upper Deck Equipment Guide	LARS, Winches, Cranes, A-Frames, and Buoys	

ON&T YOUNG PROFESSIONAL AWARD GOES TO JOSHUA BAGHDADY

The Marine Technology Society has announced its 2019 award winners. The individual recipients—students, young professionals, and career professionals—have distinguished themselves in their work, through technological accomplishment, volunteer service, or mentorship. Companies and MTS Committees and Sections are also honored.

The awards will be presented on October 29, 2019, at the OCEANS 2019 conference, in Seattle.

This year's recipients include:

• **Ocean News and Technology Young Professional Award**: Presented to an MTS member, 35 years old or younger, who has demonstrated leadership in the Society and works in a professional capacity in management, engineering, or research and development in a marine technology field.

Recipient - Joshua Baghdady

• **Compass Distinguished Achievement Award**: Presented to an individual whose career includes achievements that have had a significant impact on the fields of marine science and technology.

Recipient - David Rivera

• **Compass International Award**: Presented to an individual, company, or organization (outside the United States) for outstanding contributions to the advancement of marine science and technology.

Recipient - Center for Ocean Ventures and Entrepreneurship

• **Compass Industrial Award**: Presented to any industrial firm (excluding government and non-profit organizations) that has demonstrated outstanding contributions to marine science and technology.

Recipient - L3 Harris ASV

• **Lockheed Martin Award for Ocean Science and Engineering**: Presented to an individual who has demonstrated the highest degree of technical accomplishment in the field of marine science, engineering, or technology.

Recipient - Roger Hine

• **John P. Craven Mentor Award**: Recognizing the long and impactful career of John Piña Craven, the award is presented to an individual who has demonstrated outstanding and sustained service to the field of marine technology through mentoring.

Recipient - Andrew Clark

• **MTS Outstanding Service Award**: Presented to an MTS member or member organization in recognition of outstanding accomplishments in fulfilling the objectives and missions of the Society.

Recipient - Donna Kocak

• **MTS Outstanding Section Award**: Presented to an MTS Section in recognition of activities conducted in the advancement of the objectives of the Society.

Recipient - Monterey Section (California)

• **MTS Outstanding Committee Award**: Presented to an MTS Committee in recognition of activities conducted in the advancement of the Society's objectives.

Recipient - Buoy Technology Committee

• **MTS Outstanding Student Section Award**: Presented to an established MTS Student Section that demonstrates superior performance in the advancement of the Society's objectives.

Recipient – SRM Institute of Science and Technology- Deemed to be University, India

• **MTS Fellows**: Since 1975, the MTS Fellow title has been awarded to MTS members who have made outstanding contributions to the advancement of the Society's objectives and who have distinguished themselves in their fields.

Recipients - Josh Kohut, John Potter, Ralph Rayner, and Ramasamy Venkatesan

• **Walter Munk Scholar Award**: The Walter Munk Scholar Award is jointly awarded by the Walter Munk Foundation for the Oceans and the Marine Technology Society. The Award is presented annually to a scholar currently enrolled in an undergraduate, graduate, or postdoctoral program. It recognizes their outstanding contributions in areas fostered by the sponsoring organizations.

Recipient - Alfredo Giron (announced previously at the OCEANS 2019 conference in Marseille in June).

"All of these awardees represent the excellence and dedication to the field of marine technology that is so valued by our society. Their imprint on our community will be long-lasting and impactful," said Rick Spinrad, MTS President.

Learn more about the MTS awards. Nominations for next year's award will be accepted from January 1 – May 31, 2020. For eligibility and nomination instructions, visit *www.mtsociety.org/awards-honors.*

marine technology SOCIETY

About the Marine Technology Society

Founded in 1963, the Marine Technology Society is an international, not-for-profit, community of ocean engineers, technologists, policymakers and educators. The Society raises awareness about marine technologies, promotes scientific advancements in the field, and supports the professional development of practitioners through education and research sharing at international conferences and workshops, in technical committees and local Sections, and through its publications such as the peer-reviewed Marine Technology Society Journal. Visit *http://www.mtsociety.org for more information.*

FIRST EVER AZIPOD®-POWERED SHIP TO REACH THE NORTH POLE

Norwegian Coast Guard's vessel KV Svalbard was on an international environmental research expedition when it became the first ever Azipod®-powered ship to reach the North Pole

» *Commanding officer Geir-Magne Leinebo and expedition leader CAATEX Dr. Hanne Sagen at the North Pole. Photo courtesy of the Norwegian Coast Guard.*

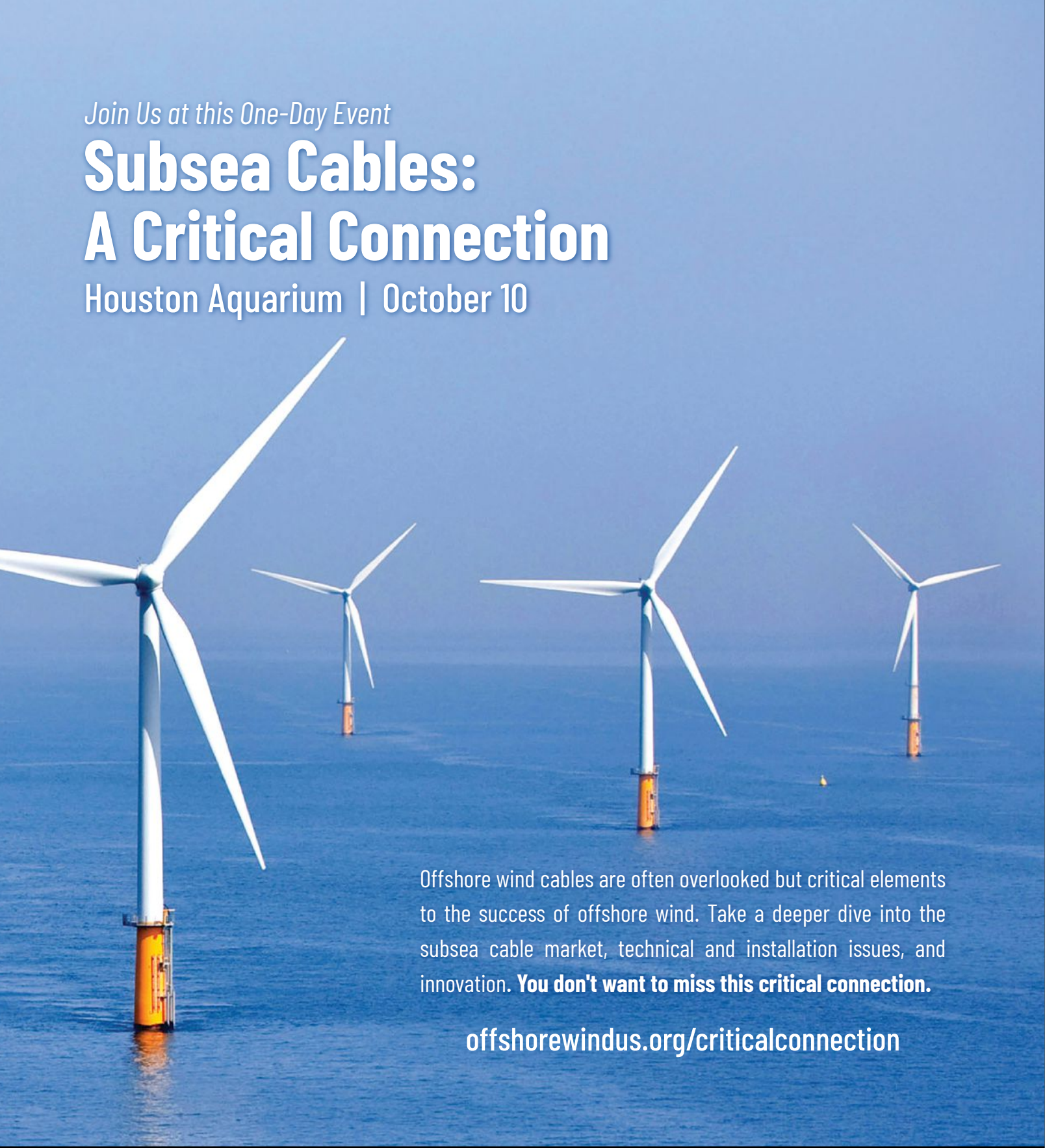
With its superior performance in the harshest of ice conditions, Azipod® propulsion has become an industry standard for ice going vessels, enabling vessels to cross the Northern Sea route independently. In late August 2019, Azipod® propulsion has made history, driving a Norwegian Coast Guard icebreaker all the way to the North Pole. In another historical debut, KV Svalbard became the first Norwegian vessel to sail to the 'top of the world'.

KV Svalbard, built in 2001 and equipped with twin 5MW Azipod® icebreaking units, was sailing in the Arctic waters as part of the international scientific expedition, Coordinated Arctic Acoustic Thermometry Experiment (CAATEX), led by a Norwegian non-profit research foundation Nansen Center.

The aim of the expedition was to place seabed sensors that would allow the scientists to monitor water temperatures in the Arctic waters. Reaching the North Pole adds another dimension to the research, enabling data collection from some of the most remote parts of the Arctic Ocean.

The Azipod® propulsion system, where the electric drive motor is in a submerged pod outside the ship hull, can rotate 360 degrees to increase maneuverability, which is particularly crucial for vessels operating in ice. Azipod® icebreaking propulsion is capable of breaking up to 2.1 m thick Arctic ice and has a proven ability to cut fuel consumption by up to 20 percent compared to traditional shaft line propulsion systems.

» *The crew of KV Svalbard at the North Pole. Photo courtesy of the Norwegian Coast Guard.*



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CSA OCEAN SCIENCES EXPANDS ENERGY MARKET DIVISION

CSA Ocean Sciences (CSA), a leader in marine environmental consulting and provider of multidisciplinary services, has appointed Mary Jo Barkaszi to lead their growing Offshore Wind and Ocean Energy unit, a component of CSA's Energy Market division.

Ms. Barkaszi's 30-year career has centered on the evaluation and mitigation of impacts on marine mammals, sea turtles, and other vulnerable species with implementation of the Marine Mammal Protection Act, Endangered Species Act, and other regulatory guidelines throughout the world. She has led numerous Incidental Harassment Authorization (IHA) applications for offshore wind development and has emerged as a subject matter expert (SME) for several offshore wind projects.

"With Mary Jo leading this growing market for CSA, we can focus on the support of our clients' regulatory compliance needs in the intersection of living resources and Offshore Wind and Ocean Energy development," said Mr. Kevin Peterson, CSA's Chief Executive Officer. "Mary Jo's unique background in marine mammal and ocean sound science gives her the knowledge to both understand and anticipate our client's needs in this rapidly evolving regulatory environment and will prove to be a valuable resource to our customers."

Ms. Barkaszi holds a BSc in Biology from Wittenberg Univ. and an MSc in Biological Oceanography from the Florida Institute of Technology. Besides a long engagement in studies of the biology and ecology of marine mammals, Ms. Barkaszi is highly experienced in measuring the marine sound environment and translating this information into compliance with regulatory requirements. She has been a member of NOAA science teams for aerial, shipboard, and acoustic marine mammal surveys for which she implemented transect-based population surveys for scientific data collection and collaborated in developing the technical standards for visual and passive acoustic monitoring of marine mammals and sea turtles. She continues to train Marine Mammal Observers and assist in many field surveys throughout the world.

For more information, visit
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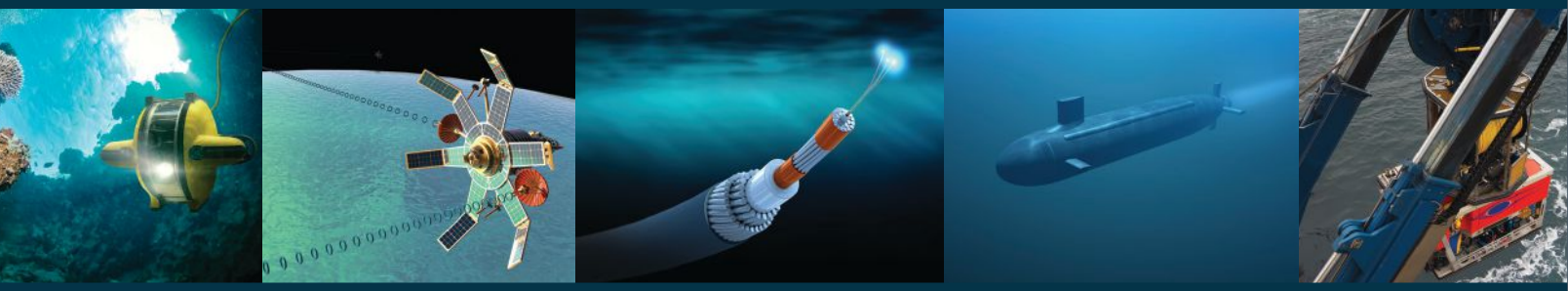

January 14 - 16, 2020
Salve Regina University, Newport, Rhode Island

The Blue Innovation Symposium is New England's premier event for connecting the marine technology industry. 2020's theme, ***Sensors and the Next Wave of Data***, is set to gather key stakeholders from the Blue Tech community to discuss the trends shaping the industry, whilst also showcasing the start-ups and breakthrough technologies making sensors smarter, more reliable and cost effective for the maritime industry, research organizations, and state and federal agencies.

.blue innovation SYMPOSIUM
at Salve Regina University

information and registration at:
blueinnovationsymposium.com

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Contact: Shannon Searing

Teledyne RESON together with Teledyne BlueView and Teledyne Odom provides a range of high quality underwater acoustic hardware and software solutions for underwater imaging within Teledyne Marine. These solutions are delivered through recognized brands such as SeaBat, BlueView, Odom, HydroSweep and ParaSound Multibeam Echosounder and Teledyne PDS software suite.

Teledyne Marine is a group of leading-edge subsea technology companies that are part of Teledyne Technologies Incorporated. Through acquisitions and collaboration over the past ten years, Teledyne Marine has evolved into an industry powerhouse, bringing Imaging, Instruments, Interconnect, Seismic, and Vehicle technology together to provide total solutions to our customers.

ADCP/DVL

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Nortek excels in the development and manufacture of acoustic Doppler instrumentation. Doppler Velocity Logs (DVLs) are used for subsea navigation. Acoustic Doppler Current Profilers (ADCPs) are used to understand physical processes in the ocean, rivers, lakes and laboratories. We pride ourselves on being innovative in product development and production processes. Nortek provides solutions to engineers and scientists by offering real-time data collection and support from our responsive technical team.

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Contact: Paul Devine

Teledyne RD Instruments, Inc., located in Poway, CA USA, specializes in the design and manufacture of underwater acoustic Doppler products and oceanographic sensors for a wide array of commercial, academic, and defense applications.

Originally founded in 1982, RD Instruments developed the industry's first Acoustic Doppler Current Profiler (ADCP). Through the years, this innovation has spawned a full line of ADCPs for current profiling in environments ranging from the shallowest stream to the deepest ocean. Expanding on this technology, the company also offers their industry-leading Doppler Velocity Logs (DVLs) for precision underwater navigation onboard manned and unmanned submersibles.

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Website: www.DeepWaterBuoyancy.com
Contact: Dan Cote, Sales Manager

DeepWater Buoyancy Inc. is the world's largest producer of subsea buoyancy products for the oceanographic community and has a vast product line of buoyancy solutions for offshore oil & gas, energy and technology companies. This product portfolio has been built over the course of 35 years serving these industries. Though products are offered for shallow water applications, the company specializes in deepwater, providing solutions to depths of 6000 meters and beyond.

NAUTILUS MARINE SERVICE GMBH

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Cathx Ocean design and manufacture advanced subsea imaging and precision measurement systems for subsea operations.

Designed to meet stringent technical, operational and integration requirements associated with various subsea applications and vehicle types, Cathx Ocean's systems offer precision, reliability and peace of mind. Products include advanced still imaging, colour laser point cloud and video systems, designed to deliver precision subsea data in a way that allows automation for subsea vehicle operations.

The range includes the Hunter system (AUV Imaging and Laser), the Scout system (Observation Class ROV Imaging and Laser Profiling), the Pathfinder system (Work Class ROV Imaging and Laser Profiling) and the Prowler I & II systems (Towed Vehicle Imaging Range and Scale Measurement).

DEEPSEA POWER & LIGHT

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Website: www.southbaycable.com
Contact: Gary Brown, Sales Manager

Since 1957, South Bay Cable Corp has designed and manufactured specialized electrical, electro-mechanical and electro-optical-mechanical cables for use in demanding marine environments. Cables are designed to meet customer requirements and include tether and umbilical cables for ROVs, tow cables, video inspection, faired cables and a host of other customer specific applications.

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Birns Aquamate design and manufacture underwater electrical connectors, cable assemblies, and cable terminations. The company produces a wide range of standard industry products such as the **5500 Series, SC, MC, LP, FAWL/FAWM, NANO, TC, Rubber Molded, etc.** Birns Aquamate is the only manufacturer to guarantee compatibility with other uw connectors. Birns Aquamate also specializes in fast turn-around for custom design of special connector solutions. All connectors are manufactured under DNV ISO 9001:2000 certification. Dealers in Canada, Brazil, UK, Belgium, Holland, Norway, Germany, South Africa, Holland, Italy, and China.

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Teledyne Marine Interconnect Solutions integrates the resources of ODI, DGO, Impulse, and Cable Solutions into a single organization that supplies innovative, high-performance solutions for harsh environment interconnect. Solutions for these harsh environments include wet-mate, splash-mate and dry-mate connectors, pressure boundary penetrators, cable assemblies, cable terminations, and custom-engineered encapsulation and molding. TMIS contains a broad portfolio of field-proven, time-tested electrical, optical, and hybrid interconnect capabilities optimized for applications where performance and reliability are imperative. Products are available as stand-alone items, or as complex solutions that integrate technologies into advanced, value-added systems.

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Ocean Specialists, Inc. (OSI) is a system development and advisory firm for undersea cable projects and technology with global capabilities. OSI works with clients during all project phases of subsea network development, from planning and design to procurement and implementation. Our customers, primarily representing Oil and Gas, Telecommunications and Ocean Observing, recognize the value of fiber optic networks to their field and services solutions, and look to OSI to deliver the skills and experience that developing these networks require.

GYRO COMPASSES

KONGSBERG SEATEX AS
Pirsenteret
N-7462 Trondheim, Norway
Tel: +47 73 54 55 00
Fax: +47 73 51 50 20
E-mail: km.seatex.sales@kongsberg.com
Website: www.km.kongsberg.com/seatex
Contact: Finn Otto Sanne at finn.otto.sanne@kongsberg.com

Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

LIQUID STORAGE

AERO TEC LABORATORIES, INC. (ATL)
45 Spear Road Industrial Park,
Ramsey, NJ 07446 USA
Tel: +1 201 825 1400
Fax: +1 201 825 1962
E-mail: atl@atlinc.com
Website: www.atlinc.com
Contact: David Dack

ATL specializes in the design/manufacture of custom bladder-type fluid containment systems, including tanks, inflatables, pillows and bellows for surface and subsea. ATL's flexible fluid containers boast unparalleled chemical tolerance, abrasion resistance, and remarkable durability - used with methanol, diesel fuel, gases, ethyleneglycol, hydraulic fluids and chemical cleaning cocktails. Expedited deliveries are also available.

MARINE ENVIRONMENTAL CONSULTING SERVICES

CSA OCEAN SCIENCES INC.
8502 SW Kansas Avenue
Stuart, FL 34997
Tel: +1 772 219 3000
Fax: +1 772 219 3010
E-mail: gstevens@conshelf.com
Website: www.csaocean.com
Contact: Gordon Stevens

CSA Ocean Sciences Inc. (CSA) is a marine environmental consulting firm specializing in multidisciplinary projects concerning potential environmental impacts of activities throughout the world. With extensive experience in environmental sciences and technical field operations, CSA is staffed and equipped to offer a complete range of services for projects in offshore, nearshore, estuarine, wetland, and freshwater environments.

MARINE VENTURES INTERNATIONAL, INC. (MVI)
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Fax: +1 772 419 9628
E-mail: kcomer@marineventures.com
Website: www.marineventures.com
Contact: Kevin Comer

Marine Ventures International, Inc. (MVI) provides high quality, marine environmental and technical experts to conduct coastal and offshore field operations worldwide. We leverage our wealth of talent and resources to bring you a customized team of independent contractors, subject matter experts and specialized equipment to get the job done. Our professionals work in a variety of sectors from submarine cable projects and engineering services to protected species observation and environmental consulting.

MOTION SENSING EQUIPMENT

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Website: www.km.kongsberg.com/seatex
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NAVIGATION & POSITIONING SYSTEMS

ADVANCED NAVIGATION
Level 8, 37 Pitt Street, Sydney 2000
New South Wales, Australia
Tel: +61 2 9099 3800
E-mail: sales@advancednavigation.com.au
Website: go.advancednavigation.com/ONT

Advanced Navigation is a privately owned Australian company that specialises in the development and manufacturing of navigation technologies and robotics. The company has a focus on generating products of the highest quality standard, both in terms of hardware and software. Advanced Navigation has specialised expertise across a broad range of fields including sensors, GNSS, inertial navigation, RF technologies, acoustics, robotics, AI and algorithms. Advanced Navigation is an ISO 9001 certified company and maintains a strict quality control system across the two research facilities and three manufacturing facilities that they operate in Australia. Advanced Navigation is a carbon neutral company, offsetting all emissions due to energy use through the planting of trees.

EVOLOGICS GMBH
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Fax: +49 (0) 30 4679 862-01
E-mail: sales@evologics.de
Website: www.evologics.de

EvoLogics provides the world's most advanced spread-spectrum underwater communication systems (S2C) with multi-channel data management, networking capability, built-in tracking and positioning functions with USBL. Data loggers, acoustic wake-up module and releasers optionally included. Deployments in offshore platforms (FPSO, ABS), environmental monitoring, defense systems, ROV and AUV operations and more. Applications include simple positioning and sensor information to transmission of underwater photos.

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

RJE INTERNATIONAL, INC.
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E-mail: sales@rjeint.com
Website: www.rjeint.com
Contact: Bruce O'Bannon

RJE International offers product design, development, evaluation and marketing for military divers, offshore and marine scientific communities, search and rescue teams, and more. RJE has become the industry leader in diver navigation and acoustic relocation. Our team has an extensive background in developing, manufacturing, and supplying underwater acoustic marking and relocation systems, diver navigation platforms, and other subsea equipment.

NETWORK & DATA COMS

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

OCEANOGRAPHIC INSTRUMENTS/SERVICES

ASL ENVIRONMENTAL SCIENCES, INC.
Victoria, BC, Canada
Tel: +1-250-656-0177
E-mail: asl@aslenv.com
www.aslenv.com

• **Metocean Equipment Leasing:** Acoustic Doppler Current Profiler ADCPs (including StreamPro & RiverRay), Ice Profilers, AZFP, acoustic releases, wave/tide gauges, pingers, satellite beacons, CTD+DO+Tu profilers, DO & turbidity loggers, weather station, cages, flotation, bottom frames.

•**Oceanographic Products:** Acoustic Zooplankton Fish Profiler (AZFP), Ice Profiling Sonar (IPS5) & shallow water Ice Profiler (SWIP), Imagenex scanning sonar logger (IRIS), instrument cages, bottom frames. Custom acoustic products and system integration.

• **Consulting:** Field work, data collection, analyses, numerical modelling, acoustics, remote sensing, oceanographic mooring design and system integration.

• **Manufacturer's Representative:** Teledyne RD Instruments, Deep Water Buoyancy, WERA Northern Radar.

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rue Gutenberg
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- Fresh and marine waters multiparameter probes: CTD, dissolved oxygen, turbidity, chlorophyll, Phycocyanin, Phycoerythrin, CDOM, detection of hydrocarbons, pH, Redox.
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- Drifting surface buoys with temperature and GPS receiver for Surface velocity project.

RBR
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RBR creates instruments to measure the blue planet. From the ocean abyss to the polar ice caps, our sensors track water parameters – temperature, depth, salinity, dissolved gases, pH, and many others. With design and manufacturing centrally located in Ottawa, Canada, our team works in a fast-paced, dynamic atmosphere to serve customers all over the globe.

ROMOR OCEAN SOLUTIONS
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Contact: Darrin Verge, President & CEO

ROMOR Ocean Solutions provides instrumentation solutions for the geophysical, oceanographic, defense, security, oil & gas, and renewable energy industries. By partnering with world renowned manufacturers, ROMOR is able to offer technical knowledge, value added services, logistics expertise, and the most reliable instrumentation on the market.

SEA-BIRD SCIENTIFIC
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Website: www.sea-birdscientific.com
Contact: Calvin Lwin, Sales

Sea-Bird Scientific provides best-of-class sensors and systems for oceanographic research and environmental water quality monitoring of physical and biogeochemical properties. Sea-Bird Scientific is the leader in accurate, stable ocean instruments for measuring conductivity (salinity), temperature, pressure, oxygen, pH, chlorophyll, CDOM, turbidity, beam attenuation, irradiance, radiance, PAR, nitrate, and phosphate. Our CTD profilers, water samplers, moored CT recorders, wave/tide recorders, DO sensors, and optical sensors are used by research institutes, ocean observing programs, government agencies, and navies globally.

STAR-ODDI
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Fax: +354 533 6069
E-mail: baldur@star-oddi.com
Website: www.star-oddi.com
Contact: Baldur Sigurgeirsson

A manufacturer of miniature data loggers with sensors as temperature, depth/pressure, salinity, tilt/acceleration, compass direction/magnetometer, light levels, acoustic receiving/transmitting. The loggers are used for various researches, including oceanography, fishing gear studies, equipment behavioral monitoring and fish tagging.

SONAR SYSTEMS

ECHOLOGGER

303 Venture Center,
76 Hanggongdaehak-Ro, Deokyang-Gu,
Goyang-Si, Gyungki-Do, 10540, Korea
Tel: +82-2-3158-3178
Email: info@echologger.com
Website: www.echologger.com
Contact: Doowon Choi

Echologger represents the best quality sonar products in the market. We are a leading developer/manufacturer of high-end ultracompact echosounders and high resolution scanning sonar that are equipped with state-of-the-art features and essential functionalities to match customers' needs in affordable price.

Founded in 2009 and a company located in South Korea, and with a brand name Echologger, EofE Ultrasonics Ltd. is a knowledge-based company that continuously designs, develops and manufactures high technology sonar devices and solutions to meet the changing needs of the customers. Having been in the industry for years, the company understands how the industry operates and what works best for the benefit of our valued customers.

EDGETECH

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Website: www.edgetech.com
Contact: Amy LaRose

EdgeTech designs, manufactures and sells industry-leading side scan sonars, sub-bottom profilers, bathymetry systems and combined sonar systems. Additionally, the company produces world class underwater actuated and transponding solutions including deep sea acoustic releases, shallow water and long life acoustic releases, transponders, reliable USBL acoustic tracking and positioning systems, and custom-engineered acoustic products.

KLEIN MARINE SYSTEMS, INC.

11 Klein Drive
Salem, NH 03079
Tel: +1 603 893 6131
International: 603 893 6131
E-mail: sales@kleinmarinesystems.com
Website: www.kleinmarinesystems.com

Celebrating over 50 years in the marine technology industry, Klein Marine Systems continues to be a world leading sensor technology manufacturer of high-resolution side scan sonar equipment and radar-based security and surveillance systems. Klein Marine Systems has developed a worldwide reputation of excellence in the industry by providing quality products and excellent customer service. Klein sonar systems are deployed by government agencies, navies, port authorities, surveyors, oil companies and universities worldwide. Visit our web site at www.KleinMarineSystems.com and discover how Klein is Making the Oceans Transparent!

MARINE SONIC TECHNOLOGY

120 Newsome Dr. Suite H, PO Box 1309
Yorktown VA 23692-1309
Toll Free: +1 800 447 4804
E-mail: Regan.Lipinski@na-atlas.com
Website: www.marinesonic.com

Marine Sonic Technology builds high quality, high resolution side scan sonar systems. Located in Yorktown, Virginia, Marine Sonic has been in business for more than 25 years. Our towed systems are rugged, easy to deploy and simple to operate. We also offer highly efficient AUV/ROV embedded systems, which occupy minimal space and low power consumption.

SOUND VELOCITY PROBES/CTDS

SAIV A/S

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Tel: +47 56 11 30 66,
Fax: +47 56 11 30 69
E-mail: info@saivas.com
Website: www.saivas.no
Contact: Gunnar Sagstad

- STD/CTD, Sound Velocity probes/recorder with optional multi-parameter facilities; Turbidity, Fluorescence, Oxygen etc. The new CTD/STD model SD208 with wireless communication and high accuracy: 0.002 mS/cm, 0.002 °C.
- Precision pressure /depth (0.01% accuracy) and temperature sensors/recorders. Applications: hydrographic profilings, installation on ROVs and towed systems, etc. Robust and compact designs are combined with accuracy and "plug and play" compatibility. Output format for sonar equipment, e.g. EM1002, EM3000, SSP, HiPAP and Reson 8125.

SUBSEA FABRICATION

NEW INDUSTRIES

6032 Railroad Avenue
Morgan City, LA 70380
Tel: +1 985 385 6789
E-mail: bill.new@newindustries.com
Website: www.newindustries.com
Contact: Bill New

New Industries provides quality fabrication services to the offshore oil & gas and marine industries focusing on large diameter pressure vessels, suction piles, DNV buildings and deepwater subsea production equipment such as jumpers, PLETs, PLEMs and manifolds.

SUBSEA TECHNOLOGY

KONGSBERG MARITIME AS – SUBSEA DIVISION (DIVISION OF KONGSBERG GROUP)

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Kongsberg Maritime is a marine technology company providing innovative solutions for all marine industry sectors including merchant, offshore, subsea, naval and fisheries. The company delivers systems that cover diverse maritime applications. Within subsea, Kongsberg Maritime's sonars, Sub-bottom profilers, multibeam and single beam echo sounders, cameras, positioning and underwater communication & monitoring systems, instruments, software and Marine Robotics are used in survey and inspection operations worldwide. Working closely with customers to develop technology that pushes the limits in subsea applications, Kongsberg Maritime is also dedicated to developing innovative environmental monitoring solutions such as the K-Lander system in addition to cutting-edge Marine Robotic platforms such as the futuristic Eelume vehicle.

UNMANNED MARITIME VEHICLES

GENERAL DYNAMICS MISSION SYSTEMS' BLUEFIN ROBOTICS PRODUCTS

553 South Street
Quincy, MA 02169
Tel: +1 617 715 7000
E-mail: adam.mara@gd-ms.com
Website: gdmissionsystems.com/underwater-vehicles/bluefin-robotics
Contact: Adam Mara

General Dynamics Mission Systems' Bluefin Robotics products provide undersea capabilities for defense, scientific and maritime customers worldwide. Bluefin Robotics products offer a range of systems and configurations that can operate in the open ocean and in constrained waterways. Our core autonomous product line includes Bluefin SandShark, Bluefin-9, Bluefin-12, and Bluefin-21, Hovering Autonomous Underwater Vehicle (HAUV), and Subsea Power technologies.

The Bluefin Robotics AUV family shares a free-flooded, modular, and open architecture backbone that has enabled the integration of 70+ sensors. We have developed and delivered AUVS worldwide to research institutes and industry and have provided AUVS to the United States' and International Navies.

INTERNATIONAL SUBMARINE ENGINEERING LTD. (ISE)

1734 Broadway Street,
Port Coquitlam, BC, V3C 2M8
Tel: 1-604-942-5223
E-mail: info@ise.bc.ca
Website: https://ise.bc.ca/

International Submarine Engineering Ltd. (ISE) is a world leader in the design and integration of autonomous and remotely operated robotic vehicles and terrestrial robotics. Over our 40+ years in business, we have accumulated a great deal of expertise in the design, manufacture, and maintenance of:

- Autonomous Underwater Vehicles (AUVs)
- Remotely Operated Vehicles (ROVs) for subsea operation
- Human Occupied (HO) submersibles
- Customized systems for the offshore oil industry
- Customized systems for the Military-Naval sector
- Hydraulic, pneumatic, and electric robotic manipulators
- Teleoperated and autonomous robotic systems
- Robotic systems for nuclear Industry applications
- Communications and real-time control system

L3 OCEANSERVER, INC.

275 Martine Street
Fall River, MA 02723 USA
Tel: +1 508 678 0550
Fax: +1 508 678 0552
E-mail: sales@ocean-server.com
Website: www.iver-auv.com
Contact: Jim Kirk

L3 OceanServer, Inc. is one of the leading manufactures of unmanned underwater vehicles (UUVs) with over 300 units delivered to customers around the world.

The Iver UUV is an affordable, simple to operate commercial system for military, survey, water quality, and research applications.

OUTLAND TECHNOLOGY

38190 Commercial Ct.
Slidell, LA 70458 USA
Tel: 985-847-1104
Fax: 985-847-1106
E-mail: jeff@outlandtech.com
Website: www.outlandtech.com
Contact: Jeff Mayfield

Offering the most rugged equipment and unsurpassed customer service, Outland Technology has been the world's leading manufacturer of underwater video, lighting and ROV equipment for over 30 years. We recognize that no two jobs are the same and specialize in products that are customizable for your specific applications.

TELEDYNE OCEANSCIENCE

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Poway, CA 92064
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E-mail: oceanscience.sales@teledyne.com
Website: www.teledynemarine.com/oceanscience
Contact: Jamie Carrig

Teledyne Oceanscience manufactures unmanned deployment platforms for echosounders and environmental monitoring instrumentation. Our major products are remotely-controlled Q-Boats and tethered instrumentation deployment Riverboats for echosounders and ADCPs, remotely-controlled Z-Boats for hydrographic surveys in shallow or hard to access areas, the Underway CTD that provide affordable and compact profiling from a moving vessel, and the popular Sea Spider and Barnacle seafloor platforms.

TELEDYNE SEABOTIX

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Teledyne SeaBotix is a world leading manufacturer of capable underwater MiniROVs that perform a multitude of tasks including maritime security, search and recovery, hull and pipeline inspection, hazardous environment intervention, aquaculture, sensor deployment and oceanographic research. The Little Benthic Vehicle systems have become the benchmark in compact ROVs around the world and ROV equipment for over 30 years. We recognize that no two jobs are the same and specialize in products that are customizable for your specific applications.

VIDEORAY

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Fax: +1 610 458 3010
E-mail: sales@videoray.com
Website: www.videoray.com
Contact: Chris Gibson

With more than 3,700 ROVs in service around the world, VideoRay is the global leader in Observation ROV technology. VideoRay's underwater robot systems are extremely versatile, portable, affordable, and reliable solution for underwater operations including surveys, offshore inspections, search & recovery, homeland & port security, science & research, aquaculture, and many other underwater applications. The latest Mission Specialist systems provide solutions for particularly difficult underwater challenges. VideoRay is available on the General Services Administration (GSA) Schedule.

WINCHES, HANDLING, & CONTROL SYSTEMS

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Seattle, WA 98108 USA
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Fax: +1 206 623 9839
E-mail: info@markeymachinery.com
Website: www.markeymachinery.com

Preferred by the U.S. fleet, Markey's advanced oceanographic winch systems provide ultimate dependability, reliability and precise performance when and where you want it. Operating within critical windows of opportunity you can count on our custom winches, capstans, windlasses and auxiliary machinery for the successful execution and completion of your research.

OKEANUS SCIENCE & TECHNOLOGY LLC

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E-mail: info@okeanus.com
Website: www.okeanus.com
Contact: Ted Brockett

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SOSI and DT Marine brand winches, handling systems, and engineered solutions are now available exclusively from Okeanus Science & Technology. Proven, reliable, and cost-effective standard and custom designed winches range from small all-electric instrumentation winches to high horsepower all-electric or hydraulic umbilical and multi-purpose oceanographic systems. SOSI brand winches can be packaged and supplied with skids, A-frames, over-boarding sheaves, HPUs, and other auxiliary equipment. Okeanus has offices in Houston, TX, Redmond, WA and Houma, LA. Call, email or visit www.okeanus.com for more information.

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- time, space and cost-saving solutions
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- advanced data delivery algorithms, addressing and networking, remotely configurable settings
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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

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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reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, the S2CM-HS high-speed modem, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

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

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sales@evologics.de
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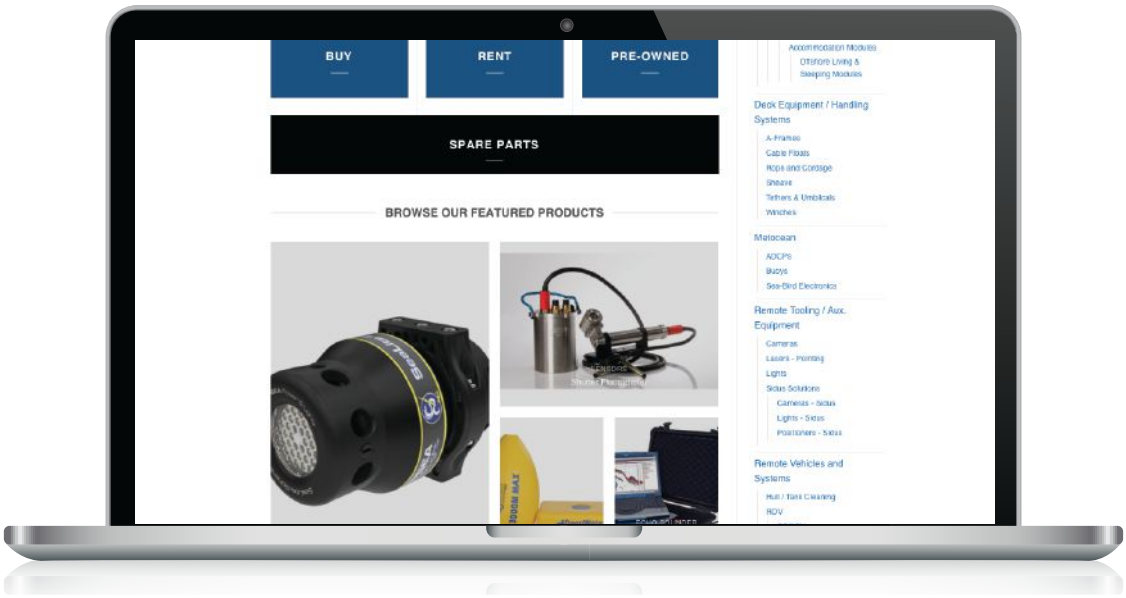

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