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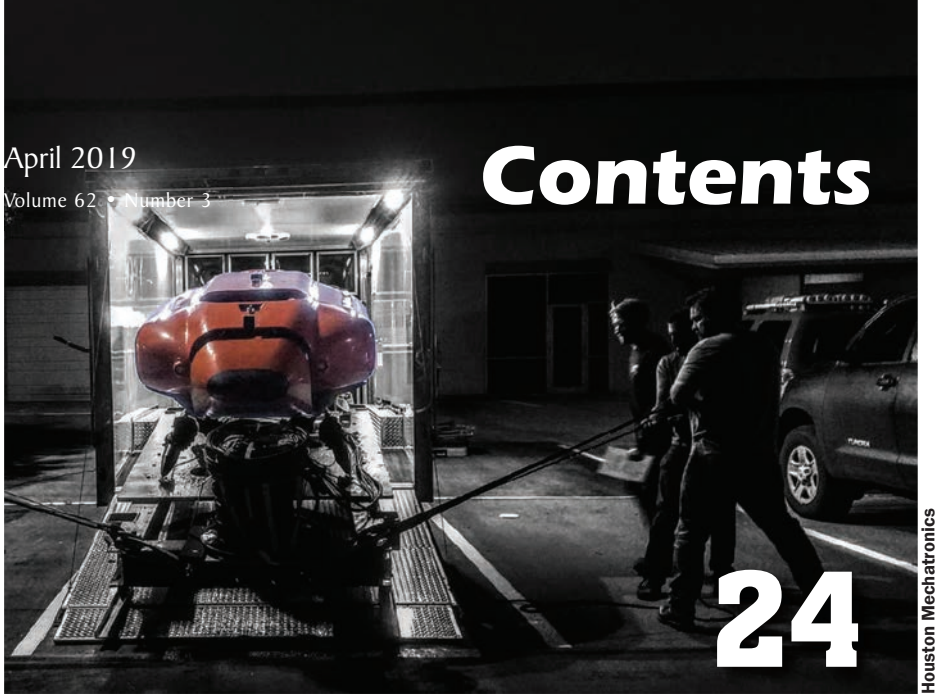

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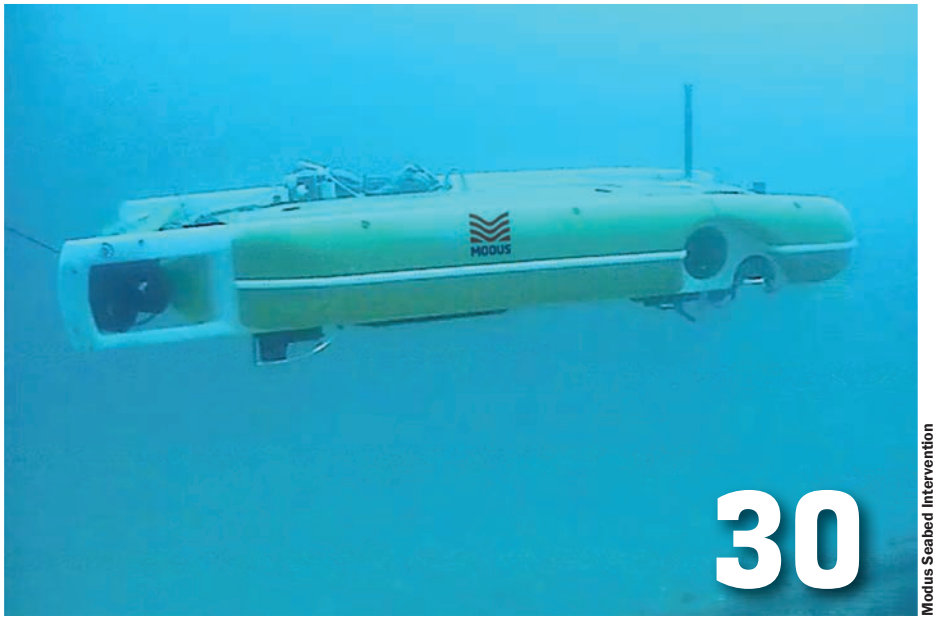

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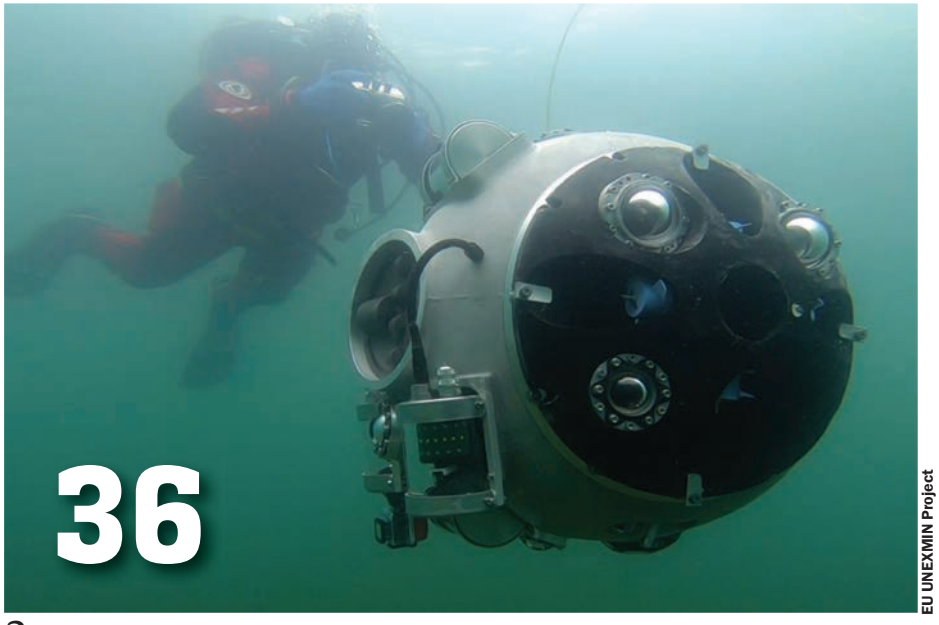

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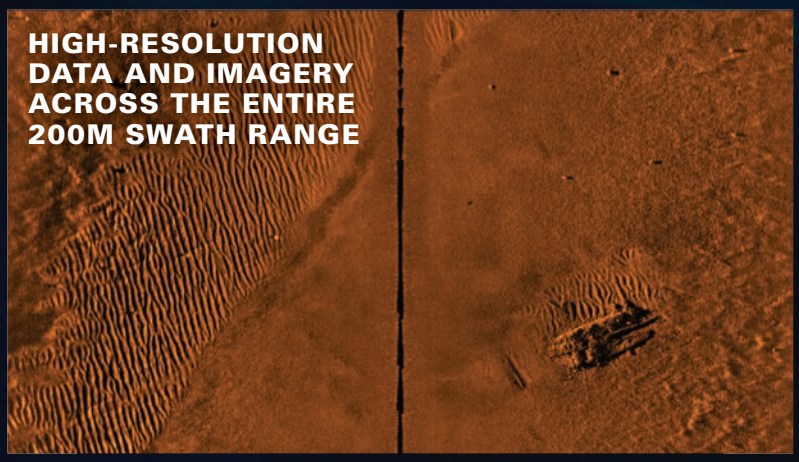

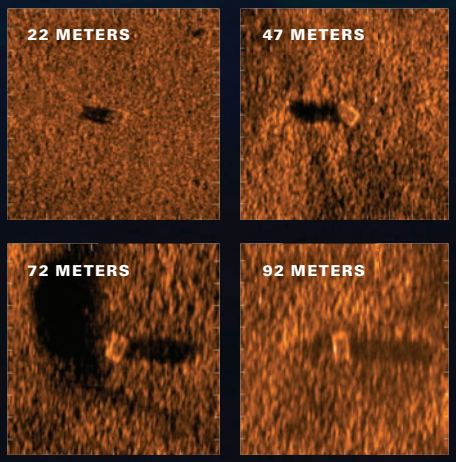

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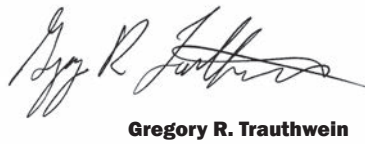
Editor's Note

As this edition went to press, I was literally on a plane returning to New York City from Ocean Business, a successful exhibition by any metric. We have participated in Ocean Business since Versha Carter and her team hatched the event in 2007, and Ocean Business has grown significantly ever since. Situated at the facilities of the National Oceanographic Center in Southampton, England, there is arguably no better setting for this bi-annual meeting of industry, academia and government, as its position on this historic campus, on the water in the heart of the Port of Southampton gives to you nearly every element of the combined maritime, port, logistics and, of course, subsea industries, in one tidy package.

By many accounts, this industry is on solid footing and on the rise again following the collapse and protracted 4+ year recovery of the offshore oil and gas industry. Make no mistake, the offshore business, a critical piece in the pace, direction and development of the subsea industry, is a far way off still from the halcyon days of 2013/14 when oil was trading at $120 per barrel and the 'oil boom' seemed to have legs to run for generation. But as many reading these pages know all too well, the high times never last, as an outside influence or two usually conspires to break the momentum.

While this downturn is severe and long-lasting, there is general consensus that the abyss has been hit and there is gradual movement upward. There are more calls of inquiry, and projects that have been shelved have had the dust blown off the covers and plans start anew.

Make no mistake that your businesses are at the heart of a successful path ahead, as offshore oil and gas producers look to new evolutions of autonomy and efficiency to make successful, profitable operations in the 'new reality.' And these evolutions of autonomy were on full display earlier this month in Southampton at Ocean Business.



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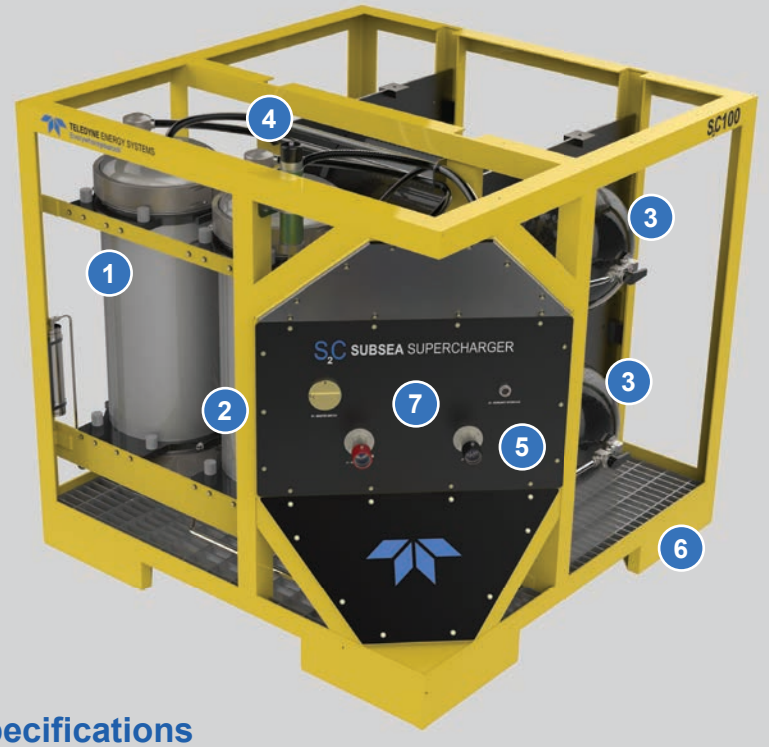

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- Voltage range: as specified
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Authors & Contributors

Carlon

Manley

Maslin

Murdock

Paschoa

Stoichevski

Carlon

Ryan Carlon is responsible for Liquid Robotics', A Boeing Company, Global Commercial Environmental Assessment team that focuses on supporting the Science and Research community. He joined Liquid Robotics in 2012 and has been leading the sales initiatives for the Science and Research community ever since. Under his leadership he has helped establish the Wave Gliders for Researchers Program and the Science & Research User Group.

Halpin

Sean Halpin is the Aquanaut Product Manager at Houston Mechatronics. He has significant energy industry experience with previous leadership roles at Liquid Robotics and DOF Subsea.

Manley

Justin Manley is a technologist and executive with experience in startups, corporations, academia, and government. At Just Innovation Inc. he supports clients with a focus on unmanned systems.

Maslin

Elaine Maslin is an offshore upstream and renewables focused journalist, based in Scotland, covering technologies, from well intervention and asset integrity to subsea robotics and wave energy.

Murdock

Chad Murdock is a lead applications engineer at Cortland Company. He manages relationships with strategic key accounts in a wide variety of industries to provide highly engineered custom electromechanical cable solutions. Chad has experience in mechanical product design, manufacturing, and testing for custom cable applications ranging from oceanographic research to aerospace. Driven by technical expertise and a problem-solving-approach, he provides innovative solutions and support to customers around the globe.

Paschoa

Claudio Paschoa is MTR's contributor stationed in Brazil.

Stoichevski

William Stoichevski is an Oslo-based journalist reporting on maritime and offshore energy topics for multiple New Wave Media titles, including Marine Technology Reporter, Maritime Reporter & Engineering News and Offshore Engineer.

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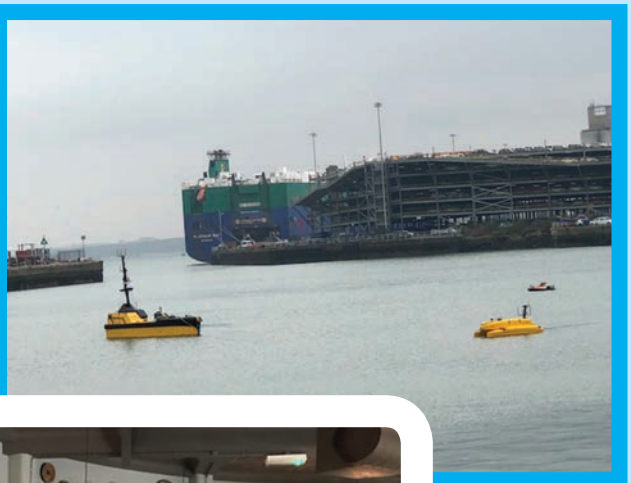
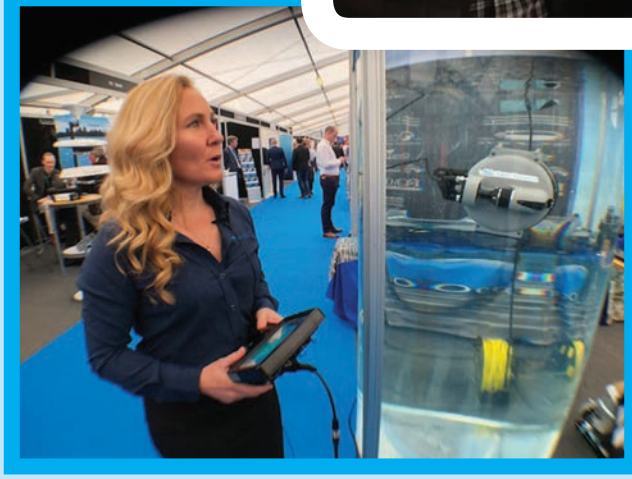
THE FUTURE IS ELECTRIC

That's a Wrap: Ocean Business 2019 in Southampton

In the coming weeks check in on **MarineTechnologyNews.com** for a series of business and technology related videos and interviews which were recorded at the National Oceanographic Center @ Ocean Business 2019. And join *Marine Technology Reporter* and sister-publication *Offshore Engineer* at the world's largest offshore industry event, the Offshore Technology Conference in Houston in early May 2019.





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Export Licensing:

Tips U.S. Exporters Shouldn't Overlook

Export Control Lists Include Key Marine Tech Categories

By Curt Cultice, U.S. Commercial Service, U.S. Department of Commerce

Each year, the U.S. Department of Commerce receives thousands of inquiries from businesses looking to export, many of which involve licensing questions. The Commerce Department's Bureau of Industry and Security (BIS), together with other USG agencies, is responsible for export licensing and controls. BIS export licenses may be required for items (commodities, software, or technology) with proliferation, military, or terrorist uses, or which warrant control for other reasons. Export licensing requirements can apply to a wide array of products, including marine technologies.

A license may also be required because of the end use or end user. Items not licensed by BIS may still require a license from other agencies, including the State Department for defense articles and services subject to the International Traffic in Arms Regulations which are listed on the United States Munitions List (USML). When it comes to determining whether your export might need a license, there are a few sometimes overlooked aspects that U.S. businesses should be aware of before they export. After reading, go to our video web page to find out more about export licensing.

- Don't make any assumptions. For example, just because you are exporting a small amount of a commodity, sending it to a friendly country or e-mailing software doesn't mean you shouldn't check to see if an export license is needed. Screen all the parties to your transaction.

- Review the control lists carefully. The USML and the BIS-administered Commerce Control List (CCL) include not only complete systems and key parts and components, but also raw materials, production equipment, and other related items. For marine technology exporters, key entries can be found in USML categories VI (surface vessels of war), XI (underwater electronics and acoustic systems), XII (optical and inertial sensors) and XX (submersible vessels); and CCL categories 5 (telecommunications), 6 (acoustic sensors), 7 (inertial sensors and navigation), and 8 (marine).

- Different levels of technology can affect where you can export. The level of a product's technology and market destination can be important factors as to whether an export license might be needed. For example, BIS authorized one U.S. exporter of high-end infrared technology to sell a certain level of its technology to Country A, but denied the company's request for a license to export the same level of technology to Country B. The company received authorization to export a less technologically sophisticated product to Country B instead.

- Be aware of "deemed" export licensing requirements. Transferring technology to a foreign person in the United States is just like exporting to a foreign country. If an export license is required to export that technology to a specific country, a license requirement will also apply to transfer the technology to a citizen of that country while that person is in the United States. Persons with U.S. permanent residence, and persons granted status as "protected individuals" are exempt from the "deemed" export rules.

- Don't forget about re-exports. For U.S.-origin items, U.S.

export regulations extend beyond the initial export out of the United States. A re-export of a U.S.-origin item from one foreign destination to another, including use aboard a vessel in multiple territorial waters, can also trigger a license requirement. Such scenarios can be built into an export license, so when applying for export licenses, remember to keep the larger picture in mind, rather than only the initial export.

- Protect your items against transfer and transshipment. Foreign buyers are not allowed to resell a controlled item without prior authorization, so protect your company by filling out the destination control statement on your commercial invoice. This legal statement signifies the exports are destined to the end-user indicated in all the shipping documents, and cannot be transferred or transshipped by the foreign buyer without permission from the U.S. government agency with jurisdiction over the licensed item. If you find out that the item has been resold, you should report that fact to the U.S. Government agency with jurisdiction over the item.

- Be aware of criteria for transactions agreed upon under the Incoterm "Ex Works." Under Ex Works, the foreign buyer only becomes responsible for determining licensing requirements and obtaining any required licenses when a specific writing has been obtained first by the U.S. seller from the foreign buyer stating they (the foreign buyer) assume this responsibility. Simply stating the sale is being completed under "Ex Works" does not comply with this requirement. See Section 758.3(b) of the Export Administration Regulations for more details on this requirement.

- Remember that help is available. BIS has counseling desks, located in Washington, DC and California, which are staffed Monday through Friday during business hours by BIS personnel. The Desks' contact information is as follows:
  - o Washington, DC: (202) 482-4811
  - o Irvine, CA: (949) 660-0144
  - o Santa Clara, CA: (408) 998-8806

  You can email your question to: ECDOEXS@bis.doc.gov

Does your U.S. product or service require an export license? Learn more about the export licensing process by viewing our export regulations video and web page which links to the Bureau of Industry and Security, U.S. Commercial Service worldwide network of export assistance, and other key resources.

Cable to Make a Difference in Underwater Missions

By Chad Murdock, lead applications engineer, Cortland Company

The US GEOTRACES program is dedicated to collecting trace elements and their isotopes from the world's oceans for scientific purposes. Oceanographic working environments can be harsh, so durable equipment is essential for successful underwater missions.

Electromechanical cable specialist Cortland supplies equipment which is used by research institutions around the world to help track and monitor changing ocean conditions. Our team led by renowned biogeochemist Dr. Greg Cutter, Professor of Ocean, Earth and Atmospheric Sciences at Old Dominion University, Virginia, developed an oceanographic solution

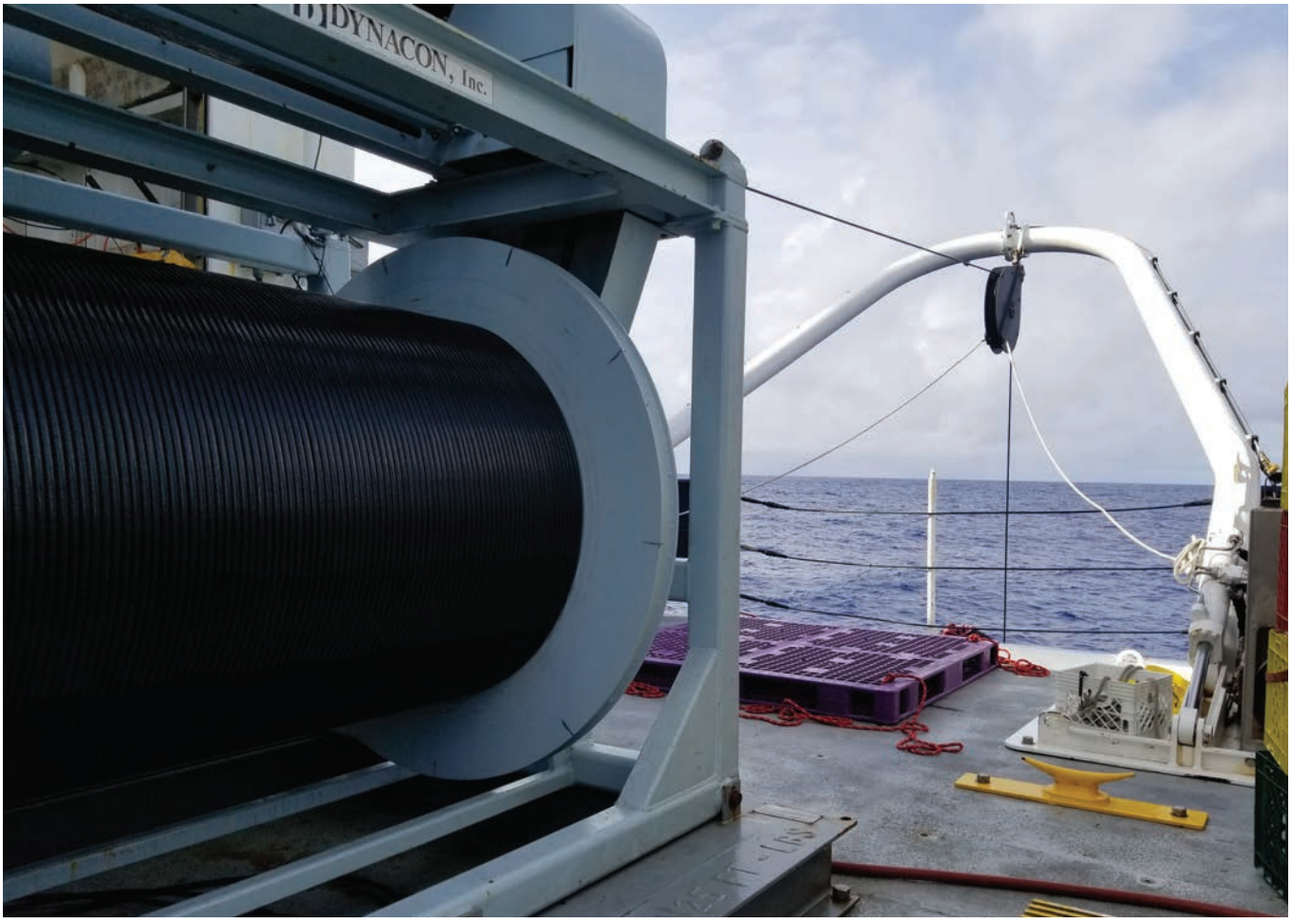


Photo: Cortland

for US GEOTRACES.

To support the scientific challenges, a suitable cable had to be non-metallic to meet non-contaminating criterium as any exposed metal can interfere with the sample quality of trace elements, such as iron and zinc, by the time they return to the surface. A lighter-weight solution would also allow deeper ocean sampling, compared with metal-clad electromechanical cables ordinarily used for campaigns. These older models of cables are considered too heavy for winching within safe working limits when lowered to depths of more than 5,000 meters.

Ideally, the solution had to have no exposed metal, lower the weight and deploy rapidly. It also had to be strong enough to handle variable loads under tension due to the movement of the ship and be long-lasting. The cable and connected hardware would also have to endure more than 100 deployments per expedition.

Cortland's cable has now been used on more than 600 ocean research deployments. It safely holds the weight of 500 kilograms of equipment, including a carousel of 24 12-liter sample bottles. As it is lowered through the water column to depths of 7,000 meters, it endures factors including cold temperatures, bending, tension cycling, corrosion, marine abrasion, compression and even attack by sea-life. It must flex and bend to deal with winching, marine currents, and pressures exceeding 550 bar (55,000 kPa).

Each cable provides the physical connection for real-time power and communication connectivity. Designs have to be rigorous, and manufacturing takes attention to detail and proven processes.

Material gains

The requirements for underwater sampling and monitoring are diverse. Projects can include seismic surveys, marine life studies and pollution tracking. The cables are manufactured differently from general industrial versions, hand-build for often unique purposes. Notably, Cortland has worked with the School of Marine Science and Technology at the University of Massachusetts to produce a specially designed electrical coaxial cable to conduct a census of Atlantic sea scallops, and

with the National Oceanic and Atmospheric Administration (NOAA) to decrease deployment infrastructure and costs for tsunami warning buoys. Both projects needed cables which were not commercially available off the shelf to provide the protection, accuracy and durability required. For US GEOTRACES, a 14 mm Vectran cable was designed, manufactured and supplied by Cortland for the deepwater oceanographic research application. The use of Vectran, a high-performance synthetic fiber, provided the high-strength, low-stretch and flexible properties needed as the cable's strength member.

Within the core, Cortland supplied electrical and communication wiring with the capabilities to relay signals through deep ocean depths. Surrounding the entire cable construction was an abrasion-resistant, extruded polyester outer jacket.

The materials used were strong, but lightweight and flexible. The outer coating was durable enough to handle deck and overboarding activity on the vessel, and to withstand potential damage from temperature changes, tension cycling, and ultraviolet light.

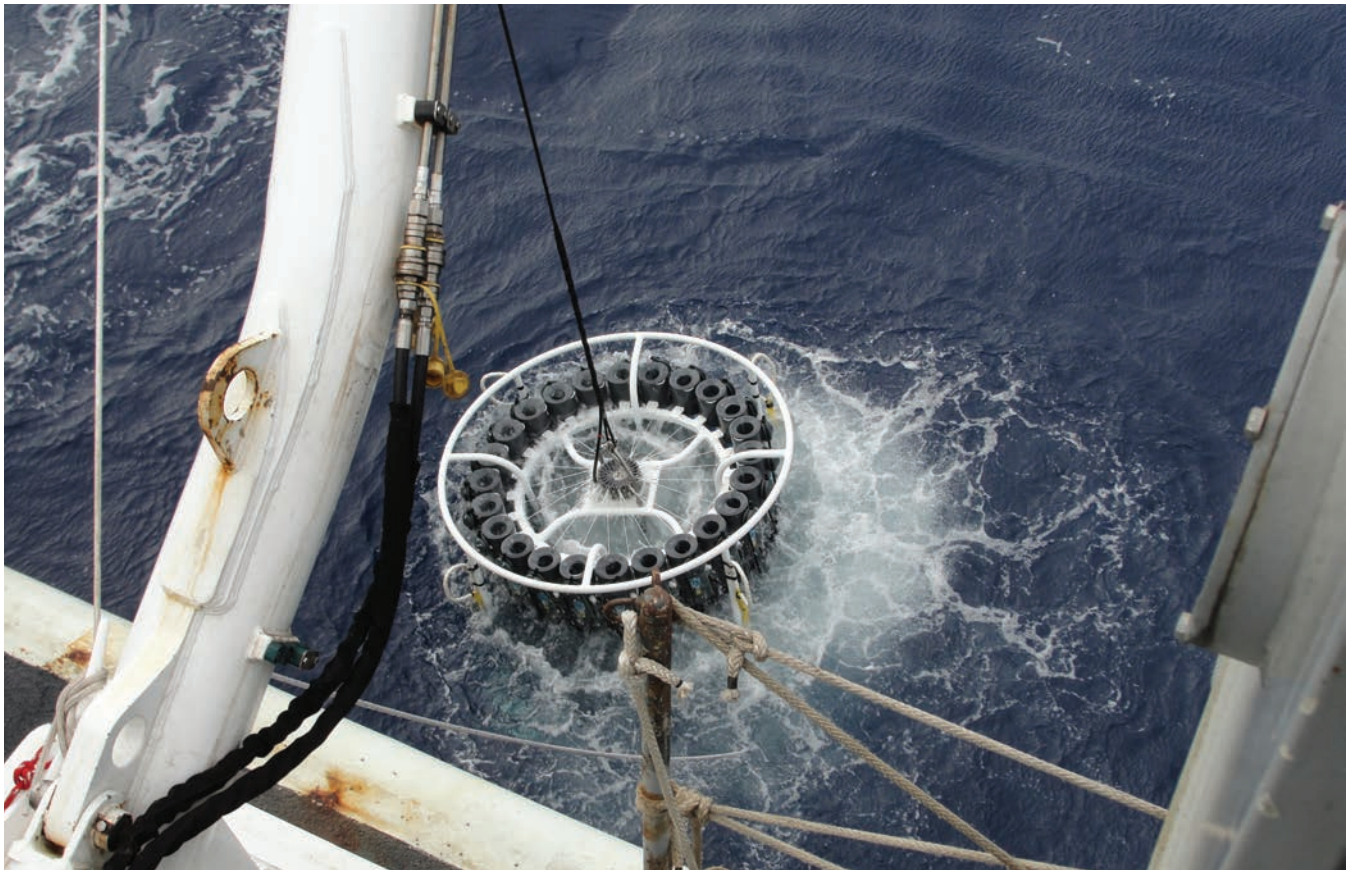
These protective elements allowed uninterrupted signals between surface and carousel for crucial real-time data monitoring. US GEOTRACES could monitor temperature, pressure, conductivity and other sensed parameters throughout the lowering process, and trigger sample bottles during ascent. Cortland's synthetic version was designed to have all the functionality and capabilities of steel cable alternatives, yet at much lighter weight, while also eliminating metal contamination.

Future use

US GEOTRACES has achieved the capability to lower the carousel deeper than ever before without weight concerns. The researchers can collect more samples faster and there is virtually no risk of contamination from exposed metal components.

The organization has now used the custom cable for dozens of missions, in regions as diverse as the Arctic to the tropical waters of Polynesia. It has proven ideal for the expeditions, carried out every two years since 2008. It is set to be deployed again in 2021. Near identical cables are now in use in China, Germany, India and Antarctica.

We've learned through experience that cables used in dynamic subsea environments have to be custom designed and built for the specific harsh environments our customers encounter. The properties of synthetic strength members and outer jackets can make the difference to scientific expeditions, particularly those performed over long-timeframes in remote locations and at great expense. Our teams aim to be an extended part of these missions and take pride in their successes too.



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Tappan Zee Constructors 'See' Above and Below the Hudson

With Trimble Marine Construction Systems and Teledyne Marine Imaging, bridge deconstruction projects can now have pinpoint accuracy.

Since 1955, the Tappan Zee Bridge has been a critical thoroughfare for New Yorkers commuting between Rockland and Westchester Counties, located approximately 20 miles north of Manhattan and across the Hudson River from each other. However, a heavy increase in traffic and exponentially increasing maintenance costs ultimately lead to the decision to replace the bridge.

The Governor Mario M. Cuomo Bridge, the longest crossing in the New York State Thruway system, is designed to meet the needs of the future while supporting economic growth. In 2013, Tappan Zee Constructors was contracted to design and build the twin-span crossing. The north span

Image Courtesy Trimble

of the bridge officially opened to westbound traffic in August 2017 and, a few weeks later, temporarily began carrying eastbound traffic until the eastbound span was completed in September 2018. Tappan Zee Constructors began deconstructing the old bridge in 2017, work that continues in 2019.

The new structure is already a landmark, featuring a 3.1-mile twin span cable-stayed structure and angled main span towers that make the bridge visually striking from all angles. When fully completed, the new bridge will include eight general traffic lanes, four emergency shoulders, a shared bicycle/pedestrian path and state-of-the-art traffic monitoring systems. Also unique is that the bridge has been designed and constructed to be mass-transit ready and can accommodate commuter rail.

Challenges

When it began in 2013, the Governor Mario M. Cuomo Bridge was the largest infrastructure project in the U.S., one that required careful design and planning through all phases. The project scope required driving more than 1,000 cylindrical piles into the Hudson riverbed to create 41 pillars to hold up each span of the bridge. The final phase of the project involved the careful deconstruction and removal of debris from the old bridge. Making the deconstruction phase more challenging was the accelerated schedule for the project, the sheer size of the bridge, variable water depths of the Hudson River below, and windy conditions. The flow of the Hudson River, wide tide ranges, and water clarity and visibility were also major issues.

"As soon as the excavator bucket, clam shell bucket, cutter head on a dredge goes under the water you can no longer see it, so you really don't know what's happening," said Lou Nash, president of Measutronics Corporation, an integrator of Trimble Marine technology.

Tappan Zee Constructors consulted with Nash, the Measutronics team and Trimble to overcome these challenges. The positioning and guidance systems used included Trimble and Teledyne components – Trimble software, hardware,

and sensors for positioning, guidance and tracking of machines, and Teledyne marine imaging sonar for subsurface applications. Measutronics calibrated the equipment and installed the systems and all the sensors. Once the system was calibrated, Measutronics was able to check against the survey and start training the operators on how to use the software. The team also set up the machine in-cab screens and made sure the data flow was accurate.

"We listen to the operators during setup and if they say, 'Yeah, I like that but I really need this,' then we'll add that component," said Nash. "The end users are the guys in the seat all day, so we listen to what they have to say and we make sure the system fits their needs."

Eliminating Unknowns

Trimble Marine Construction software was used on all tools across the project for excavation, placement of structures and demolition work. Heavy equipment used included excavators, clam shell cranes, cutter head on a dredge and more. Regardless of the tool being used with the machine – buckets, pincers, shears, hammers, jackhammers – using the marine software and sonar equipment each had precise guidance, giving operators clarity and visibility to work.

Blake Yaffee, area manager for the project's demolition

Image Courtesy Trimble

portion, said his team started by using the system to establish a baseline of conditions in the river. This began with 3D point cloud data collection of submerged features via a survey vessel using sonar. "We're able to look at the structure beforehand and then take that imagery, evaluate and confirm elevations, quantities and conditions. We were able to deal with any items that might create issues in advance of even setting foot out or performing any actual work on the structure."

Precise demolition

After a baseline was set, Tappan Zee Constructors used TMC software and Teledyne SeaBat T20 high resolution multibeam echosounder to create a plan for breaking up the old bridge's concrete structures into rubble, which could then be safely removed from the Hudson River bottom. Surface data was provided to the various machine types for guidance in deconstructing the submerged structures. TMC software was also used to monitor and visualize deconstruction progress of submerged structures and bridge components. As deconstruction progressed to the removal phase, the survey vessel continually collected data and updated the existing 3D surface model, which was transferred in near real time to the machine fleet to provide the operators with updated views.

"From our system, what the operator sees in the first phase is where the tool has been so that he's getting proper coverage of the inner deconstruction process," said Nash. "Once he feels he has reached a certain level that they want to start removing the materials, the sonar comes in and maps out the debris so it's able to track the tool as he's doing a deconstruction and he's able to provide guidance to the machines that have to remove the debris."

A 'bird's eye view'

Andrew Teese, a machine operator with the International Union of Operating Engineers 825 in New York, said using Trimble's positioning equipment has been a significant advancement compared to conventional 'hunting and pecking' required for this type of marine construction work. Using traditional methods, a crew would likely excavate in a grid-like pattern in the general location of the old pier, from one end to the other. Instead, he was able to use the Trimble system on a Manitowoc 999 crawler crane with a clamshell tool to clean up the bottom of the river where the old pier was dismantled. Using the TMC software and Teledyne technology, from inside his

Image Courtesy Trimble

cab Teese can see precisely on the ground under the water where his boom point is compared to the terrain.

The software follows a 'traffic light-like' pattern, indicated in green on the operator's control box when excavation is needed and changing colors to yellow as the operator gets closer to grade. The system provides updated information so as the structure is broken up and moved under the water, the images and colors are updated in real time. On the screen, Trimble's TMC software shows elevation, location, and a real-time 3D view. Operators can rotate these views so that the boom point is followed by the software, or they can leave the image itself and have the crane go in and out of the image. The software provides highly accurate locations and visualization, according to Teese. He has even been able to see and retrieve football-size pieces of concrete, which would have been nearly impossible to spot without sonar capabilities.

A clear view

"I also have depth, I have the bucket position in two different views, which aided me in locating debris to be removed," said Teese. "It gives me a precise location, kind of a 'bird's eye view' and I can position my boom point wherever I want on the image and find whatever was previously scanned. It's pretty accurate too."

He explains the sonar picture greatly accelerated his work because he was able to understand what was going on underneath the water's surface.

"It's a lot faster because we can see where we have been, we can see how wide the material had spread and we can progress through the pier and the rubble pile with accuracy," said Teese. "Things that you missed as you go through the area you can get a pinpoint location on, you don't have to look around for things, you just know where everything is."

With pinpoint imagery, including overlaid reference points and coordinates on top of the survey, the team then drew prisms around those 'missing' pieces of material and imported that data into operators' control boxes.

"Anybody that has performed water demolition is familiar with the term 'working in the blind' because that's basically what people do," said Yaffee. "For us, the investment in the product against the scale of the project, together with the fact that the sonar and the software can be reconfigured and used on the next project, made it very easy for us to make the decision to bring this equipment on."

In addition to quickly identifying and removing debris underwater, precise positioning from TMC and Teledyne has helped Tappan Zee Constructors break up difficult components and material underwater, without relying solely on divers. Divers also have a more predictable and well-documented plan before they go underwater to work, which improves diver safety.

"Cutting steel piles with excavator mounted shears without either the support of a diver or spending a significant amount of time just feeling around is nearly impossible," said Yaffee. "With this level of visibility and positioning we are certainly able to review the conditions with the divers before they go under."

Scanning the river bottom, the team also identified eroded structures, components and materials that had collected over the years from the old bridge. Tappan Zee Constructors recorded these scans and was asked by the New York State Thruway to remove the material. As a result, the site was returned to the state of New York in a more pristine condition then when they started work.

Improved documentation and cost savings

Yaffee believes that the Trimble system combined with sonar capabilities from Teledyne has also allowed the team to carefully evaluate and document the project progress. The tool's real-time as-building capabilities provide daily insight into productivity and documentation that benchmarks were being met. Once tasks were completed, the team collected images of the area and identified any follow-on work that needed to be done.

"Now we have this multibeam, point cloud image that's more than just a picture, it's actual hard data and we're able to say, 'this is the elevation of that point and this particular item,'" said Yaffee. "I use it for evaluating different conditions when we're either dealing with a subcontractor that we suspect didn't finish their scope of work, or a condition that is outside of our scope of work with the owner and we need to prove it to them."

Following this new marine workflow, Yaffee explains his team's work has been safer, faster and more accurate. Not only that, the extended team can't imagine going back to conventional methods.

"We no longer go through an evaluation process that we did initially to determine if it's worth the investment, if there's going to be a return on investment of bringing this equipment on," said Yaffee. "In other words, it's not going to make financial sense for us to have a piece of equipment out here that's 'blind' while all the other pieces of equipment 'have eyes'."

Project @ a Glance

Customer Profile: Tappan Zee Constructors, LLC is a consortium – including Fluor Enterprises, Inc., American Bridge Company, Granite Construction Northeast, Inc., and Traylor Bros., Inc. – that was hired to design and build the new Governor Mario M. Cuomo Bridge, one of the largest single design-build contracts for a bridge project in the United States. The project was started in January of 2013 and, after a phased opening that started in 2017, the final south traveling lanes were opened in September of 2018. Deconstruction work on the old bridge continues.

Business Challenge: The retired Tappan Zee Bridge opened in 1955, and served more than 140,000 vehicles per day, far exceeding the amount it was expected to carry. The Tappan Zee Constructors team was tasked with designing and constructing a new bridge to accommodate additional travel lanes (including bus and bicycle/pedestrian) and emergency shoulders and with safely demolishing the old bridge. Tappan Zee Constructors reached out to the Measutronics Corporation and the Trimble Marine Construction team to improve productivity across the removal of the old bridge.

Solution: Trimble Marine Construction Software (TMC), Trimble precision GNSS receivers, Teledyne SeaBat T20 high resolution multibeam echosounder for marine imaging for subsurface applications

Accomplishments

- World's first application of real-time machine guidance for on-water cranes/excavators/jack hammers, with sonar verification: The system combines Trimble Marine's positioning, machine guidance and real-time visualization capabilities with Teledyne's sonar capabilities.
- Eliminated 'working in the blind': Safer, faster, more accurate dredging and demolition.
- Accelerated demolition and debris removal: 'Bird's eye view' and precise accuracy show elevation, location, depth, bucket position and real-time 3D view of debris.
- Improved revenue capture with documentation with 'as-building' capabilities: Multibeam sonar and image capture document benchmarks are met; plus identifies 'extra' work

Sea Star Population in Danger

The combination of ocean warming and an infectious wasting disease has devastated populations of large sunflower sea stars once abundant along the West Coast of North America, according to research by Cornell University and the University of California, Davis, in Science Advances.

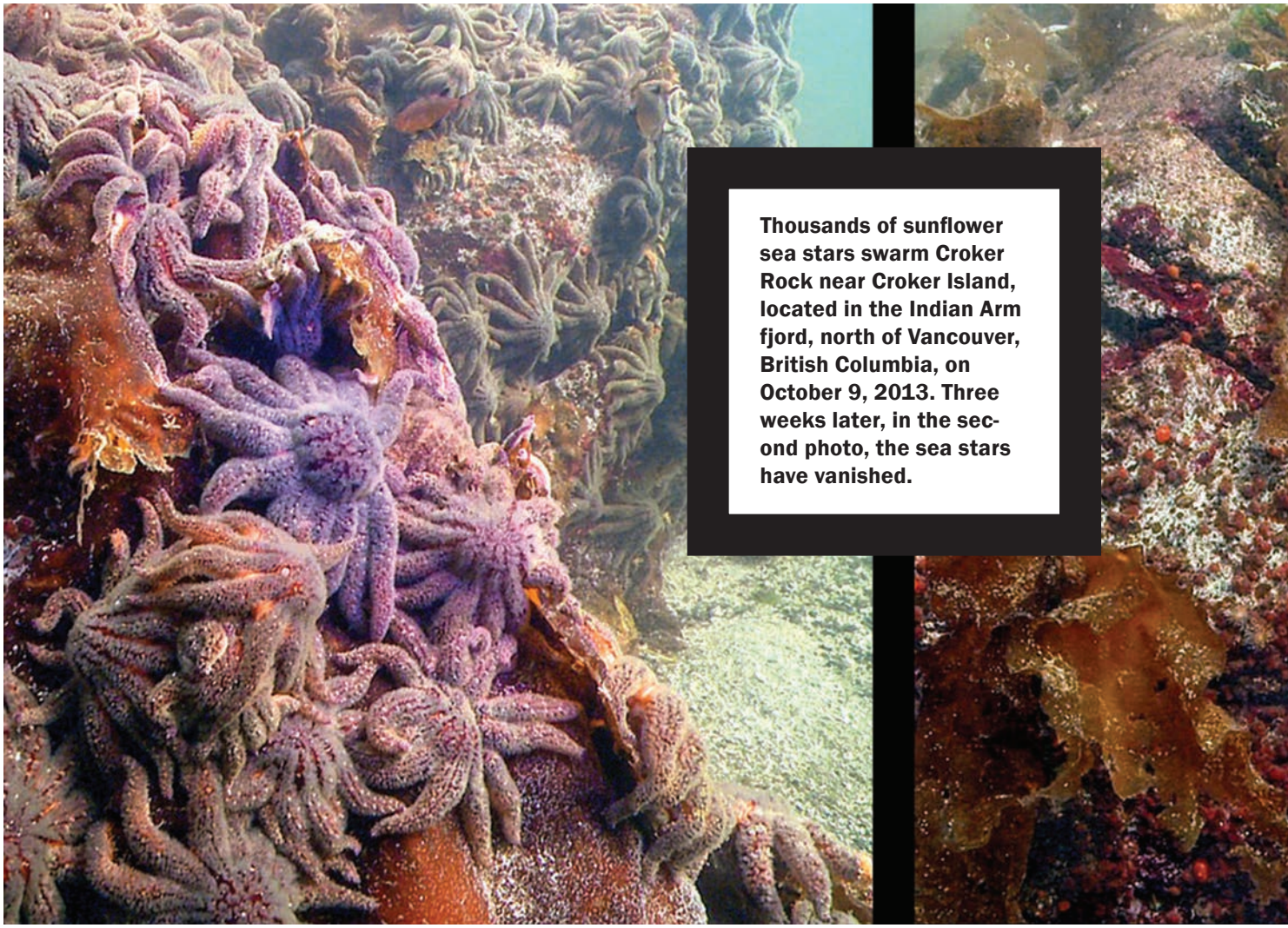
"At one time plentiful in nearshore waters, the sunflower sea stars right now cannot be found off the California coast and are rare into Alaska," said Drew Harvell, Cornell professor of ecology and evolutionary biology, a co-lead author. "Numbers of the sea stars have stayed so low in the past three years, we consider them endangered in the southern part of their range, and we don't have data for northern Alaska."

Since 2013, sea star wasting disease has brought about massive mortality in multiple sea star species from Mexico to Alaska. The East Coast has not been immune, as the disease has affected the shores from New Jersey up to New England. Diego Montecino-Latorre, a wildlife epidemiologist with the UC Davis One Health Institute and a co-lead author, said the sunflower sea star continues to decline even in the deepest ocean, and it is not recovering in the same way experienced by the intertidal Ochre star.

"This is likely because this disease has many hosts, and other species that tolerate the pathogen better may spread it to the sunflower star," he said.

Global warming due to a changing atmosphere is likely a major factor.

"The heat wave in the oceans – a product of increasing atmospheric temperatures – is exacerbating the sea star wasting disease," said Harvell, a fellow at Cornell's Atkinson Center for a Sustainable Future. "It's a lethal disease,



Thousands of sunflower sea stars swarm Croker Rock near Croker Island, located in the Indian Arm fjord, north of Vancouver, British Columbia, on October 9, 2013. Three weeks later, in the second photo, the sea stars have vanished.

Credit: Neil McDaniel

and when you add a higher temperature to that, it kills faster, causing a bigger impact."

Fisheries depend on nearshore kelp forests to form a healthy environment for fish and the broader oceanic ecosystem. With the demise of sunflower sea stars, sea urchin populations in some areas have exploded, substantially reducing the kelp, Harvell said.

The sunflower sea star is large, about the size of a manhole cover, and possesses an enormous appetite. It crawls over the seafloor like a robotic vacuum cleaner, munching on everything in its path.

"In California, Washington and parts of British Columbia, sunflower sea stars keep urchins under control," said Joseph Gaydos, senior author on the paper and director of UC Davis' SeaDoc Society program. "Without sunflower stars, urchin populations expand and threaten kelp forests and biodiversity. This cascading effect has a really big impact."

For this research, "Disease Epidemic and a Marine Heat Wave Are Associated with the Continental-Scale Collapse of a Pivotal Predator (Pycnopodia Helianthoides)," the other partner institutions were Simon Fraser University, Stanford University, Hakai Institute and the National Oceanic and Atmospheric Administration (NOAA).

Between 2006 and 2017, scientists and trained citizen scientists with Reef Environmental Education Foundation (REEF) conducted 10,956 roving-diver surveys from Southern California to Alaska. Before 2013, divers reported an abundance of sea stars, but between 2013 to 2017 the population collapsed.

Scientists from Simon Fraser University and the Hakai Institute confirmed the loss from remote Calvert Island in British Columbia. The ocean warming recorded at REEF locations corresponds to an increase in water temperature by up to 4 degrees Celsius that started in 2014.

NOAA scientists surveyed sunflower sea stars in thousands of deep trawls from Mexico to the Canadian border and recorded 100 percent decline in all states in deep water down to 1,000 meters.

The research was supported by the National Science Foundation, Natural Sciences and Engineering Research Council of Canada, NOAA and the Department of Commerce.

In mid-April, the University of California Press will release Harvell's new book, "Ocean Outbreak: Confronting the Rising Tide of Marine Disease," on the oceanic epidemics that are impacting our food chain and proposing solutions to slow a looming global environmental disaster.

Solving the Real Problem: *The Subsea Business Model*

By Sean Halpin, Aquanaut Product Manager, Houston Mechatronics

We seem to be experiencing an underwater technological renaissance. It's extremely exciting, but will this tranche of development allow us to solve the REAL problem we have in the industry?

For the past few years the effects of the 'downturn' in oil and gas have dominated the industry's technology roadmap. After evaluating OPEX budgets nearly all offshore oil and gas operators determined that they need to dramatically lower the cost of doing business offshore. Many companies set goals to dramatically lower the cost of intervention and inspection work by 2020 or 2030. Nearly all of these plans require service companies to lower their reliance on the ubiquitous (and very useful) vessel fleet, because vessels are expensive.

Most subsea businesses are hamstrung by vessels in oil and gas. When these expensive assets appear on the balance sheet

Image: Houston Mechatronics

they dominate it. Often subsea service company quarterly reports are summaries and projections of the number of vessel days sold. These large businesses are successful because they optimize operations to support the ecosystem they inhabit. This, in turn, has resulted in business models which are very hard to change. When the oil and gas downturn began, very few companies revisited the balance of their business models. Instead, the industry released a large number of staff, lowering costs without fundamentally changing the business. The companies which comprise the market waited for a stronger demand to implement change.

This demand from the customer base has forced service companies to respond with innovation. The response: Resident seafloor technology (Residence). Some companies determined that the cost of delivering subsea service can be lowered by delivering and operating technology subsea without surface vessel assistance. While this concept is a logical step it isn't the easiest to deliver reliably. Keeping equipment working underwater is challenging, the ocean isn't kind. Corrosion, biofouling, hydrostatic pressure, and anthropogenic dangers are constantly fighting to eliminate technology from the field.

From a business perspective, residence is challenging because of economic single point failure. In order to reduce the cost of inspection the vehicle must be delivered to site once and maintained infrequently. If a vehicle fails, and requires maintenance, a costly vessel must enter the field with a crew to service the vehicle. The cost of an emergency intervention due to technology failure dramatically shifts the value proposition of residence. There are many advantages to technology deployed on site permanently. One of these advantages is that inspection tasks may be conducted more frequently because the cost of incremental inspections will be negligible. This puts more cycles on equipment and likely decreases Mean Time Between Failure (MTBF). To enable

long-term residence, many service companies are conducting MTBF studies in underwater robotics. No matter how good a study is, and how well equipment is engineered the ocean will likely not disappoint. There are many stories about indestructible ships and technology at sea. Given enough time, any equipment deployed in the ocean will be destroyed or will malfunction and we, as an industry, must face the fact that the technology we deploy at sea is anything but permanent, nor is it perfect.

We believe there are quite a few technical challenges to bringing seafloor residence to market. In addition to technical challenges, residency requires customers to pay for a service 24/7/365. The business model employed is identical to a long-term vessel charter. The customer must pay a fee even if the vehicle is idle, because the service company has priced the risk of residency into operations. Is this really what the customer wants? Or, is there a business model which works for the customer and service provider? We evaluated some of the disruptive business models in the commercial service sector outside of oil and gas. Businesses like Uber, AirBnB, Alibaba and Amazon have all transformed our personal lives. Why? It's pretty simple: consumers love convenience at a price advantage. If it's cheaper and more convenient we are open to adopting it in our personal lives. Oil and gas operators have different criteria for adoption. They examine the risk and consequence of every operational change. Therefore, the key to adoption in oil and gas is to offer convenient risk reduction. New technology must be more cost efficient but must not introduce any new risk to the operator's business, and to truly transform the value of subsea we must dramatically reduce our reliance on vessels. With this in mind we identified a business model that offers the benefits of seafloor residency and the availability of vessel operations. We call this concept Virtual Residency and the technology which fulfills it - Aquanaut.

Virtual residency employs many of the same concepts of traditional subsea resident technology. However, this model assumes that robots are not tied to subsea fields in a 1:1 ratio. Virtual residency employs and extrapolates the concept of robotic correspondency to both the technology and the business model. Presently, three to seven technical staff on a vessel employing 10 or more crew are deployed to site to run one to two remotely operated underwater vehicles (ROV). The correspondency ratio of the operation is very low. Many people are required to run one or two robots at sea. Even more people are required to support that operation onshore. Most subsea resident concepts require one ROV for every one field. We believe 1 robot can serve multiple fields and that one human being should be able to operate up to seven robots. That seems more economical for the customer and takes advantage of the fundamental innovations robotics enable.

In virtual residency, vehicles will be stowed on topside facilities scattered around ocean hotspots or stowed subsea in garages on the seafloor. The vehicles will be ordered, much like rideshare services are today. The vehicle will deliver itself to site and will begin work.

The concept of virtual residency was not achievable with conventional underwater robotic technology. We needed an efficient way to deliver the technology to site and a way to interact with customer facilities during inspection with limited surface support. These requirements drove the development of a new class of vehicle we call an autonomous underwater robotic vehicle (AURV). An AURV is a multi-mode vehicle that is capable of delivering itself to site efficiently (in AUV mode) and is equally capable of conducting manipulation work when

at site in ROV mode. All without a vessel. Put simply, it's a Transformer.

Upon arrival at site the vehicle transforms from its AUV form factor to its ROV form factor. This transformation is achieved through hull separation. Once the hull separates the vehicles arms activate and the machine is ready to manipulate and inspect its environment. Aquanaut is not just a paper design. It has been built and is undergoing testing now.

One of the biggest advantages of virtual residency is availability. Ultimately, customers require extremely high availability, not reliability. Conventional resident seafloor systems will require excellence in engineering and will need to be nearly perfect because of the high cost of vessel intervention. In the virtual residency model, vehicle number four may start a project while vehicle nine may finish it. In this scenario we need not achieve perfection in subsea robotics, we need to develop an asset network which meets customer required service levels. The vehicle still needs to be reliable – but perfection is not required as operational issues may be overcome by backfilling additional assets.

There are many threads of component technology which powers Aquanaut and the concept of virtual residency. These include innovations in acoustic communications, machine vision, local area navigation, and wide area navigation. Thankfully, the technological revolution we are experiencing in subsea technology is bringing us ever closer to closing the technology gap in all of these domains.

As these component technologies will take some time to mature, we needed to ensure that a lack of advanced technology does not hamper the progress of the virtual residency business model. Like any disruptive business, elements of the business model will be phased in to enable market success.

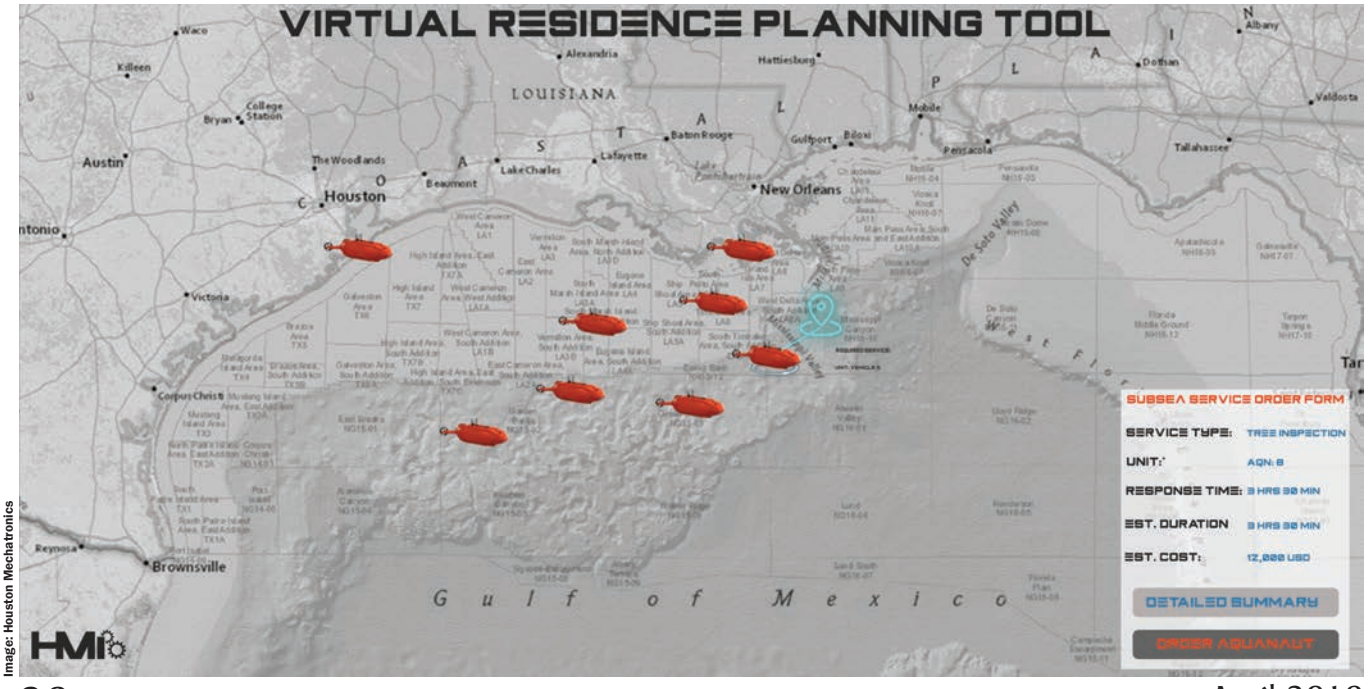
Image: Houston Mechatronics

The first phase of Virtual Residency will leverage the enabling technology's ability to achieve a correspondency ratio similar to warehouse robotics. This results in a lower logistics footprint for operations and a compensatory cost reduction. In the second phase of virtual residency, communication and robotic systems development will be integrated into operations to enable vehicle delivery to site efficiently and safely.

The customer base in oil and gas has sent clear signals to the service sector. Some will respond with incremental change and some will respond with transformational propositions. Regardless of the preference, it is evident that we all need to change the way we perform work at sea.

The future of the subsea industry is uncertain for all, but there are a growing number of companies who are pressing ahead, laser focused on innovating new business models and technology to truly fulfill customer needs.

Image: Houston Mechatronics



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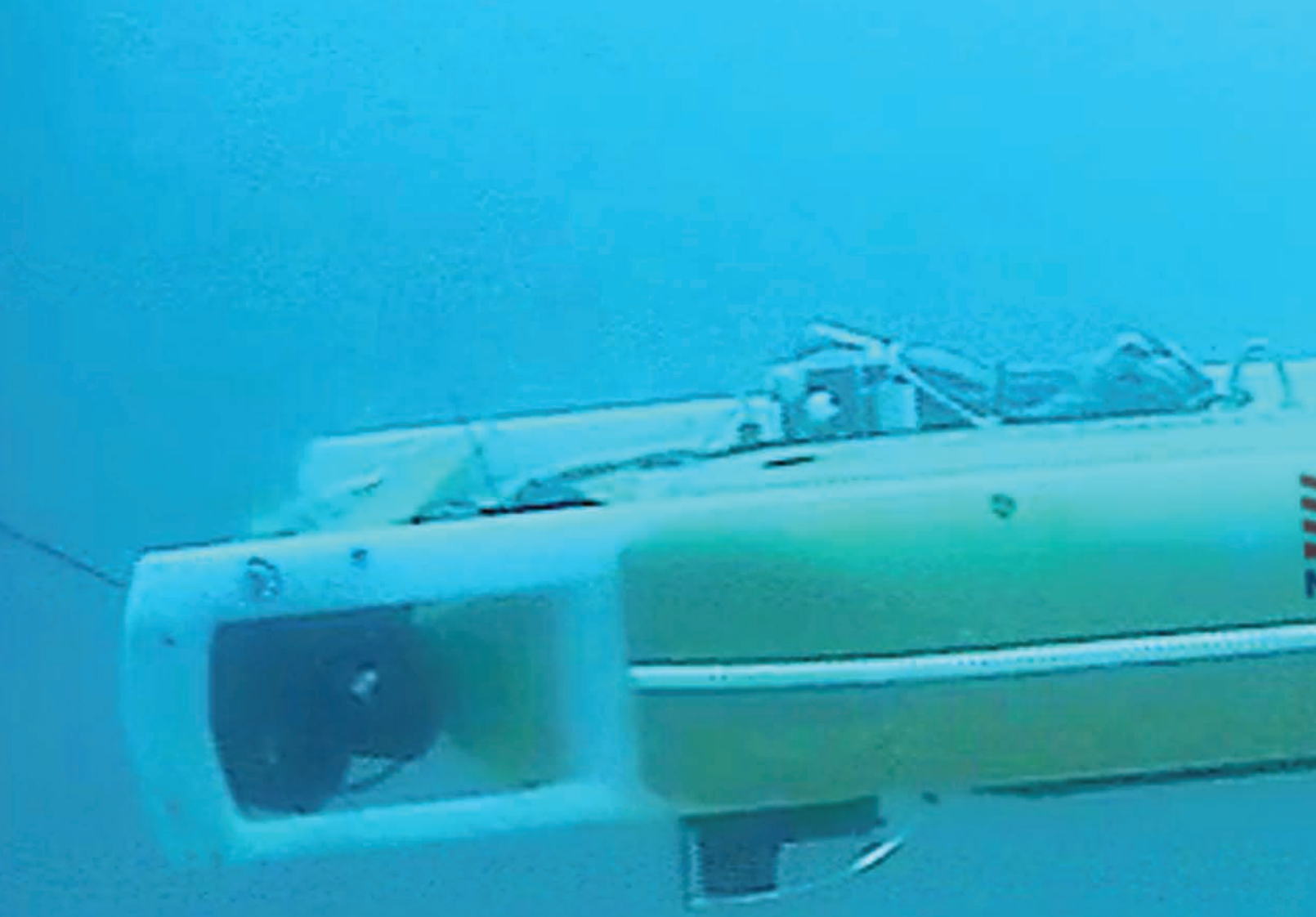
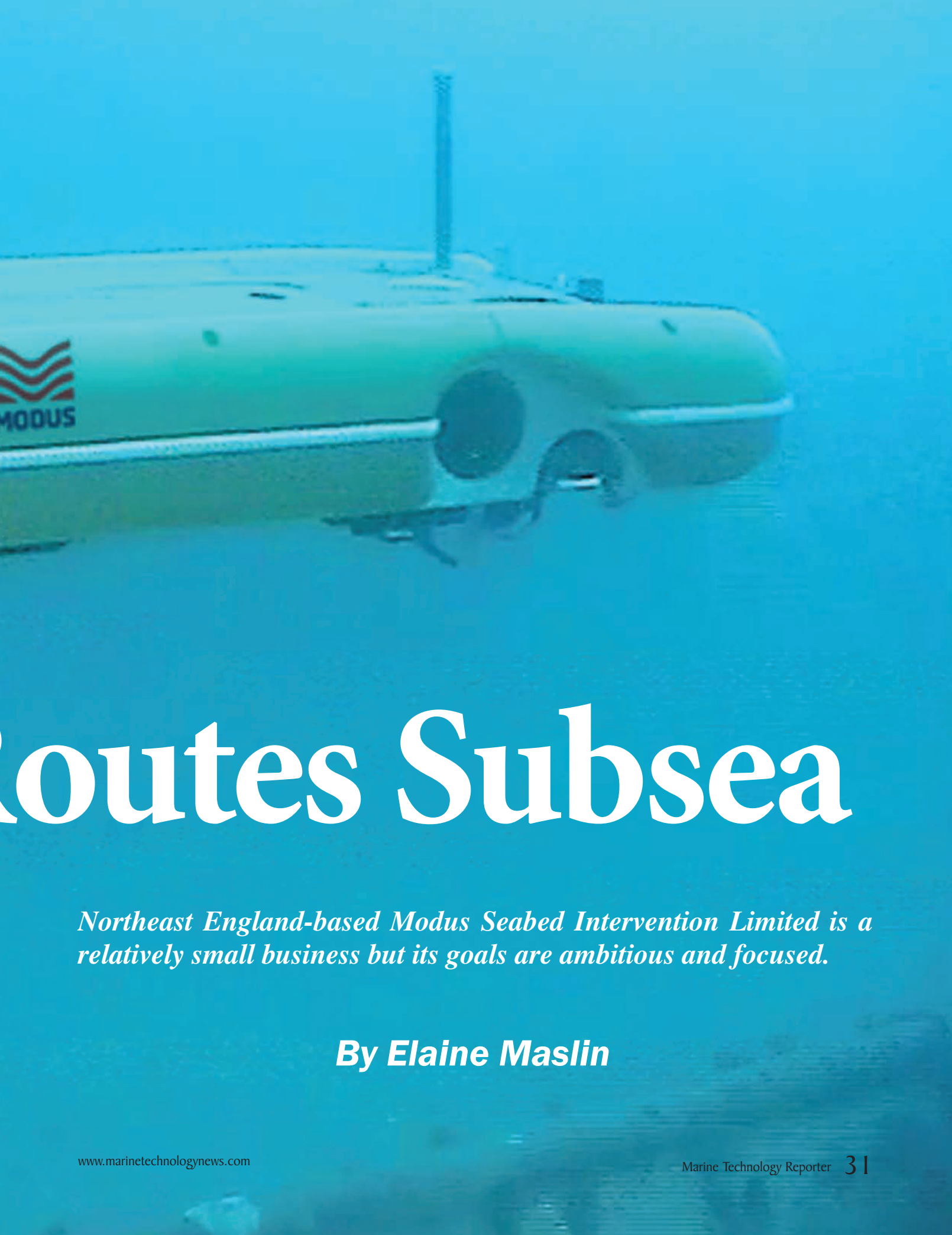


Flying New R

Image: Modus Seabed Intervention



Routes Subsea

Northeast England-based Modus Seabed Intervention Limited is a relatively small business but its goals are ambitious and focused.

By Elaine Maslin

After four years spent developing an autonomous underwater vehicle (AUV)/remotely operated underwater vehicle (ROV) hybrid (HAUV) based on a modified Saab Sabertooth AUV system, Modus Seabed Intervention has now bought its second, deepwater rated Sabertooth, which will be delivered this summer.

The acquisition of its latest 3,000-meter-rated Sabertooth, will enable the company to continue to build on its track record and to offer vehicles with enhanced artificial intelligence and autonomy capabilities.

The company's vision is for its HAUVs to operate infield at offshore oil and gas and renewables sites, including wind farms, independent of service vessels. This could be via a surface deployment system or via a subsea garage/docking station, which the vehicle can 'fly' in and out of. From the docking facilities, the vehicle can operate as an AUV (without a tether), using onboard batteries, or, where direct control is required, it can operate like an ROV either via a fiber optic tether (which enables very long excursions), or by means of a full power and control umbilical.

Instead of being deployed from a dedicated support vessel, the docking station is designed to be deployed to the seabed from a vessel crane. The aim is to use a vessel already engaged at a specific location, such as a supply vessel, dive support vessel or offshore renewables service vessel. The HAUV can then perform inspection and/or survey independently, in synergy with the vessel's primary activity, reducing costs. The HAUV will return to its dock on completion of the work scope and will wait to be recovered at a convenient time. "For example, if you have engaged a vessel to perform a platform supply run, you can drop off the HAUV on the way out and then pick it up on the way back after it has completed its predetermined task," says Nigel Ward, Modus' chief commercial officer. Based on the battery capacity of Modus' current HAUV, surveys covering about 60 kilometers can be run on a single autonomous charge, with survey time depending on speed and payload.

Modus' background is in subsea trenching services. When the company was looking to invest in new technology, it felt that the ROV market was mature, if not saturated, so Modus looked to diversify and acquired a Remus AUV with a view to providing lower cost survey and inspection services from vessels which were already out working. The intention was to piggy back off vessels and let the Remus go off and do its work while the vessel continued with its primary task (instead of an ROV being used, tying up an ROV support vessel The benefits were seen to be a reducing human error making offshore projects easier, keeping skilled staff onshore and reducing costs and increasing safety.

The Remus was not quite the right vehicle for the activities Modus were involved with. It came with a side scan sonar, but customers wanted bathymetry and, like many AUV systems, it was difficult to upgrade the vehicle or change out sensors for different applications," says Ward. "In any event, the existing

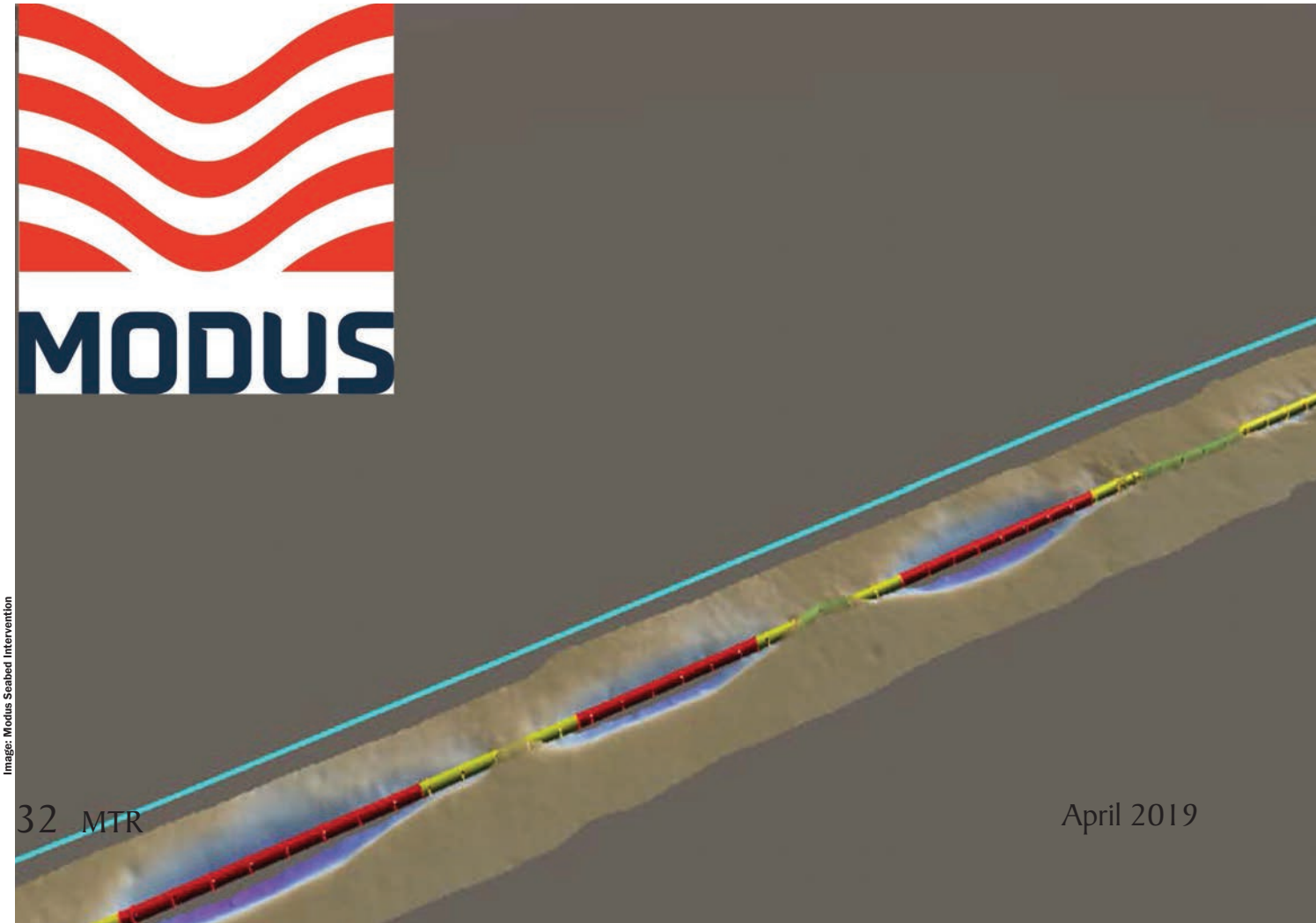


Image: Modus Seabed Intervention

AUVs in the market are not actually that autonomous; often the vessel needs to track the vehicle during a scope, which, in our eyes, defeated the object of the autonomous feature."

So, Modus looked at Saab Seaeye's Sabertooth. "It's a cross between an ROV and an AUV. We wanted the benefits of both. The ability to mount a flexible survey sensor payload quickly and easily is critical to meet customer requirements. We can hire a sensor, integrate it and away you go. There's so much new survey technology being developed at the moment, so we wanted to make sure we could use it so as to future proof the vehicle.

"We also wanted to be able to hover like an ROV, have the speed of an AUV and be able to perform truly autonomous operations, so you don't have to dedicate a vessel to chase the HAUV with an ultra-short baseline (USBL) positioning system. We felt that the Saab Sabertooth meets this criteria.

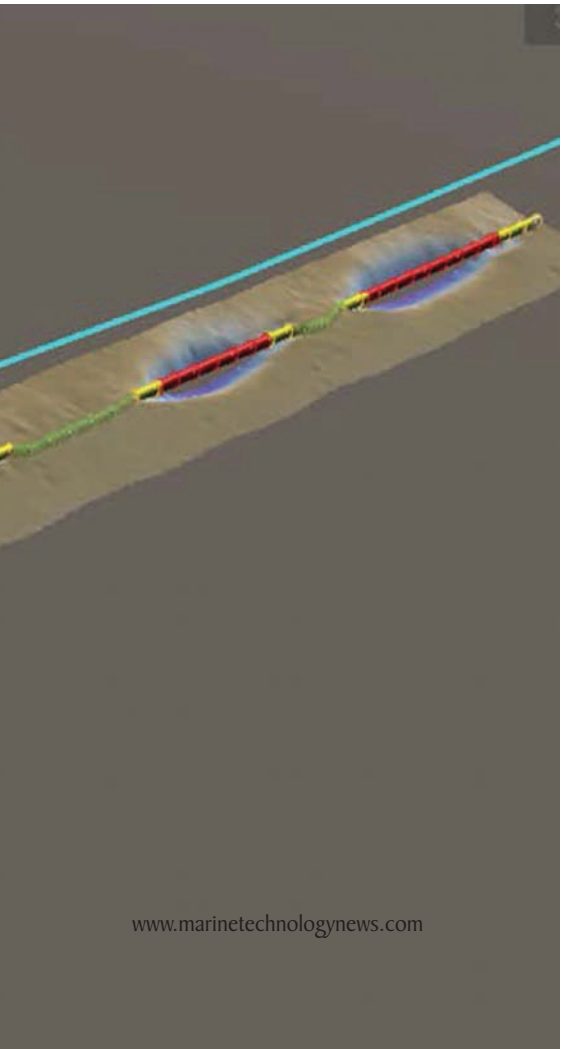
"The vehicle relies, in its base package, on its IXBlue Phins3 inertial navigation system (INS), and RDI workhorse doppler velocity log (DVL), with data acquisition, navigation and processing of sensor data managed by QINsy, which also takes in Novatel DGPS data. However, the payload is flexible and it could also work within long baseline (LBL) arrays or with a USBL system where required, with a Sonardyne AvTrak 6, providing a transducer, transceiver and telemetry link in one."

In 2017, the company performed demonstrations and trials and the HAUV was ready for commercial operations in 2018. In one of the trial projects in 2017, the HAUV was launched from a quayside at a lake close to Saab's Facility in Sweden to perform a "mow the lawn" style pre-programmed survey collecting multibeam echosounder (MBES), sidescan sonar (SSS) and sub-bottom profiler (SBP) data over about a 15-kilometer route, with no external aiding from a support vessel (just the vehicle's DGPS, INS and DVL).

"Having gone out and repeated the survey, it saw very little drift," says Ward. The vehicle was also successfully trialed multiple times, autonomously docking into its subsea garage. In early 2018, this function was further developed, as part of an Innovate UK funded project for wind farm resident inspection performed. This trial was run at the ORE Catapult facility in Blyth and also involved indirect power coupling and data transfer using a Blue Logic inductive connector.

In the final phase of this funded demonstrator project, later this year, in between its commercial commitments, the company will trial a resident hybrid AUV concept at an offshore wind farm in the UK. The HAUV and its docking station will be dropped off for a mission, similar to a demonstration at the ORE facility. On this occasion, it will not interface with any of the wind farm infrastructure. "However, to plug the docking station into a wind farm, to access power and communications would be relatively straightforward," says Ward, "as there's already available power and data infrastructure used for work on the turbines that we can tap into."

Last year, Modus deployed a HAUV offshore Northwest Australia to perform circa 240 kilometers of pipeline integrity



survey, producing stunning images, as well as point cloud data, of both the pipeline and passing marine life (see inset with detail of the shark's teeth, taken at 2 knots) using a Cathx Scout laser profiling and HD imaging spread alongside a MBES.

The survey time was half of what it would have taken using a traditional ROV to perform the survey and it could have been faster," says Ward. "Such a survey is possible without a tether, but it was performed with a tether on this occasion so that real time data could be collected."

For navigation, the vehicle used USBL aiding to follow a route position list from as-built charts of the pipeline. This can be combined with the autonomous pipe tracking algorithm which uses pipe profile data collected for the MBES to follow the pipe route. This is particularly helpful if the as-built position is not accurate which may be caused by inaccuracy caused by positioning tolerances. "Because of these systems the AUV can, in effect, see the pipeline, it means that USBL aiding isn't always required to perform a pipeline inspection, enabling autonomous operations away from support vessels," says Ward. "The CathX Laser system provides a very high-resolution point cloud of the pipeline and adjacent seabed. The laser and MBES point clouds were combined in post processing and used to assess position and possible freespans. The very high resolution obtained from the laser system makes it suitable for spool deflection and other photogrammetry-based metrology surveys."

Because the vehicle is stable, quiet and can fly at a constant height above the pipeline, imagery and measurements that are produced from laser-based point clouds, stitched together with the HD camera imagery, are highly accurate and easy to process.

One of the markets Modus is targeting is offshore wind. Turbine array fields are often in high current areas, so in 2017 the company put its HAUV to the test at a hydroelectric plant in Sweden, where the 4.5-knot speed capable vehicle demonstrated its ability to maintain position and maneuver successfully in 3 knots of current. At offshore wind sites, often there are walk-to-work service vessels deployed in field for main-

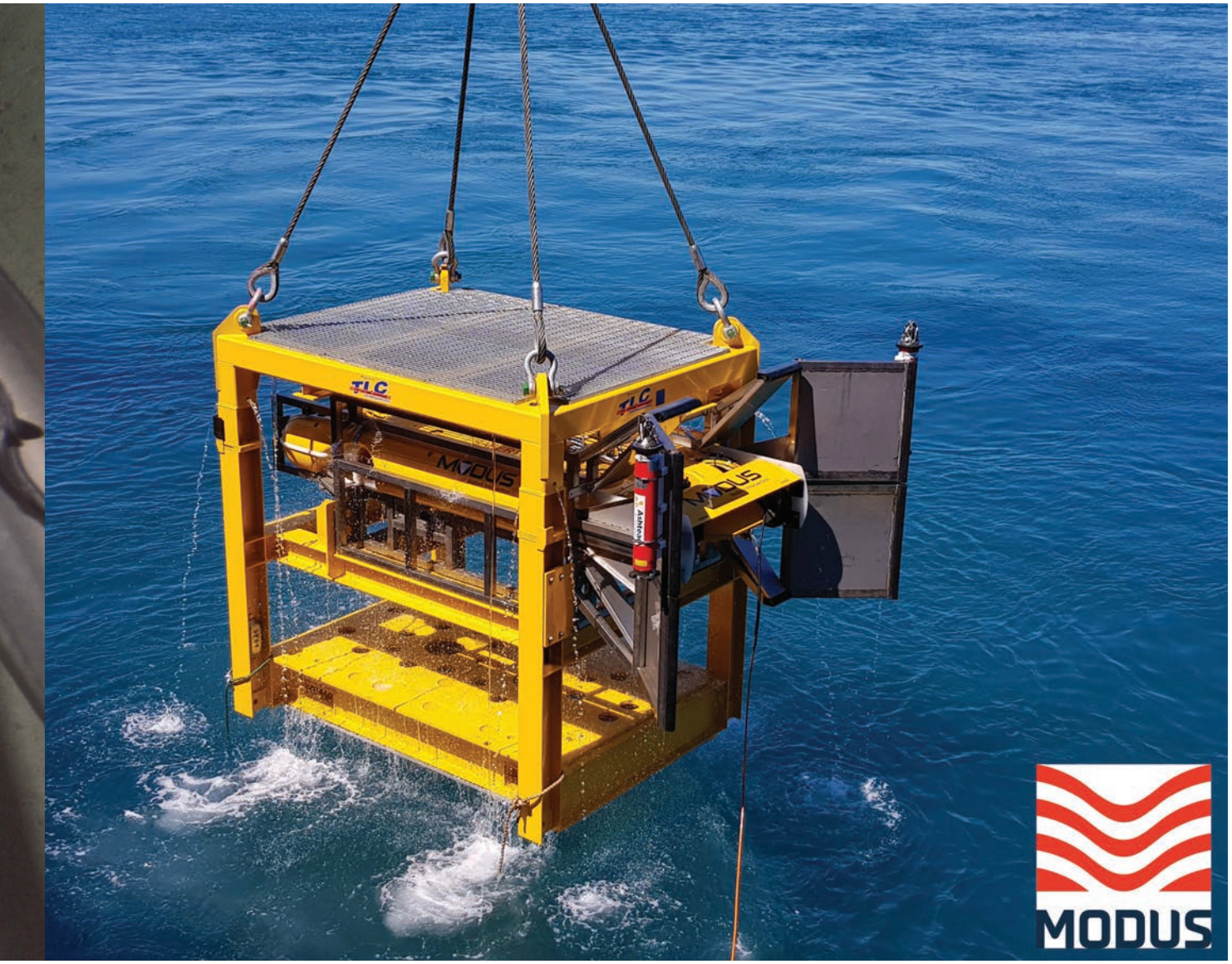
Image: Modus Seabed Intervention

tenance activities, these are effectively hotel boats with a lot of redundant time. We have developed HAUV to be able to be deployed and recovered from these vessels essentially replacing the need to mobilize an ROV vessel to perform inspection activities. It makes the service vessel more valuable.

For Modus, it is not just about visual inspection. The company has also been trialing Force Technology's FIGS system, which can do noncontact cathodic protection surveys at 4knts, alongside while doing general visual inspection (GVI) survey.

"Saab have designed a robust subsea vehicle and we have developed it further so that it can be operated as a class leading survey and inspection vehicle," says Ward. "We have focused on how the sensors are integrated, how they talk to each other, mission software and we are now moving into artificial intelligence and machine learning capabilities. We can already say 'go here, if you see a pipeline, follow it, or if you see a monopile, perform an inspection around its circumference'. This has all been demonstrated in trials. The next set of autonomous developments will be very exciting. In the near term we want to develop the HAUV track and survey buried cables autonomously. Various pipe tracking technologies are currently being trialed. This is expected to be a quick development as we can use similar algorithms to those used to track visible pipelines."

It's not been an easy journey, but Ward sees that some are seeing the potential. "There is no doubt we have faced challenges in bringing this technology to market," he says. "Primarily, many companies want to carry on doing operations the way they always have, for example some operators still specify ROV and boom cameras for pipeline inspection. But those customers who have embraced this HAUV, that require a slightly different approach to tackling GVI, have reaped the benefits in cost savings and improved data quality. "HAUV has been fully commercially operational for nearly a year now, it has a growing track record and we are very excited about the further optimizations and features that we plan to commission over the coming months, in addition to welcoming our second HAUV to the fleet in a few months' time."



Mining Enabler: INESC TEC's TURTLE lander (in an equipment bay and rising for maintenance)

Photo: INESC TEC

Mining for AUVs

In Europe, there are sure signs that underwater mining is the next big market for autonomous underwater vehicles (AUV), remotely operated underwater vehicles (ROV) and new "drones" called HROV, DART or TURTLE. Among the indicators is the involvement of mining companies, governments, rich subsea players and a Dutch dredging community. New vehicles are being developed from Hungary to Hawaii, although Portugal, it seems, is at the forefront of commercialization.

By William Stoichevski

Apart from dredging up gold and diamonds nearshore, underwater mining is about two activities: tapping the leftover mineral deposits in about 3,000 flooded and abandoned European mines and, more pertinently, mining for minerals in the exclusive economic zones (EEZ) of maritime countries where rare earth elements (REE) are known to lie. There's a quiet desperation surrounding both enterprises, as REEs are the stuff of iPhone screens, military-grade aluminum, hybrid cars, televisions and the newest batteries.

Enter the drone. The European Union is marshalling its mechatronic (multidisciplinary, robotic) research communities — its university engineering faculties and applied-science scientists — and its geologists to build a supply chain that can mine underwater. EU-funded projects, of which there are many, have helped launch a new spherical drone called UX-1b to map and monitor the contours of confined sunken mines, and an EU-backed consortium is also about to launch (as are the Norwegians) a mining system comprising a nodule-crunching tracked vehicle, its launch-and-recovery unit and a specialty "drone". In fact, the future of subsea mining looks set to always be a tracked vehicle with a supporting cast of ROV, AUV and now HROV escorts.

The EVA subsea-mining support vessel, a hybrid or HROV, is part of a mining system that consists of a large, 20-metric-ton mining vehicle and a surface launch-and-recovery barge that might be easily replaced by a vessel with moonpool.

"EVA is used for real-time pit modeling and for assisting the underwater cutting operations providing visual and detailed sonar information from multiple points of view of the cutting, launch and recovery of the miner," explains Alfredo Martins, senior researcher at INESC TEC's Center for Robotics and Autonomous Systems. "This information is fed into an integrated virtual environment for the human operators and supervisors," Martins says, before confirming that EVA can also deploy offshore "either operating in AUV mode or in ROV mode." The 60-strong community of researchers appears to lead the drones-for-mining pack when it comes to vehicle "awareness", autonomy, control and commercialization. INESC TEC's researchers have developed a disproportionate number of robots for ocean industries. These include the DART deep sea survey AUV and the autonomous deepsea robotic lander dubbed TURTLE.

"The (TURTLE) has clear applications in subsea mining as it is a special AUV that can stay on the bottom for extended periods of time and is capable of moving itself to another location. In deep sea mining, it can be used either in local support of operations (as in providing local acoustic navigation support or an AUV charging dock) or in the transport of equipment to and from the sea bottom to the surface."

EVA

While the TURTLE and the DART appear to be commercially available from, the EVA is still being evaluated as part of a mining system by an EU consortium that includes SMD, Damen, Sandvik, INESC TEC, Fugro, Zentrum fur Telematik and BMT Group. When we called, they were deliberating on commercial ways forward for EVA et all. "It certainly has been a success," Martins says. "EVA packs an extensive set of sensors (multiple cameras, laser-based light systems, multiple sonar types) in a versatile and highly maneuverable system. It was used successfully in a challenging environment, such as the underwater mining scenario, in industrial conditions, and while providing crucial data for the planning, supervision, command and control of the (mining) system."

In general, AUVs, ROVs — together, are seen doing sam-

pling survey, mapping, hyperspectral photo work (metals detection), environmental monitoring, risk assessment, cutting-process observation and serving as equipment mules from seabed to surface. The EVA HROV also uses advanced mineralogical sensors, or Laser Induced Breakdown Spectroscopy (LIBS), to analyze the seabed or minerals being lifted. In all, INESC TEC developed the "perception, navigation and awareness systems" for the mining vehicle and EVA robot (together the same EU project).

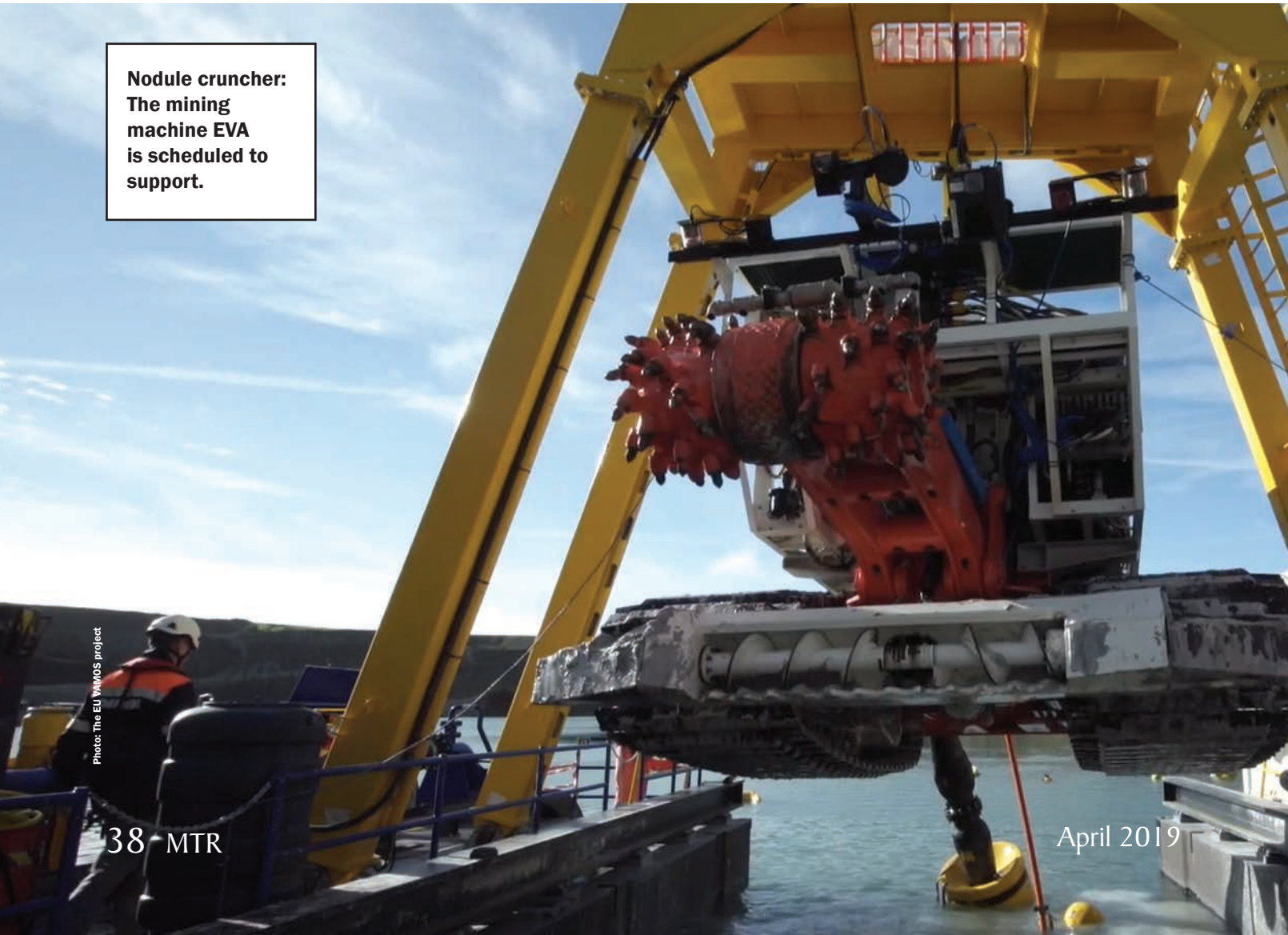
The other AUV developed under the aegis of the EU is the UX-1 (prototype) or UX-1b, a spherical vehicle equipped with lasers to help mining vehicles navigate and mining companies understand the contours of an underwater mine. Impressively, INESC TEC is also a key outfitter for this Europe-wide research success story that involved 17 consortium partners from nine European countries, including robot developers SMD and BMT (UK), Damen (the Netherlands) and Sandvik (Germany).

Subsea who's who

Well-financed, subsea-focused Norwegians centered around the University of Bergen have certainly taken note of these mining equipment successes. In the run-up to and follow-up of the 47th Underwater Mining Conference in Bergen last year — yes, the 47th — organizers noted the achievements and attendance of a who's who of subsea maintenance and survey work.

Among them, organizers heralded the news that Swire Seabed had just acquired a HUGIN AUV from Kongsberg Maritime after doing pipeline inspection work for oil company Equinor. In a press release, the Singapore-based outfit said it was now ready to "go beyond current industry needs". In fact, early in 2018, Swire Seabed had begun the Norwegian government's first commercial cruise to map marine mineral resources of copper, lead and silver on the Norwegian continental shelf (by AUV survey and ROV rock sampling).

"This can become a new market for them (Swire Seabed) and possibly for the entire subsea industry," a Norwegian taxpayer-funded incubator outfit said on its Web page (fittingly, we went to press, massive deposits of REEs were being found in fabled Norwegian county, Telemark). Swire's Norwegian advisor for survey and AUV operations was quoted as saying, "our equipment and competency is very well suited to this emerging market". He said deepsea mining — seen as poised to take off — mostly requires AUVs for mapping. Meanwhile, at INESC TEC and elsewhere, including the University of Ha-



Nodule cruncher: The mining machine EVA is scheduled to support.

Photo: The EU VAMOS project

waii, underwater mining tools target the whole gamut of mining support tasks.

High-stakes ops

Some high-capital mining and subsea players have already surged ahead, if mostly in the dredging of coastal zones. Earlier out than Norway, Papua New Guinea, Japan and the Cooke Islands have created rules to govern this nascent industry.

Toronto-listed Nautilus Minerals is deeply involved in the Bismarck Sea project, Solwara 1, where the world's first, large-scale, deepsea mining project at depths of 1,600 meters targets copper that's nearly 14 times richer than that found on land. A large new vessel is being built for an undertaking that will use risers to lift minerals.

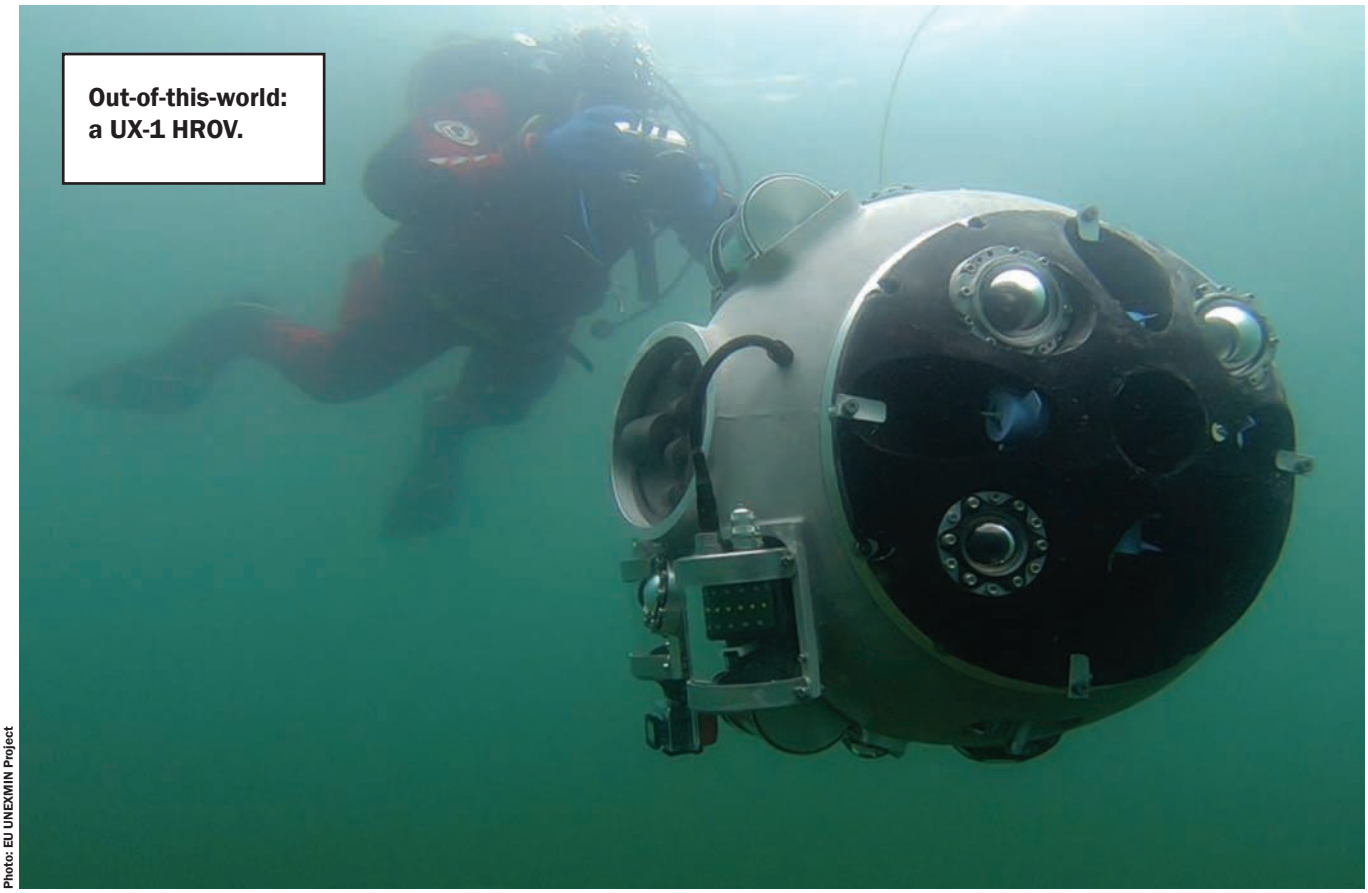
Swire Seabed, too, has worked with Ocean Infinity, a Houston-based seabed exploration company which has paired six HUGINs with six unmanned surface vehicles, or AUVs, to survey vast areas of seabed using multi-beam (seismic) bathymetry and echosounders; bottom profilers; HD cameras; conductivity sensors; ocean floor magnetometers and laser sensors. Importantly, those AUV payloads largely require the REEs subsea mining seeks.

Deepsea mining techniques are being polished in the wake of major offshore acreage awards. Deepsea miner, Ocean Minerals, says REEs are "17 chemically similar metals consisting of the 15 elements known as the lanthanides plus yttrium and scandium" and they're of value due to their "unique magnetic, chemical and luminescent properties" and essential to makers of hybrid vehicles, mobile telephones, computers, etc. That's why the company, in 2017, secured exclusive rights to 24,000 square kilometers of the Cooke Islands EEZ. The South Pacific nation has had a Seabed Mining Act since 2009, and OML will work with its Seabed Mining Authority to make the most of exploration licenses and permits acquired since 2013. The Cooke Isles target are seabed sediments beneath nodules identified as potential sources of REEs and scandium, an aluminum strengthener. A survey of the resource has found what looks like 200 million tons of the polymetallic nodules. The trove is potentially also, "the largest known primary cobalt resource in the world."

Proven techniques

The company says a 2016 multi-year R&D pact between the (Aberdeen Proving Ground) in Maryland and Deep Reach Technology of Houston identified over 180 MM t of REEs and Sc. Not surprisingly, and in light of its recent REE discoveries,

www.marinetechnologynews.com



Out-of-this-world: a UX-1 HROV.

Photo: EU UNEXMIN Project

Versatile: The off-shore and inland HROV, EVA.

Photo: INESC TEC

AUV visuals: Swire Seabed's user interface.

Photo: Swire Seabed

Norway has announced it will follow the Cooke Isles example of issuing licenses to qualified subsea mining companies.

Ocean Minerals' qualified offshore process involves lowering pipe bound to nodule-harvesters on the seabed. Nodules are collected, screened, separated and concentrated for transfer via lift pipe to a production vessel as seawater slurry. Another pipe adjoining the lift pipe returns seawater back to the ocean. So, deepsea mining combines the tech and experience of offshore oil and gas (risers, umbilical, surveys and "drones") with the experience of dredging; nearshore diamond and gold mining and the land-based mining industry.

"It is a relatively small industry sector at the moment, but with potential to grow," says Richard Mills, Kongsberg Maritime's director of Marine Robotics sales. While its clear that Kongsberg's payload-rich, torpedo-shaped AUVs will be valuable as pre- and post-exploitation survey vehicles, there might also be a subsea mining role "in association with the excavators" for the company's uncannily eellike Eelume ROV.

Meanwhile, Swire Seabed and associates Ocean Infinity are understood to have over a dozen HUGIN AUVs in service, and they ran the Norwegian Petroleum Directorate's minerals cruise. HUGINS doing survey work might always take the lead offshore in the preparatory stage of subsea mining. "We are not always aware of what our customers do with the vehicles," Mills says.

Once the mining begins, it'll be ROVs and HROVs like the EVA or TURTLE. The latter is INESC TEC anticipating the future costs of seabed mining: the versatile TURTLE robotic lander doesn't need specialized launch equipment, it relocates autonomously and can come to the surface for maintenance without expensive vessel support.

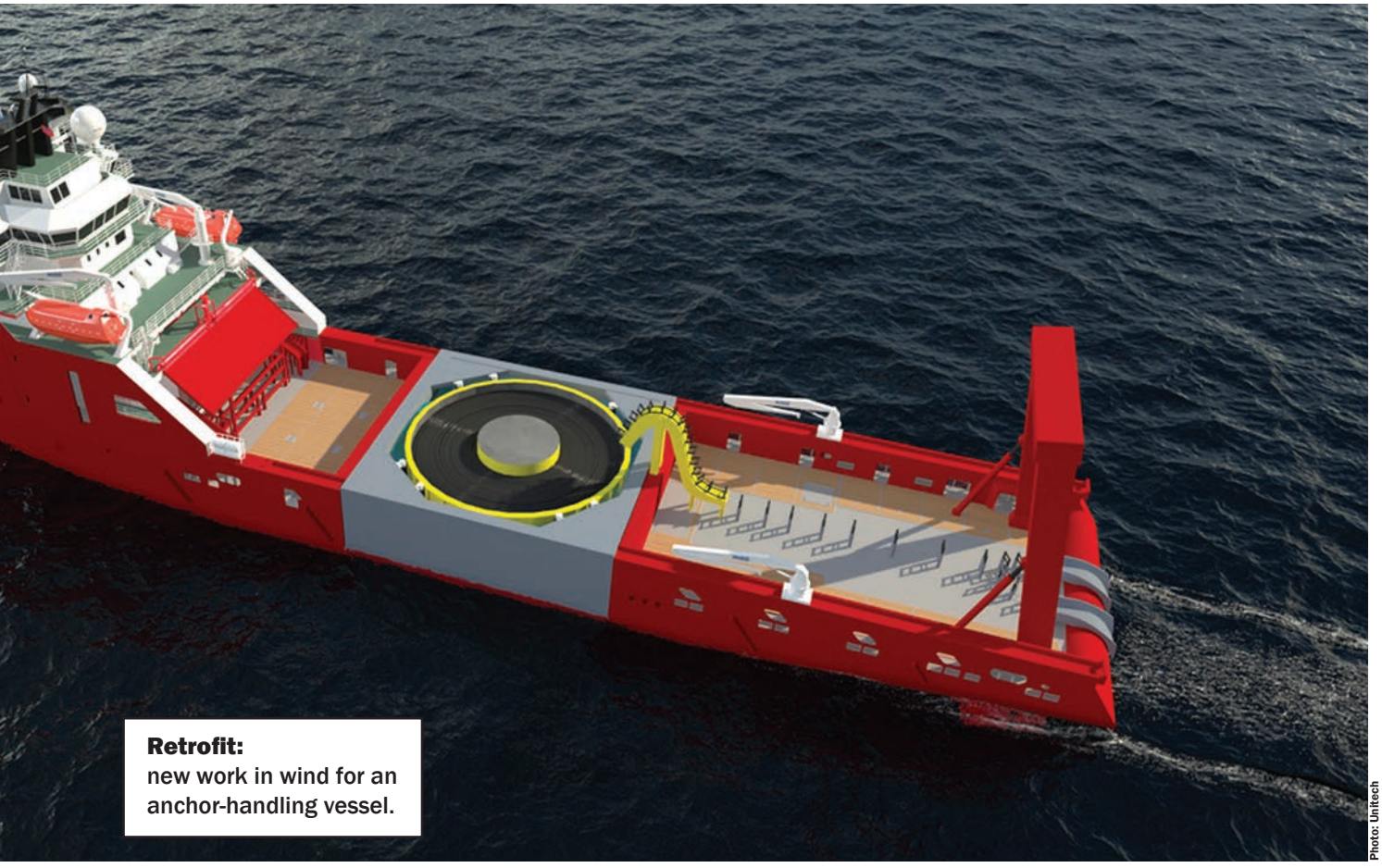
Offshore wind:

Photo: Equinor

The making of a (supply chain) star

Wind is "the tech of choice," the International Energy Agency said recently, just as a new report by the University of Delaware outlined the opportunity in U.S. offshore wind: 5,000 miles of offshore cabling and 1,700 turbines, it turns out, are bundled into current state-side plans. Yet, serious observers of the first U.S. offshore wind installations saw inefficiency: unwieldy lifts; few specialist vessels on-hand; and cables were "just cables." Supply chain innovation, people say, lags other industries.

By William Stoichevski



Retrofit: new work in wind for an anchor-handling vessel.

Photo: Unitech

In Europe, where offshore turbines heavily dot maritime maps, there's acknowledged room for innovation in turbine construction, support shipping and subsea. Installations here, too, can seem encumbered and slow. Cables and power are said to be "laid" when they could be better "distributed."

To "catapult" a new wind supply chain into the fore, Norway is inviting supply chain hopefuls from around the world to an incubator program aimed at making offshore — and especially floating marine wind installations — as efficient as surface and subsea operations in offshore oil and gas.

The Norwegian start-up program features The Sustainable Energy Test Center at Bomlo near coastal city Haugesund, where Equinor has left in place a floating offshore HyWind turbine so suppliers and would-be suppliers can test their wind energy innovations. One of the program's first start-up success stories is Unitech Subsea, which took over ownership of the HyWind turbine this year. Unitech's offshore oil and gas offshoot has zeroed in on the spooling of wind energy power cables that aim to perfect and customize power distribution to get the most out of a wind turbine's power outputs and drives.

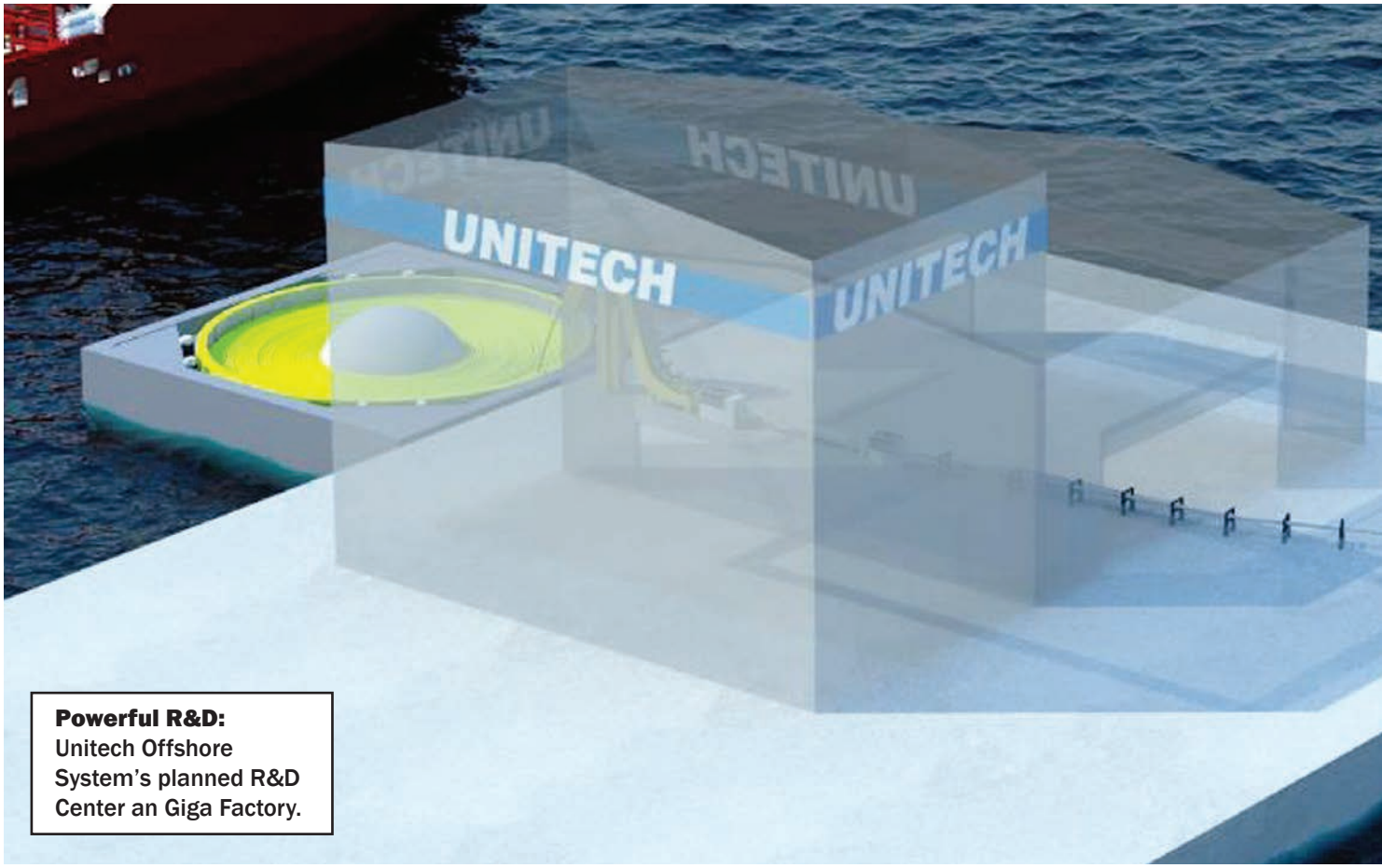
The system envisions turbine drives from Yaskawa company, The Switch; newly developed, aluminum-threaded cables just for wind from Unitech Subsea, and the use of a mobile spooling system by local outfit Cabletanker that retrofits onto a modified anchor-handling vessel to "spool-as-you-go" between wind turbines. The spooling system can also be mounted as a barge.

Spooled cable is custom "spun" like yarn from a fixed or floating "subsea power cable (and) umbilical factory" to a wind park's power requirements. The custom cable mounts onto, moves aboard and, if desired, spools directly from a modified offshore vessel or new-build design.

"Yes, (the floating vessel and floating cable factory) are the same technology developed and patented by Cabletanker. We have tested a prototype and are now building a pilot with capacity for 500 (metric tons)," Unitech Subsea Systems CEO, Gunnar Birkeland, tells *MTR*. He says Unitech, which has a strong presence in the Houston, can save grid operators a large chunk of CAPEX and OPEX before and after the wind blows.

"The key for floating wind is to radically come up with new solutions to be able to cut cost significantly to be competitive. There is no way you can cut enough cost by optimizing existing solutions — no way," Birkeland asserts. The Unitech concept for cable-laying and production "turbine-to-turbine" and to shore is one part of a major "positive deviance" in supplier thinking Birkeland attributes to Unitech Offshore founder and owner, Bernt Hellesoe.

"The installation methodology is not stand-alone but dependent on Unitech's completely new cable design (patent pending)," he says, adding, that the new cable design allows for "simple" production and installation. "This can be adapted to any region," Birkeland adds.



Powerful R&D: Unitech Offshore System's planned R&D Center an Giga Factory.

Photo: Unitech

At least one unnamed wind player (our guess is Equinor) has already signed on with Unitech. While they've opted for wind power cables, Unitech is also in negotiations with clients for new, customized cable designs and installation technology.

"Our business plan is based on this being our major income within three years," a confident Birkeland says. It's a bold statement in Norway, where subsea cable players serving oil and gas are well-known and well-capitalized.

It's been a year since the company announced it was investing millions of kroner in a subsea power cable and umbilical "giga factory" at Bomlo Norway. The factory — partly reproduced aboard a prototype modified anchor-handler — takes aim at the massive heavy-lift vessels normally associated with cable-laying and at subsea cables not customized for wind turbines. When built, and together with the floating spooling systems, it'll disrupt European cable-making and cable-laying by keeping operations lean, nimble, grid-optimized and super-local.

Unitech's floating production line at Bomlo will feature floating cable tanks that can produce 4,000 tons of cable that offload onto modified offshore vessels or newbuilds "for rapid mobilization and installation". The factory will weave cable near the Unitech Research & Technology Center, understood to be part of the Sustainable Energy Test Center.

Wind-energy start-ups

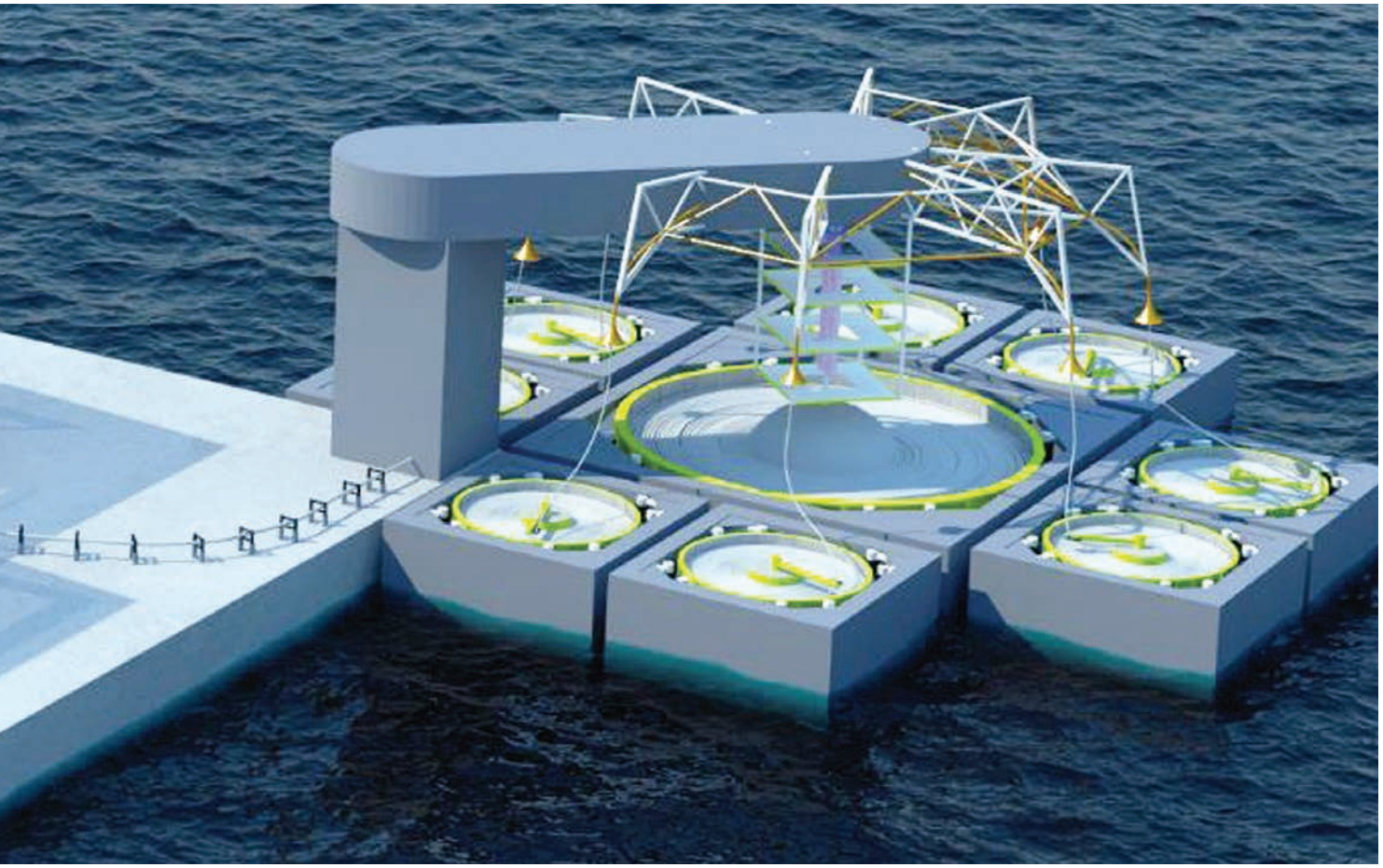
Meanwhile, the Norwegian offshore wind incubator project, the Sustainable Energy Norwegian Catapult Center — or just "Norwegian Catapult" or the Test Center — is hoping to produce other Unitechs out of an expected stream of startups.

By pumping cash into innovation at the Center, the Norwegian government will offer would-be wind suppliers from around the world access to the Unitech floating turbine and other infrastructure, as well as access to potential future wind clients looking on and a chance to see breakthrough innovations find immediate use. Sustainable Energy Norwegian Catapult Center CEO, Willie Waagen, says the main challenge is to "normalize" solutions that make operations offshore less expensive.

"You (the wind supplier) pay me, and I pay the test center," he says in jest, although he later admits, "That's about right."

"The Center is open to all that have technology they want to test. We have facilities and the approvals to do testing, the basic thought is that instead of the entrepreneur investing in expensive equipment to show that their component works, he can rent a place with us," Waagen says, adding, "Bring only the components you're testing. You don't need to bring all the other components."

The incubator, or start-up catapult as the Center's backers prefer, is backed by Unitech, The Switch, a local power utility and a host of other agencies dedicated to evolving the marine-wind supply chain. Waagen assures applicants, "We will not own any technology." Other Norwegian tech incubators of recent years have been successful surrounding talent and tech with resources, cash and potential clients.



A place to grow

Along with the 1,100-square-meter testing and training center backed by The Switch — plus researchers, equipment and infrastructure — the Sustainable Energy catapult will also provide production material and Unitech's own prototype testing center. To help startups close the gap between their technology pilots and market introduction, the local power company will offer a grid connected to the island test center and its marine HyWind turbine.

Unitech, which took ownership of the first HyWind test turbine in February 2019, is still the key to much of the hoped-for innovation. While it's floating cable factory isn't expected to open for another two years — the approximate timeline, too, for the first spooling-ship newbuilds and the custom wind cable — Unitech is confident innovation will occur.

"It took us a year to really understand what a major player we can (and will) be," Birkeland says, adding that it's only been two or three years since the company started looking into how to optimize subsea power cables for wind.

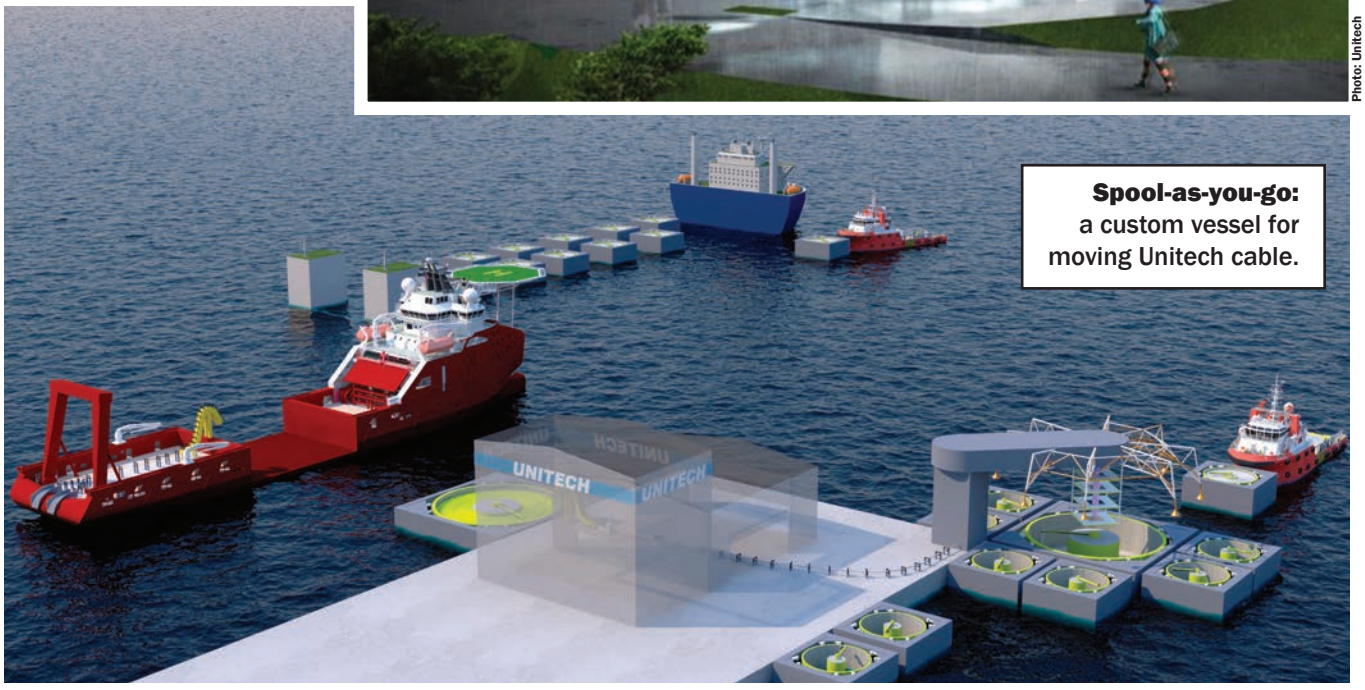
"We started looking into submarine power cables…by accident. We did not really believe that there was much development. However, it's been proven that our 30 years of subsea distribution system experience had a lot to offer the cable industry. It seems today's designs are more based on existing manufacturing facilities than the optimum design for floating wind and installations. It's like with electrical cars, it is hard to rebuild your gasoline engine factory," he says, adding that he sees Unitech as Tesla of offshore power cables.

The timing is right for a new Tesla of that type. While Unitech delivers cost savings and Waagen's Test Center attracts wind power entrepreneurs, floating or marine wind power continues to grow. Since Equinor's launch of a HyWind pilot at Peterhead, Scotland, offshore wind has surged, led by floating wind. Now, Equinor sees marine wind growing to 12,000 MW of installed power by 2030 from less than 500 MW today. It's in vogue, and new floating turbine designs are being developed by fixed wind heavyweights and floating wind newcomers alike.

Unitech and the Bomlo Test Center have every reason to expect success. They have the financial support of Oslo and the attention of a market looking for efficiencies. The logic of turning an offshore vessel owner and cable supplier into a grid owner's savings supplier seem irresistible. And although the spool-your-own ship concept doesn't yet have a designer, ship owner or shipyard lined up, the business models seem sound, and the spool barge already exists.

"Floating offshore wind has to cut cost in the level of 30-40 percent to be competitive. Unitech cable design, manufacturing and installation deliver at least 30 percent cost savings over existing solutions," Birkeland says, adding that test centers for dynamic cables are hard to find. So, Unitech and its partners are building a test center for wind's entrepreneurs and researchers, and all marine wind suppliers are welcome.

Photo: Unitech



Spool-as-you-go: a custom vessel for moving Unitech cable.

Photo: Unitech

2019 EDITORIAL CALENDAR

MARINE TECHNOLOGY REPORTER 2019 MEDIA KIT

Profile | Market Feature | Technical Feature | Product Feature

JAN/FEB

Ad Close: Dec 21

Underwater Vehicle Annual

- Subsea Defense
- Southern California Cluster
- Autonomous Navigation GNSS MEMS
- Unmanned Vehicle Propulsion

Event Distribution
Oceanology Intl North America
Feb 25- 27, San Diego, CA
Underwater Defense & Security
Mar 5-7 Southampton, UK

FEBRUARY

Ad Close: Jan 22

MTR White Papers: Oceanographic

White Paper Electronic Edition Publication Date: February 2019

MARCH

Ad Close: Feb 21

Oceanographic Instrumentation: Measurement, Process & Analysis

- Ocean Business 2019 Technology Spotlight
- Fiber Optic Cables, Connectors & Slip Rings
- Marine Drones
- Hydrographic Sonar & Software

Ocean Business
April 9-11, Southampton, UK

AUVSI XPONENTIAL
Mar 29- Apr 2 Chicago, IL

APRIL

Ad Close: Mar 21

Ocean Energy: Oil, Wind & Tidal

- Workclass ROV
- Underwater Lights & Cameras
- Buoyancy Technology
- Scientific Deck Machinery / LARS

Event Distribution
Offshore Technology Conference
May 6- 9, Houston, TX
Sea-Air-Space
May 6- 8, National Harbor, MD

MAY

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Underwater Defense Technology

- Navy
- Comms, Telemetry & Data Processing
- Magnetometers & Streamers
- Beacons, Flashers & Tracking Systems

Event Distribution
UDT
May 13- 15, Stockholm, Sweden
MAST Asia
June 17-19, Tokyo, Japan

JUNE

Ad Close: May 21

Hydrographic Survey: Single & Multibeam Sonar

- Research Institutions
- USV Platforms
- GPS, Gyro Compasses & MEMS Motion Tracking
- Interconnect: Underwater Cables and Connectors

Event Distribution
Oceans 2019
Jun 17-20, Marseille, France

JULY

Ad Close: Jun 22

MTR White Papers: Hydrographic

White Paper Electronic Edition Publication Date: July 2019

JULY/AUGUST

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MTR 100 - Edition

The 14th Annual Listing of 100 Leading Subsea Companies
MTR looks at 100 leading companies and executives in all subsea disciplines, defense, offshore energy and science.

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Sep 3- 6, Aberdeen, UK
Seatrade Offshore Marine & Workboats
Sep 23-25 Abu Dhabi, UAE

SEPTEMBER

Ad Close: Aug21

Autonomous Vehicle Operations

- Subsea Engineering: Subsea Field Architecture
- ROV Technology: Work Class to Micro Systems
- Thruster Tech: Underwater Propulsion
- Underwater Tools & Manipulators

OCTOBER

Ad Close: Sep 21

Ocean Observation: Gliders, Buoys & Sub-Surface Networks

- Instrumentation: Profilers, Samplers & Sediment Corers
- Research Vessels
- Harsh Environment Systems for Arctic Ops
- Geospatial Software Systems for Hydrography

Event Distribution
Oceans 2019 Oct 28-31 Seattle, WA
Clean Gulf
Nov 2- 5, Houston, TX
Blue Tech Week
San Diego, CA

NOVEMBER

Ad Close: Oct 22

MTR White Papers: Subsea Vehicles

White Paper Electronic Edition Publication Date: November 2019

NOVEMBER/DECEMBER

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Acoustic Doppler Sonar Technologies ADCPs and DVLs

- Fresh Water Monitoring & Sensors
- Offshore Inspection, Maintenance & Repair (IMR)
- Underwater Imaging: Lights, Cameras & Sonars
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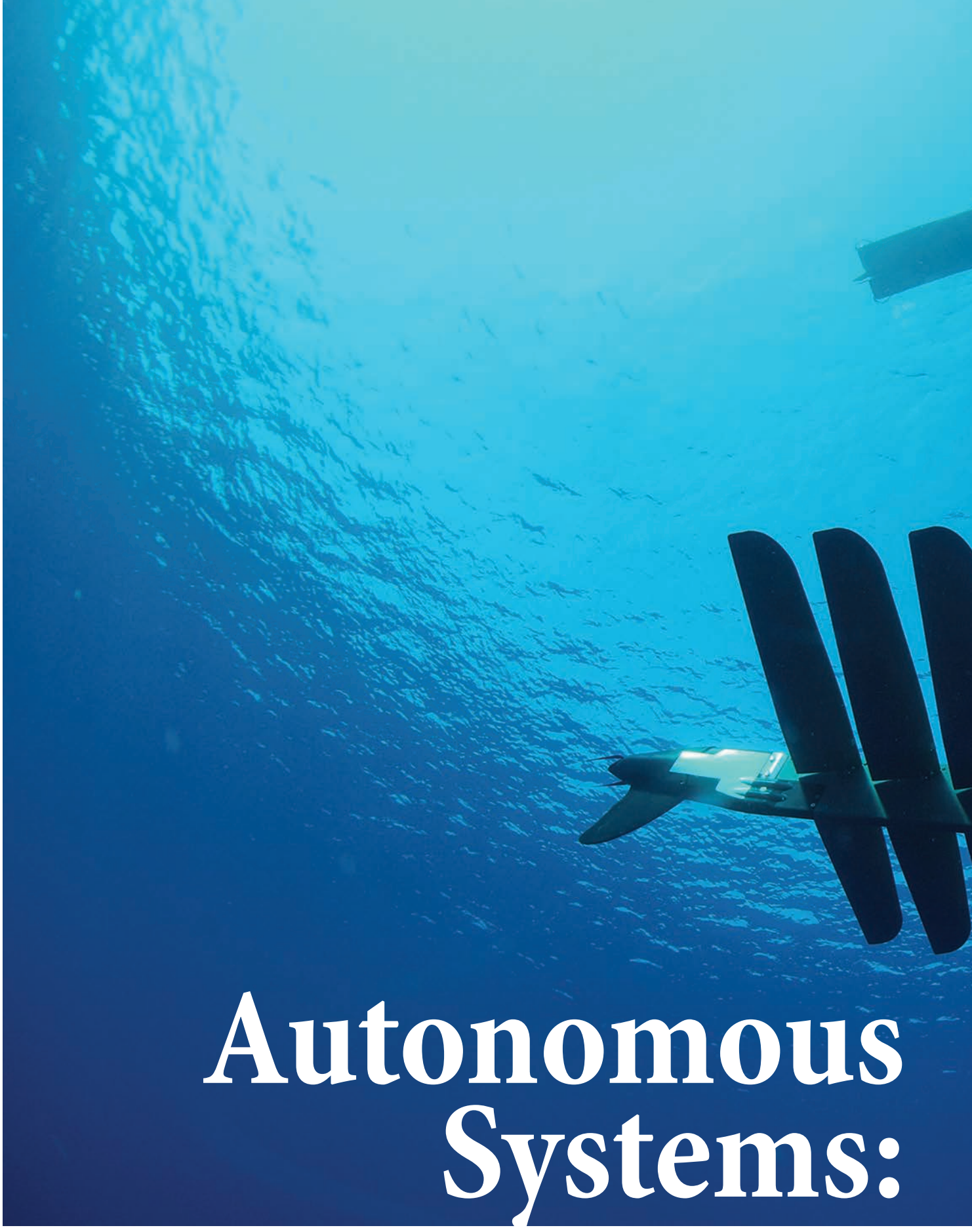
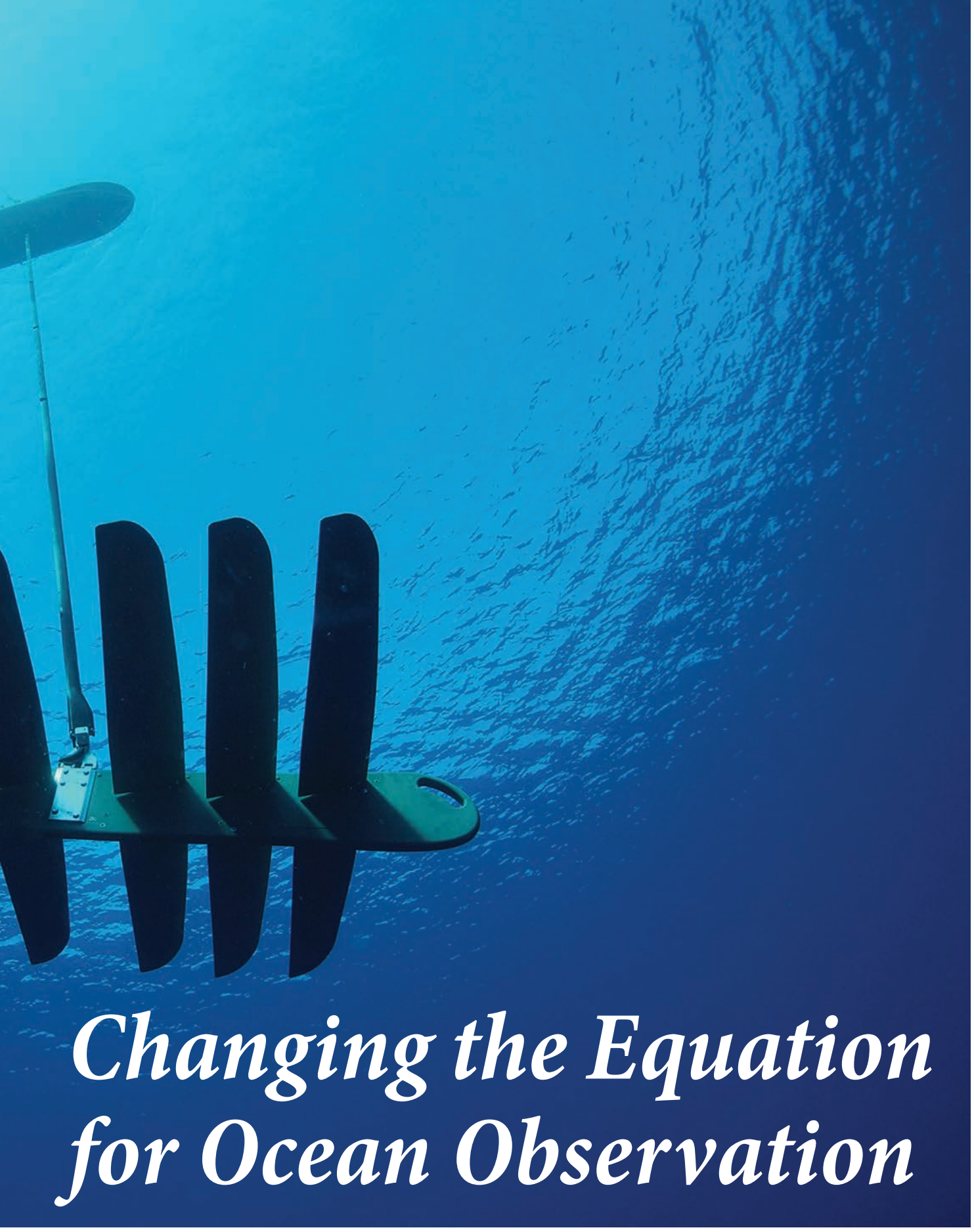


Autonomous Systems:



Changing the Equation for Ocean Observation

By Ryan Carlon

Over the past 20 years, great strides have been made in the ability to observe and monitor the worlds' ocean. Just think that less than two decades ago, one of the first global ocean observation networks, The Argo Project, began deploying profiling floats. Now nearly 3,800 of these floats operate in the major oceans taking the temperature and measuring salinity providing valuable insights into the changing ocean dynamics. Through the years, governments and international bodies have established global ocean observation systems to foster collaborative work toward improving our ability to monitor and measure the ocean. New technologies, in particular the emerging industry of unmanned maritime systems, are enabling observation and exploration in ways we had only dreamed.

We've come a long way to better understand our ocean. The reality is this is just the start.

Why? The deep ocean and our coastlines are greatly undersampled compared to the information collected by sensor networks on land and in space. To understand our planet and to solve some of the grand challenges before us such as climate change, dwindling fish/food populations, and the declining health of the ocean and marine life, we need information that today is too costly, too risky and too remote to continuously collect.

There's an opportunity before us to address this need with advancements in unmanned platforms, sensors, communications and software. The ability to create ocean networks capable of providing real time observations across all ocean domains is closer than ever before. Fleets of autonomous systems working together with manned assets collecting and communicating data throughout the ocean can help address our knowledge gaps. They will fundamentally change the economics, risks and capabilities for ocean observation.

This article highlights two customer projects that use Liquid Robotics' Wave Gliders for ocean observation. In both cases, scientists were looking for an alternative to using traditional research vessels to overcome the high costs, schedule limitations and inability to conduct adaptive sampling. The two customers are Scripps Institution of Oceanography - University of California - San Diego in La Jolla, Calif. and The Center for Fisheries and Aquaculture Science, Cefas, in the U.K.

Scripps Institution of Oceanography-University of California San Diego
GPS-Acoustic Measurements of The Cascadia Subduction and Alaskan Subduction Zones:

On land, we can measure Earth's movements with millimeter accuracy using a satellite-based GPS technique. But the radio signals that GPS relies on can't pass through water. Enter seafloor geodesy, an emerging scientific field that uses newly developed marine technology and GPS-acoustics to measure seafloor motion at centimeter-scale resolution through two miles of seawater.

Seafloor geodesy projects are underway across the globe, all in pursuit of scientific advances that will help us crack the code on earthquake and tsunami risk. The importance of this research is to better understand and measure the offshore geologic faults to help accurately predict undersea earthquakes and tsunamis. With early warning of undersea earthquakes, more lives can be saved, and property spared. This is vital especially for island nations whose coastlines are at sea level and heavily populated.

Several recent seafloor geodesy projects have been led by Dr. David Chadwell of Scripps Institution of Oceanography. In 2016 and 2017, he and his research team deployed Wave Gliders on 40-day and 31-day missions to measure the offshore geologic faults along the Cascadia Subduction Zone in the Northern Pacific Coast of the U.S.

His goal was to study the tectonic plate movement along the Cascadia Subduction Zone in order to better understand how the plates were moving and interacting. Using a Wave Glider with GPS acoustic sensors they were able to measure the seismic activity with precision resolution, down to a centimeter.

Compared with historical data collected over centuries, this new information will help scientists better predict geologic activity.

For the seafloor geodesy missions, the Wave Gliders were equipped with:

- ***Sonardyne acoustic modems***
- ***Dual frequency GPS receiver embedded in an inertial navigation system (INS)***
- ***Second GPS antenna/receiver to align the INS***
- ***High precision acoustic ranging system***
- ***Iridium RUDICS communication channel for control of data collection and offload of data***

Operationally, the Wave Gliders held station continuously over seafloor transponders. Upon detection of the precise location of the seismic activity, acoustic data was communicated to the Wave Glider and then through the Iridium RUDICS comms channel for dissemination.

Analysis of the data collected over the two missions was presented at last year's AGU 2017 conference. Dr. Chadwell shared that his two GPS-A measurements spanning only one year suggest seismic motion was consistent with displacement at the full convergence rate. From the results of his missions, Dr. Chadwell concluded the Wave Gliders have the potential to significantly increase the number and frequency of measurements of strain accumulation in Cascadia Subduction Zone and elsewhere.

Monitoring the Alaskan Subduction Zone:

Dr. Chadwell and his research team completed a mission to measure the Alaskan Subduction Zone. The subduction zones are offshore the US coasts along Northern California, Oregon and Washington State and another along Alaska and the Aleutian Islands. These subduction zones have experienced great earthquakes in the past and will do so again in the future. His goal, as well as that of the scientific community, is to better understand the geophysical processes at work at these subduction zones to improve assessment of potential hazard.

The primary problem Dr. Chadwell and his team addressed was documenting how much and where the offshore part of the subduction zone along Alaska is moving. Land-based GPS is too far from the trench – where the Pacific plate subducts below the North American plate – to resolve what is happening. To measure the activity, they collected data across three sites spaced along this trench. The land-based data suggest there is a variation in the speed at which the elastic strain is building as it moves westward across the three measurement sites.

For this mission, Dr. Chadwell deployed Wave Gliders equipped with sensors for GPS-acoustics, OTS GPS/INS (Novatel), Acoustic Communication Module (Sonardyne), Iridium RUDICS (NAL) and interfaced through a Scripps in-house developed software system hosted on a small Linux server.

The Center for Fisheries and Aquaculture Science
Autonomous Ocean Observation for Fish Stock Assessment

The Center for Environment, Fisheries and Aquaculture Science (Cefas) in the U.K. has turned to a new approach to tracking and mapping their fisheries data. Facing operations in the turbulent North Sea, scientists at Cefas are using Wave Gliders for their data collection instead of the traditional survey vessels. This approach has multiple benefits in addition to the cost savings, increased safety and efficiencies. Collecting insitu data on some of the smallest fish in the sea (zooplankton and fish) is easier and produces higher resolution data when using a small, wave powered craft moving at 1.5-3 knots. By eliminating the ship noise and operating at dramatically slower speeds, data resolution is greatly enhanced and adaptive sampling possible.

Scientists led by Dr. David Pearce, Head of Profession, Marine Observations Systems, in 2018 completed a six-week,

1,700-kilometer mission autonomously collecting fisheries acoustics and physical properties of the sea surface. As part of this multi-vehicle mission under the U.K. NERC/Defra funded AlterEco project, the Wave Glider called Lyra was deployed in the central North Sea. Lyra spent 41 days at sea, repeatedly covering a 64-kilometer-long transect along which valuable data were collected under different conditions.

The data collected included salinity, temperature, oxygen, fluorescence, turbidity and solar irradiance information. The Wave Glider was also equipped with a meteorological sensor recording wind speed and direction, air temperature and barometric pressure. This meteorological data will be used to estimate sea state and performance of the acoustic system under different weather conditions.

Dr. Pearce believes the Wave Gliders could eventually take over elements of ship-based monitoring of the fish and zooplankton community by being able to identify these components of the food chain from the acoustic data alone. This will produce a cost savings and in turn reduce the durations of ship-intensive surveys. Additionally, collecting persistent, insitu measurements through rough and cloudy conditions provides continuous data feeds during times where buoys and satellites are most restricted.

Preliminary results suggest that evidence has been captured of diurnal (day-night) vertical migrations of zooplankton and other organisms in the water column, as well as schools of fish.

The Future is Bright

The future for autonomous systems for ocean observation and exploration is bright. Increasingly, the commercial, military and scientific markets are moving to operational use of autonomous systems. Their popularity is in the ability to continuously collect data for long durations in severe conditions that would negate human exploration and observation. In addition to the economic and safety benefits, offloading monitoring tasks to autonomous systems frees up human resources, thus increasing mission efficiency.

Looking back 20 years, we celebrate the progress and advancements made in ocean observation. We've come a long way since the days of Jacques Piccard and Don Walsh's unprecedented exploration to the bottom of the Marina's Trench (1960). These pioneers set the stage for the world today by using the most advanced technologies to extend the possibilities of ocean exploration. At Liquid Robotics, we are fastening our seatbelts, excited to see how our Wave Gliders will be used by scientists to expand our understanding of our ocean in search of new discoveries.

The Author

Ryan Carlon, Business Development, Environmental Assessment, Liquid Robotics, A Boeing Company, is responsible for Liquid Robotics' Global Commercial Environmental Assessment team that focuses on supporting the Science and Research community. He joined Liquid Robotics in 2012 and has been leading the sales initiatives for the Science and Research community ever since. Under his leadership he has helped establish the Wave Gliders for Researchers Program and the Science & Research User Group.

Ryan joined Liquid Robotics with a decade of experience in robotics and advanced software development for both unmanned maritime vehicles and vision-based mapping, localization, and navigation systems. He brought this expertise to his role as Business Development at Liquid Robotics' and continues to work with scientists across the globe in oceanographic and meteorology research institutions, national science agencies, commercial businesses and academia. Ryan's deep technical knowledge and business expertise is helping customers address global ocean challenges previously too costly or possible to solve.

Ryan first became interested in robotics after taking an introductory class at MIT and has since spent more than a decade working with them. After graduating with an Electrical Engineering degree from Harvard University, he joined Vision Robotics, a robotics company in San Diego. At Vision Robotics, Ryan built autonomous robots in the agricultural and defense industries.

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World Energy News	48,236

All stats from 01/23/2019

SubC Imaging

Photo: Greg Trauthwein

SubC Imaging's Chad Collett at Ocean Business in Southampton.

SubC Imaging, located in Newfoundland and Labrador, Canada creates underwater imaging systems including cameras, lights, lasers, DVRO solutions for easy media management, and even custom solutions for client specific applications. Founded in 2010, SubC has developed an international clientele in the offshore energy, ocean sciences, and aerospace and defense sectors. Over the past eight years, SubC has been an integral part in several high-profile international projects including the search for Amelia Earhart's plane and a survey of Australia's World War II light cruiser, the HMAS Sydney. The latest addition is the strategic affiliation with OceanGate. As part of their 2019 Titanic expedition, SubC's Rayfin 4K camera, 1Cam Mk6 camera, Aquorea LED Mk2, and DVRO software will be used to gather the first 4K images and video of the iconic wreck. Each one of SubC's products are designed for harsh environments and ease of integration on ROVs, AUVs, ocean observatories, and drop-camera systems. Target applications include ocean research and exploration, environmental monitoring, port security, and seabed mapping and surveys. Testing capabilities: - 3D prototyping - 10m x 1m in-house test tank - Image calibration - Nearby port facilities for field testing.

www.subcimaging.com

Remote Ocean Systems

ROS is an ISO-9001-2008 certified company with a 28,000 sq. ft. research and manufacturing facility dedicated to producing products. Its product line includes underwater video cameras, lights, rugged pan and tilt positioning systems, video inspection systems and control systems manufactured primarily for the oceanographic, nuclear and defense industries. ROS manufacturing is a cell-based operation, incorporating one-piece flow and a 5S lean manufacturing environment. ROS' custom product development partnerships with leading ROV manufacturers foster new product designs in deep water camera technology, new LED lighting ideas and revolutionary sonar positioners that are lightweight and accurate. Whether it's the latest LED lighting design or an ultra low-light camera for deep water inspections, ROS offers a choice of technology and products.

www.rosys.com

Photo: ROS

SIDUS Solutions, LLC

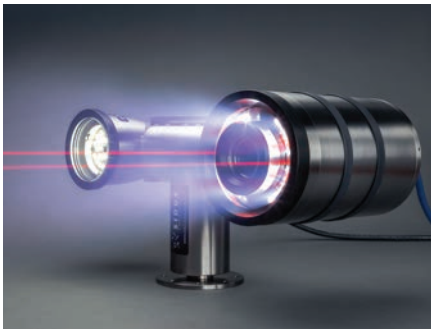

Photo: SIDUS Solutions

SIDUS Solutions, founded in 2000, produces a complete line of hazardous area and subsea video systems. In addition to product development, manufacturing and sales, SIDUS offers end-end engineering, system integration and project planning. SIDUS staff have traveled the globe to provide commissioning and technical support. A point of focus for SIDUS is Situational Awareness, as worldwide, ongoing pressure is being placed on the safe extraction and operation in energy exploration. With its products, services and target businesses, SIDUS has readily embraced 'situational awareness' in support of global safety and security initiatives. Having the right hardware is a good start, but only when the hardware can be put to work in the most efficient way, will the video system truly show its value allowing safety and security to be guaranteed. Tailoring systems to each individual applicant's demands enables SIDUS' customers to apply SA in everyday business.

www.sidus-solutions.com

Cathx Ocean, Ltd.

Cathx Ocean have manufactured what it claims is the world's first fully integrated subsea imaging system. The company's multidisciplinary engineering team have developed advanced underwater automation and robotic vision technologies for offshore and industrial operations which are used globally across many applications. Founded in 2009, Cathx Ocean have grown to be-

come one of the principal innovators in the subsea imaging and measurement industry. It is headquartered is in Kildare, Ireland with offices in the U.S., the U.K., China and Australia.

Currently the company is building systems to operate at 10,000m depth. Its advanced laser and optical based imaging systems were developed in-house and are now used worldwide in offshore energy, renewables, environmental monitoring, mapping, archaeology and for collecting evidence on salvage and defense operations.

The company's 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)

To enable faster and more efficient optical surveys, Cathx Ocean have developed an end-to-end technology architecture for acquiring and processing subsea images and laser data.

Traditional vehicles run at speeds of 0.5 knots with ranges of up to 3 meters. By enabling speeds of up to 8 knots and ranges of up to 10 meters, these imaging systems substantially reduce vessel time.

www.cathxocean.com

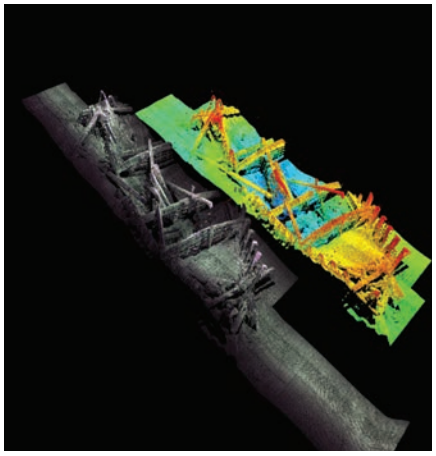

Photo: Cathx Ocean

Photo: Deepsea Power & Light

Deepsea Power & Light Vertex SeaCam

The new DeepSea Power & Light Vertex SeaCam features full HD resolution with 10x optical zoom capabilities for a wide range of tasks. These cameras feature proprietary corrector optics for the highest imaging performance, and multiple output options for easy system integration.

The Vertex SeaCam has low-distortion 80° HFOV at full-wide and 0.5 lux faceplate illumination for impressive imaging in low-light environments.

User control is simple with RS-232 and RS-485 control interfaces through VISCA or SeaSense™ Protocol. Tristate control is also available for zoom, focus, and auto focus features. Full ocean depth rating options are available.

www.deepsea.com

BIRNS, Inc.

BIRNS started out in the subsea industry creating underwater camera housings, and then soon moved on to developing lighting solutions for the U.S. Navy. Over the years BIRNS lighting systems were used in high profile excavation and archeological projects, from the Titanic to what was at the time the oldest shipwreck ever found, a 3,500 year old discovery in Turkey.

New LED lamp options are available for a range of BIRNS high performance marine lighting systems. The company has introduced new lamps for an array of lights for applications from helmet and vehicle use to PVHO, including the popular BIRNS Doubly-Safe Chamber Light-LED. The new 450 lumen lamps for this rugged chamber light have 35,000 hour lamp lives and come in a wide selection of voltage ranges, all with a mere 6.5W power draw.

The system provides BIRNS' proprietary Doubly-Safe dual helium release method, which makes the entire front of the light its own helium release valve. It consists of a back-up spring in the front lens mount, along with its additional stainless steel release mechanism, to safely and quickly remove any gas that might otherwise get trapped during compression. The BIRNS Double-Safe Chamber Light-LED is tailored for pressurized helium/oxygen use in submarines, diving bells and decompression chambers, and has a low profile of 76mm, and is easily mounted on ceilings and walls.

http://birns.com

MacArtney A/S

The MacArtney Group is a global supplier of underwater technology systems, products and integrated solutions.

The MacArtney portfolio of supplies is broad and include SubConn, OptoLink, TrustLink and GreenLink connectivity, cable and termination solutions, advanced NEXUS and EMO fiber optic telemetry systems, electric CORMAC and MERMAC winches, handling and LARS systems including active heave compensation (AHC) winches for ROVs. The MacArtney range of fast and precise remotely operated towed vehicles (ROTV) includes the MacArtney FOCUS 2, FOCUS 3 and TRIAXUS vehicles. MacArtney also designs and manufactures CEMAC offshore cable handling equipment intended for pipeline and cable-laying deployment.

The MacArtney range of dynamic MERMAC A launch and recovery system (LARS) solutions include A-frames, davits and other solutions for providing reliable and fully controllable deployment and recovery of a wide range of equipment - from small oceanographic instruments to large work class ROV systems. MERMAC A LARS solutions can be designed as portable or fixed systems and form part of compact and fully integrated winch and handling solutions on board almost any type of vessel.

Standard MacArtney MERMAC A-frame models range from the MERMAC A10 compact and portable A-frame handling system to the powerful and uniquely foldable MERMAC A50. The MERMAC A10 has been designed to incorporate MacArtney CORMAC Q winches for efficient handling of inspection ROVs, side scan sonar, survey equipment, oceanographic instrumentation and a wide range of other types of marine equipment. MERMAC A10 systems are easy to control and provide the outreach needed for safe launch and recovery. The systems can be supplied with or without a hydralic power unit (HPU).

At the other end of the range, the MERMAC A50 is a 120 kN A-frame primarily designed for handling TMS based work class ROV systems. The system design features an industry unique extra skid joint which allows the frame to fold at an extreme angle to enter transportation or deck access mode. The MERMAC A50 system can be delivered with a fully integrated docking head with latching mechanism and rotating function. Beyond the A10 and the A50, the MacArtney MERMAC A range also spans everything from basic over-the-side handling systems, including J-frames and davits, to much more advanced systems such as articulating A-frames, 45° launch position A-frames, horizontal launch position A-frames, low dip A-frames and container integrated A-frame solutions.

Applications include work class ROV systems, inspection class ROV systems, towed vehicles and instrumentation platforms, side scan sonar systems, oceanographic systems, sensors and equipment, seabed drilling and sampling systems, light handling and support for subsea completion, general marine instrumentation and piston corer handling.

www.macartney.com

Photo: MacArtney

A MacArtney A/S custom winch system.

Damen Winch Range

Damen Marine Components (DMC) designs and manufactures marine winches for a wide range of applications, but until now they have been available only on Damen-built or maintained vessels. That changes as DMC is making its winches available to third-party shipyards and equipment suppliers.

Damen Marine Components has been producing winches on a commercial scale since 2010, and Damen Winch Technology was formed in 2015, bringing on board additional engineers and creating a dedicated unit with R&D, design & engineering, production and after-sales support. Today, DMC offers a full range of escort, towing, anchor and tugger winches, and capstans.

Hawboldt Industries

Hawboldt is a designer and manufacturer of custom-built Launch and Recovery Systems (LARS). Its LARS product typically consists of an A-Frame, Umbilical Winch (hydraulic, electrical or both), with or without a hydraulic power unit (HPU). Hawboldt LARS can fit any requirement for size and configuration from 1.5mT to 25mT, with or without the Active Heave Compensation option. While many applications can be met by adapting our existing models and components, Hawboldt engineering can also design and develop compete systems to suit specialized needs.

https://hawboldtind.com

Okeanus Science & Technology L&R

Okeanus can provide a wide range of solutions to handle equipment deployment and retrieval. Its portfolio of rental equipment includes winches with a variety of cables, mobile A-frames in various sizes, vortex side-poles, mobile control units, outriggers, mobile units, and other specialty subsea applications.

The DT Marine 3025EHLWR is a 25hp electric-hydraulic Slip-Ring Tow Winch with a 2,000m 0.450" cable capacity. The winch's drum line pull is 4,000 lbs for a wide variety of oceanographic, survey, and scientific equipment deployment and retrieval. It features: 240-480 VAC – 3 phase, 4,000 lbs line pull and 2,000m .450 cable.

www.okeanus.com

DCL Mooring & Rigging

DCL Mooring & Rigging is a leader in supplying a variety of lifting, mooring and inspection products and services to domestic and international customers in the marine, construction, industrial and oil and gas industries. Based in New Orleans, La., with locations in Houma, La., and Houston, Texas. DCL fabricates all sizes of wire and synthetic rope slings for heavy lift applications. With wire rope swage capabilities up to 4.5-in. sleeve diameter, serving as an authorized Slingmax-Twinpath fabricator and with complete round and nylon sling fabrication in-house, DCL can meet any lift requirement. Product lines include all sizes of anchors, anchor chain, wire rope, hardware, deck & dock fittings, buoys, fenders, river ratchets, galley equipment and testing services. Proprietary product lines such as LBNO fittings, PeeWee sockets and its new line of synthetic rope connectors, the company sources product from international and domestic manufacturers.

www.dcl-usa.com

DeepWater Buoyancy's DeepWater Benthic Lander

DeepWater Buoyancy claims to be the world's largest supplier of subsea buoyancy to the ocean science community. The product line is more than 35 years old and is known throughout the world and in all offshore marine markets. DeepWater Buoyancy also has a large and growing product line of buoyancy solutions for offshore oil & gas and technology companies. Though it offers products for shallow water applications, it specializes in deepwater, providing solutions to depths product line improves and new items are added in response to market conditions, changing technology, and customer requirements. In addition of 6000 meters and beyond. In 2013, DeepWater Buoyancy acquired the rights and designs for the legacy Flotec material technology and products, and has been producing, improving and growing the Flotec product line. Each year the to product innovation, new processes and equipment are added to the companies already wide capabilities.

At the heart of the DeepWater Buoyancy product line are the subsurface ADCP buoys, originally developed for Teledyne RD Instruments' ADCPs. Consisting primarily of both spherical and elliptical buoys, the product line also includes the unique StableMoor Mooring Buoys. These torpedo-shaped buoys are engineered to house ADCPs and other sensors for high current data collection applications. By design, the StableMoor reduces drag and increases mooring stability in extreme flow regimes, thereby producing superior data sets. However, DeepWater Buoyancy's product line goes well beyond ADCP buoys. In the oceanographic market there are bottom mounts, instrument collars, and cable floats. For offshore oil & gas, there are installation blocks, modular buoys, deepwater marker floats and ROV buoyancy. In addition to DeepTec syntactic foam products and custom-engineered components, there are also plastic, composite, polyurethane and fabricated metal products for use subsea. DeepWater Buoyancy will also design and produce a custom product.

Pictured is a Deepwater Benthic Lander, a complete system which includes buoyancy, framework, instrument clamps, hardware and ballast. Systems are customized per the final customer's application & instrumentation, and the lander is free-fall deployed to the seafloor to collects data. The product is equipped with a dual acoustic release system which allows it to drop ballast when it is time for recovery. Once the ballast is dropped, the system is positively buoyant and returns to the surface. Significantly, the system can be designed for depths as great as 6000 meters.

http://deepwaterbuoyancy.com

Photo: DeepWater Buoyancy

Balmoral Boltless Bend Restrictor

Balmoral has extended its bend restrictor range to include a genuinely boltless restrictor (patent pending). This innovation allows fitting times to be slashed, offering savings in offshore installation costs. In line with Balmoral's track record for product improvement, value has been added by taking something away. Balmoral's boltless restrictor retains performance while offering significantly reduced installation times and costs.Features include: interlocking male and female moldings; interlock system (patent pending) removing the need for fasteners; bend restrictor lockout prevents cable/pipe over bending; and proprietary design and testing delivers long service life in extreme environments.

www.balmoraloffshore.com

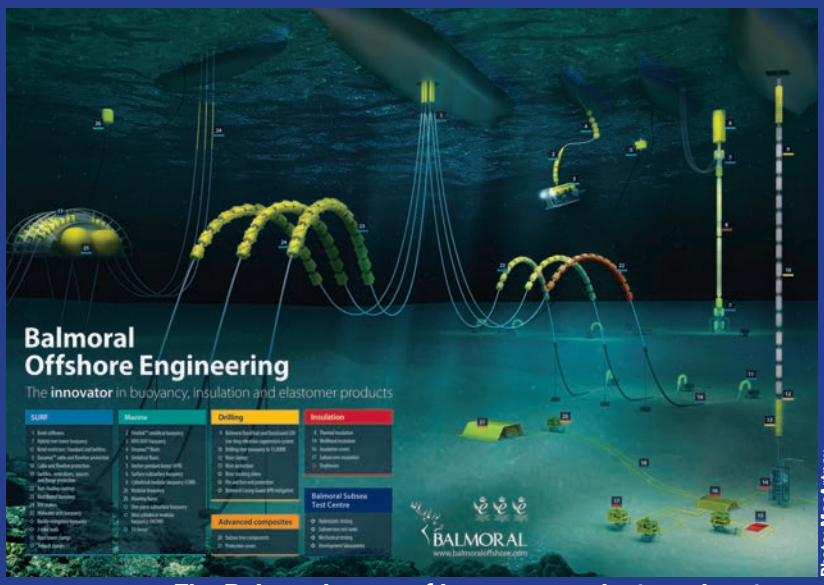

Photo: MacArtney

The Balmoral range of buoyancy products and systems.

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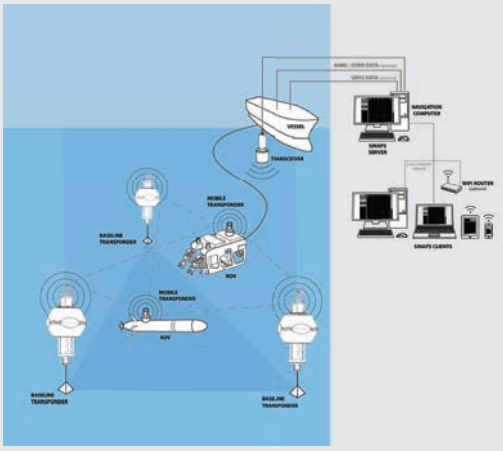
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01m



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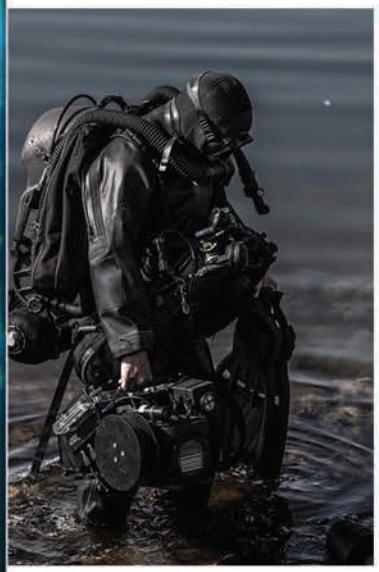

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