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January/February 2023
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Volume 66 Number 1

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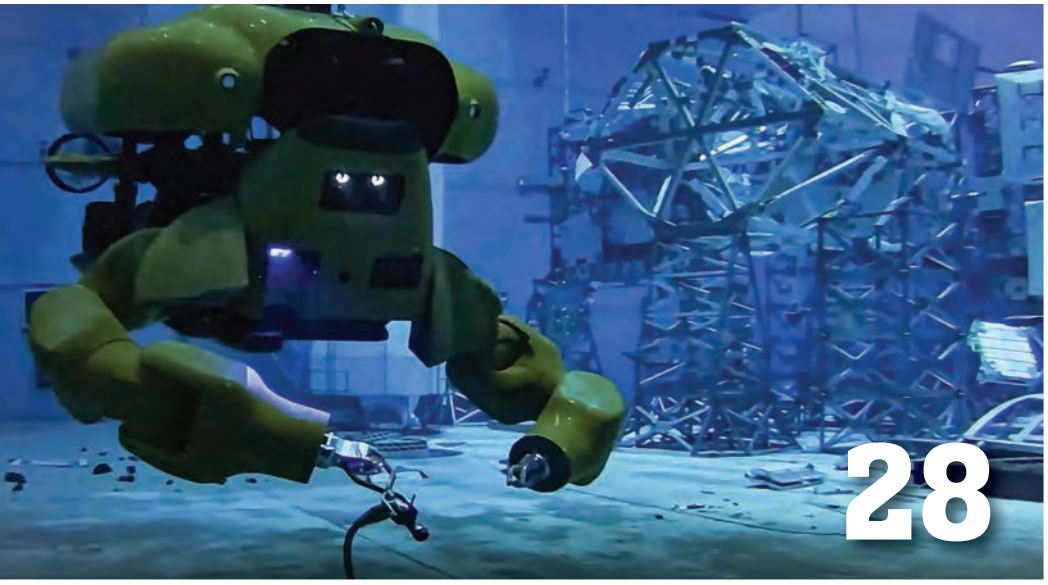

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Image courtesy Kevin Hardy

On the Cover

Vehicle technology such as DriX allows stakeholders the ability to collect ocean data faster and more efficiently.
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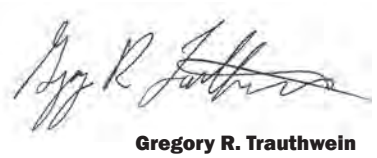
Editorial

Starting the new year always brings fresh challenges and opportunities, and 2023 is certainly no different in this regard. My number one challenge is replacing the engineering prose of **Elaine Maslin**, our long-time and highly valued contributor and friend in both the pages of *MTR* and sister-publication *Offshore Engineer.* Elaine has moved on to a full-time position outside of b2b media and maritime/offshore energy/subsea, but I'm happy to say that while she no longer makes my life easy with timely, topical and valuable content, she pings me with regularity on the interesting things she continues to see in this fascinating subsea market. With that loss, I've decided to start – for the first time in my 30-year career – an MTR Editorial Board. In doing so I'm not looking to simply stick a bunch of high-profile names on the masthead simply for the sake of sticking a bunch of high-profile names on the masthead. Instead, I've opted to slow-roll this to start, with the first two members being **Tim Gallaudet** and **Kevin Hardy**, both whom I thoroughly respect and have long, distinguished careers and a palpable passion for this industry and all that it entails. As the year progresses, I'll broaden this board to include key contributors in various sectors, including academia, offshore energy and defense.

With that, 2023 is shaping to be another banner year in our sector, as there are a number of high-level technological evolutions happening simultaneously. Energy transition is real, it's here to stay and the path is clear; but your guess is as good as mine regarding the pace, as the divorce from fossil fuels will not be short, cheap or easy.

Autonomy is another obvious topic, and in this regard the subsea sector has a significant lead on the greater maritime industry. But in this regard, I'm talking about true integrated multi-domain marine autonomy and all that it entails, from seamlessly stitching together disparate platforms and systems to deploying AI and machine learning to have a variety of robots working together, to change their mission as information changes. I and the entire MTR team look forward to working with you to bring these tech challenges and triumphs to light in 2023 and beyond.



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ADVANCED NAVIGATION

MTR Editorial Board

Gallaudet

The Honorable Tim Gallaudet, PhD, Rear Admiral, U.S. Navy (ret) is the CEO of Ocean STL Consulting and host of The American Blue Economy Podcast. He serves on several boards, is a fellow at The Explorer's Club, and is a strategic advisor for a few dozen startups, research institutions, and nonprofits in the ocean, weather, climate, and space sectors. Gallaudet is a former acting Undersecretary and Assistant Secretary of Commerce, acting and Deputy Administrator of the National Oceanic and Atmospheric Administration (NOAA), and Oceanographer of the Navy. He has a bachelor's degree from the U.S. Naval Academy, and master and doctoral degrees from Scripps Institution of Oceanography.

Hardy

Kevin Hardy is President of Global Ocean Design, creating components and subsystems for unmanned vehicles, following a career at Scripps Institution of Oceanography/UCSD. He holds important patents in the field of ocean landers. He is on the academic advisory board of Instituto Milenio de Oceanografía at the Universidad de Concepción, Chile. Hardy received an honorary Doctor of Science degree from Shanghai Ocean University in 2018. He proposed making thick wall glass spheres to Nautilus Marine Service/Vitrovex (Germany) that opened the hadal depths to routine exploration. Hardy was the Lander Team Leader for James Cameron's DEEPSEA CHALLENGE Expedition. He writes for the Journal of Diving History and the Marine Technology Reporter.

Authors & Contributors

Ewing

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Maslin

Strachan

Ewing
Tom Ewing is a freelance writer specializing in energy and environmental issues.

Konowe
Celia Konowe is from Reston, Virginia, recently graduating from the University of Rochester with a degree in environmental studies. She has study abroad experience in France and Ecuador, including the Universidad de San Francisco Quito's GAIAS (Galápagos Institute for the Arts and Sciences) program. Currently, she is pursuing her master of environmental studies degree at Dalhousie University in Halifax, Nova Scotia.

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

Strachan
David R. Strachan is a defense analyst and founder of Strikepod Systems, a research and strategic advisory focusing on autonomous undersea systems.

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Letters to the Editor

We received some terrific comments and experiences from the last Lander Lab "Underwater Releases" **bit.ly/3j2KBkZ**

Patrick Lahey, Triton Submarines, on Frangibolts

Patrick Lahey, Triton Submarines (Sebastian, Florida), spoke of their use of Frangibolts for an emergency drop weight release in their hadal class submersible Triton 38000/2 (s/n 001 named DSV Limiting Factor). The EBAD Frangibolt® Actuator is a simple and effective way to support and release loads up to 20,000 lb. Actuation occurs when power is applied to a Shape Memory Alloy (SMA) cylinder until it reaches its transition temperature. As the SMA cylinder heats up, it expands to its elongated length, producing strain on a bolt or stud until fracture occurs at a predetermined notch, achieving separation of the anchor, manipulator, or other load from the submersible. The cold temperatures of deep water are not enough to affect the operation of the Frangibolt. Standard Fastener sizes range from #8 to ¾" bolts." More information at <https://www.ebad.com/tini-frangibolt/>

From Rob Morris, EdgeTech:

Kevin, please remind your readers that EdgeTech is expanding their code structure to offer additional unique codes for their acoustic releases.

The change increases the number of possible commands from 12,000 to 131,000 per tone pair for a total possible 786,000 commands.

All new low frequency (LF) releases purchased after September 2022 will have the expanded new codes. If your group uses an existing EdgeTech deck unit that is less than 10 years old and wishes to use that deck unit with your existing releases and the new releases please contact Rob so he can arrange to upgrade your deck box. If you are unsure of the age of your deck box you can send Rob the serial number and he will check the age of it.

Deck units sold as of December 2021 will have the new expanded code structure. New deck units can be used with existing acoustic release units and the factory-new releases.

Rob.Morris@edgetech.com

From Bart Chadwick, SubSeaSonics:

Bart writes: "Take a look at the EvoLogic S2C Acoustic Release Device. It says they are hydraulic, but it'll be interesting to take a closer look at how they work. Based on the specs they are roughly compatible with the output of the AR60 link voltage and current."

https://evologics.de/components/acoustic-release

(Kevin: "Thanks, Bart, we'll take a look and discuss.")

Back when…

Scripps Institution's Frank Snodgrass, Chief Engineer for Walter Munk in the 1960's and early 1970's, always believed in dual release systems, a primary and a back-up, but also believed in using two different release types, such as a solenoid on one side and an exploding bolt on the other. His reasoning: if the same release type is used for both primary and back-up, and a mistake is made arming one, the same mistake might be made arming the other. Detailed checklists help reduce that possibility, but something to consider in system design.

More on Galvanic Releases:

Galvanic (bimetallic) releases are better used to release a recovery buoy rather than to drop the anchor weight and free a lander. Even with 1% accuracy, at 7 days the time variability is +/- 1.7 hours, or a total time window of 3.4 hours. Time the release to have the buoy on the surface before dawn during the week when the winds are light and boat traffic in the area is minimal. A high strength, low stretch, non-hockling, buoyant line, such as Samson's Amsteel-Blue Dyneema AS-78 single braid is preferred. The AS-78 1/8" diameter has a 2,500-lb breaking strength. At 20% breaking strength (500-lb load), the stretch is 0.7%. A battery powered capstan will be a big help to the deck crew if line lengths measure 100's of meters. Net weight of the buoyant lander with a negative anchor weight should be around 40-lbs, so a lightweight capstan will suffice. The capstan should be mounted rigidly to the boat frame to allow for dynamic loading with roll, pitch and heave.

Exploding Bolts, Pyrotechnic Cutters, and Pyrotechnic Pin Pullers

Other release devices I missed mentioning are explosive bolts, pyrotechnic cutters, and pyrotechnic pin pullers. In my early days at Scripps we used exploding bolts down to 5km. These devices are generally expensive and somewhat hard to ship, especially by air. (Class-1 Explosive, Division 1.4) They do work in fresh water. Pre-launch testing options are able to confirm integrity.

Exploding bolts mechanically secure two objects together, then fail on command at a weak band, with a minimum of loose debris, releasing the anchor or other object. Some bolts are designed specifically for marine critical applications where rapid structure separation is required. In-line tensile strengths from 200-lbs to 1,000,000-lbs are available.

A Pyrotechnic Cutter uses a gas generating charge and a cutting blade to sever objects. When initiated, the cutter will sever a multitude of materials and cross-sectional shapes including electrical or fiber optic cables, steel wire rope, bolts, tubes and woven or braided fiber cords, lines and straps.

A Pyrotechnic Pin Puller is used to toggle latch releases, pull locking pins or move mechanisms to perform work.

For more information, go to the PacSci EMC website: https://psemc.com.

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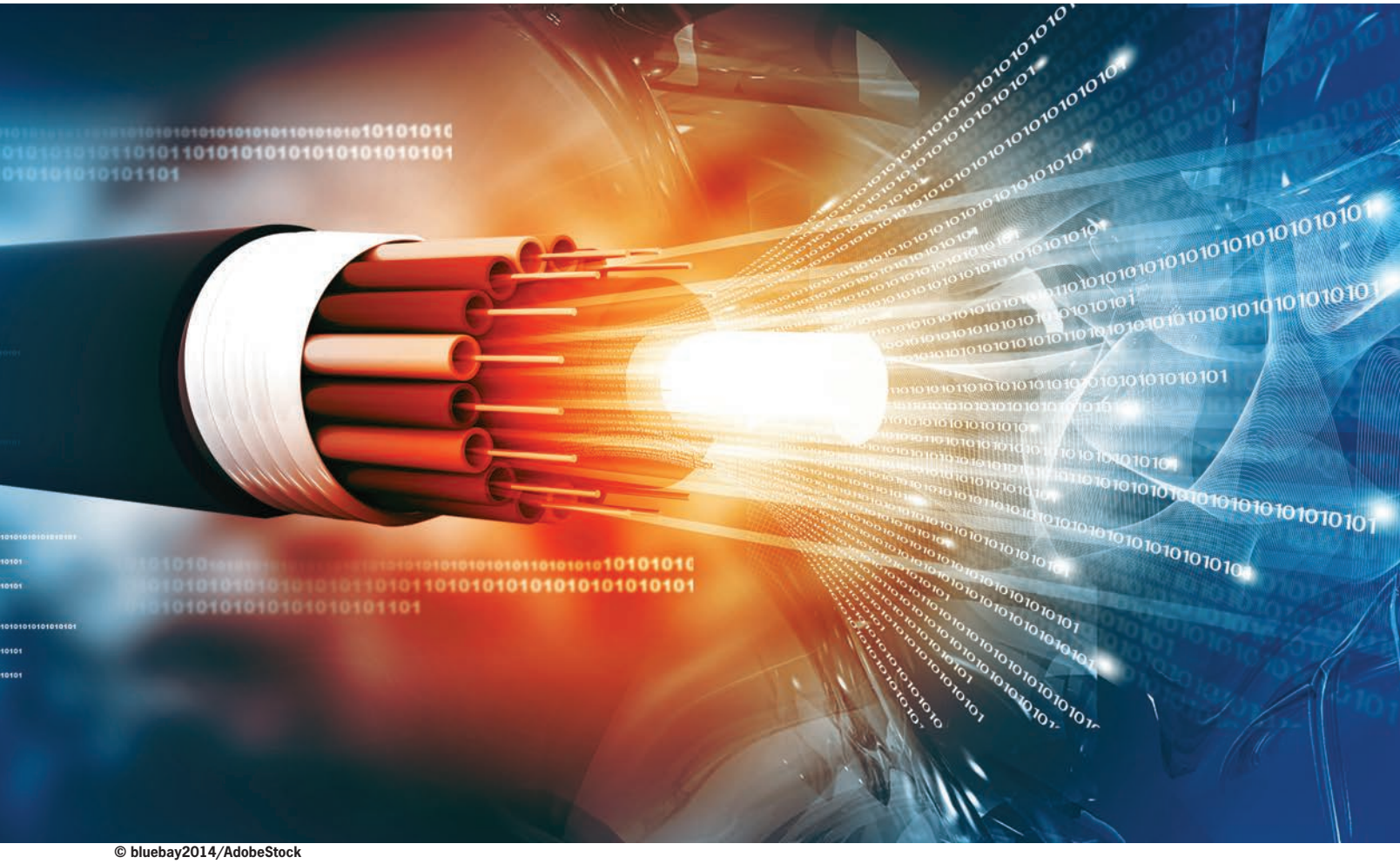
Hearing the Light:

DAS COULD REVOLUTIONIZE SUBSEA DEFENSE

By David R. Strachan, Senior Analyst, Strikepod Systems LLC



During the summer of 2020, a group of Norwegian University of Science and Technology (NTNU) marine scientists based on the Svalbard archipelago successfully detected the vocalizations of baleen whales frolicking in Arctic Ocean and North Sea, some 70-90 kilometers away. At first blush this might seem somewhat unremarkable, given that researchers regularly monitor whale behavior, and whalesong has long been known to traverse great distances. But what made this particular set of observations special was the sensor of choice. It wasn't a hydrophone, the trusted tool of the marine bioacoustics trade. Instead, it was pulses of light transmitted through 120 km of undersea fiber optic cable running between the towns of Longyearbyen and Ny-Ålesund.

The NTNU scientists utilized a relatively new and innovative technology known as distributed acoustic sensing, or DAS, which relies on fiber optics to detect pressure waves emanating from acoustic or seismic activity. Using a specialized device known as an interrogator, light pulses are sent along the length of an unused, "dark" fiber at known intervals. When the light encounters tiny defects within the fiber, some of it will be reflected back to the interrogator (a phenomenon known as Rayleigh backscattering). As pressure waves from an acoustic emission impose "nano strains" on the fiber, it causes fluctuations in the reflected light. These fluctuations can then be analyzed and, using advanced signal processing, translated into a unique acoustic signature resulting not only in the detection, but identification and even localization of the source. When DAS is used in a marine environment, the defects along the fiber essentially act as tiny hydrophones, transforming a length of fiber optic cable into a large aperture sensor array. And since acoustic waves can penetrate the seabed, the sensing fibers do not need to be fully exposed to the water column to be effective. Some segments of the cable used in the NTNU project were buried under anywhere from one to two meters of sediment.

Considering that there are 785,000 miles (1.2 million kilometers) of undersea cables strung across the globe, DAS represents a significant breakthrough in ocean observation. Instead of relying on discrete acoustic and seismic sensors dotting the seabed, dark fibers housed within undersea cables anywhere can now be repurposed as kilometers-long sensor

Considering that there are 785,000 miles (1.2 million km) of undersea cables strung across the globe, **DAS represents a significant breakthrough in ocean observation.** *Instead of relying on discrete acoustic and seismic sensors dotting the seabed,* **dark fibers housed within undersea cables anywhere can now be repurposed as kilometers-long sensor arrays,** *rigged with the equivalent of thousands of hydrophones capable of detecting both biological and anthropogenic noise.*

arrays, rigged with the equivalent of thousands of hydrophones capable of detecting both biological and anthropogenic noise. In addition to whale vocalizations, DAS has successfully detected surface ships, earthquakes, surface waves, and distant ocean storms, and could even act as a worldwide tsunami warning system.

Given its capability to provide a wide area, persistent sensor network that is already positioned throughout the vastness of the oceans, there is considerable potential for DAS in subsea defense operations – specifically, by providing an additional layer of surveillance coverage, tracking both surface and subsurface targets. DAS could detect and track surface warships, augmenting intelligence gathered from other ISR platforms such as satellites and aircraft. In addition to detecting vessels in transit, DAS may also detect the sounds of dynamic positioning systems, indicating that seabed operations are underway.

Below the surface, there are applications for undersea warfare. At the moment DAS appears optimized for detecting low frequency emissions (even into the millihertz range), and while modern submarines do emit in the low frequency range, these emissions are also low intensity – according to open source, unclassified estimates, somewhere between 95 and 110 decibels, which is only slightly higher than the ambient noise of the surrounding ocean at around 90 decibels. Given that a decibel is a logarithmic measure (i.e. each 10 decibel increase represents a tenfold increase in acoustic power, 20 decibels, 100 fold, 30 decibels, 1000 fold), compared to the moans of a North Atlantic blue whale, which can exceed 180 decibels, manned submarines generate far less acoustic power. But at closer range, submarine emissions may be more detectable, particularly by fibers that are resting on the surface of the seabed. Ultimately, DAS may provide more of an anti-submarine warfare (ASW) barrier defense that is confined to smaller regions of water space, rather than a long-range detection and tracking system.

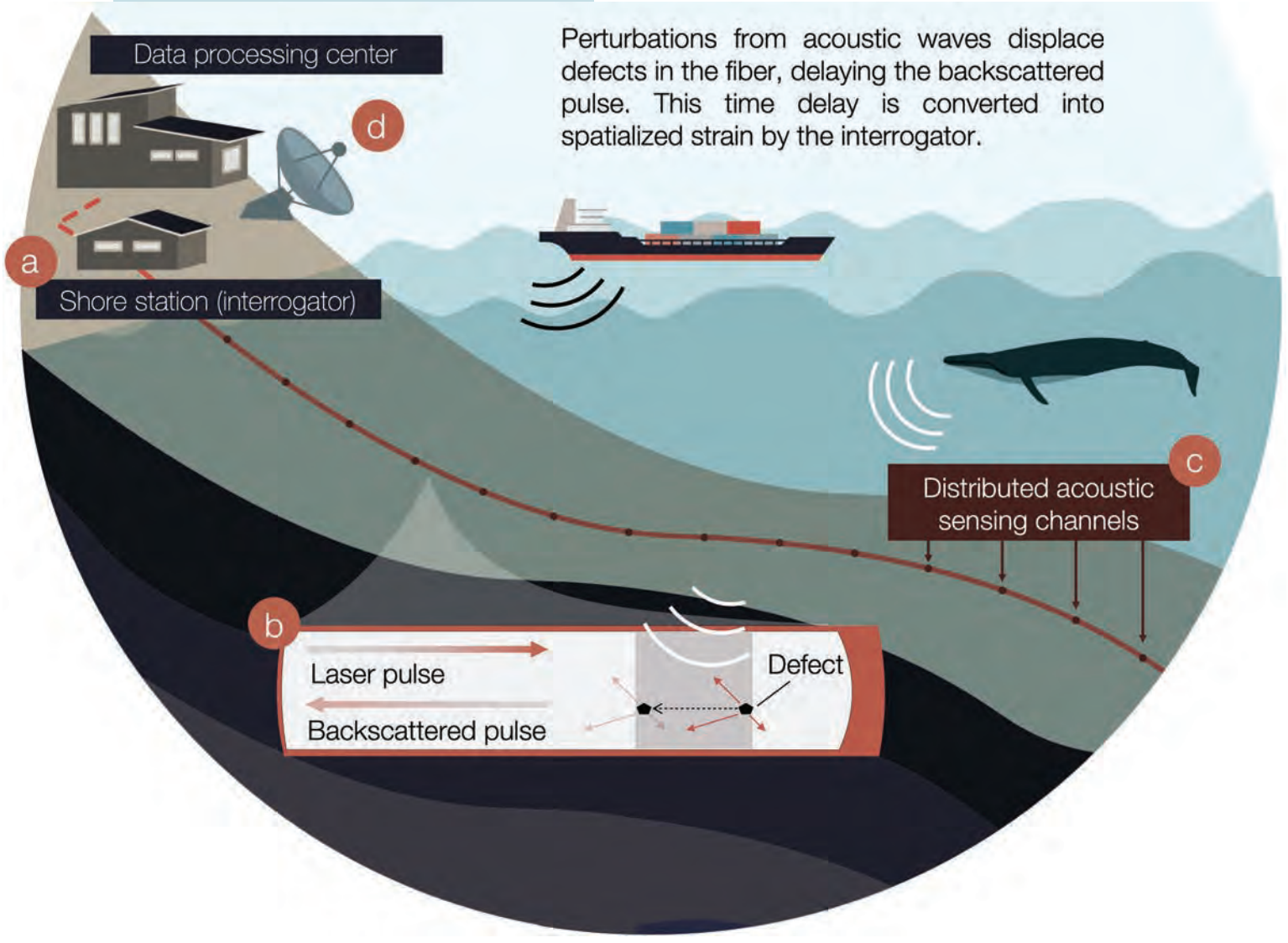
There are applications for seabed defense as well. If we consider the types of activity that would be associated with seabed warfare – cable tampering, mine warfare, the emplacement, operation, or destruction of subsea infrastructure – DAS could play a role in the detection, identification, and localization of threats. Although currently optimized for low frequency detection, DAS does have the capability to detect high frequency emissions as well, such as those generated by vehicle actuators and thrusters, as well as underwater navigation, imaging, and communication technologies. A 2020 MIT study found that small AUVs generate intense emissions in the 15-24 kHz range, which can be 10-45 decibels above the ambient background noise.† A typical DVL emits at anywhere from 400-600 kHz, while SAS emits anywhere from 60-120 kHz. Echosounders emit at high frequencies and at higher levels of intensity – anywhere from 185 to 230 decibels. And although the propulsion system of a submersible such as a swimmer delivery vehicle (SDV), large displacement UUV (LDUUV), or extra-large UUV (XLUUV) may generate low intensity sound, it may be pos-

© Evgeniy/AdobeStock

Image courtesy the research article Eavesdropping at the Speed of Light: Distributed Acoustic Sensing of Baleen Whales in the Arctic, found on **https://www.frontiersin.org/articles/10.3389/fmars.2022.901348/full#B54**

sible to detect its lower-frequency emissions if they originate at close range.

Underwater construction activity generates low frequency acoustic and seismic waves, and so the noise associated with the emplacement of seabed structures such as energy stations, AUV docking stations, or sensor arrays would be readily detectable by DAS. Freefalling sensor units landing on the seabed might generate a detectable "microseism" – a seismic wave usually associated with small earth tremors. Air dropped mines, crashing through the ocean surface, and thumping to a halt on the seabed, would likely generate powerful acoustic and seismic waves. DAS could potentially assist in the mapping of minefields, providing additional data points to aid in expediting mine countermeasures operations. And as Russia continues to move forward with the development of the Poseidon nuclear-armed, nuclear-powered AUV, DAS could play



an important role in an integrated underwater distant early warning and defense system, providing ISR or relaying targeting data to interceptor vehicles.

While DAS shows great promise for defense applications, it does have limitations – at least for now. Its effective range, for example, is roughly 50 to 100 kilometers due to the attenuation of the reflected light during its two-way travel, so a truly large scale DAS array would require some kind of amplification. An integrated DAS defense network would entail comparing sound samples against a database of known acoustic signatures in order to identify threats, and to discriminate between legitimate targets and false alarms. Thus, a high volume of current and timely measurement and signals intelligence (MASINT) will be required for DAS to assist in detecting and identifying emerging subsea threats. "And in addition to the quantity of MASINT data required, the sheer volume of acoustic intelligence (ACINT) generated by DAS will also be daunting."

The NTNU project, for example, generated some seven terabytes of data per day – or nearly 250 terabytes over the course of the study. Nevertheless, even with these challenges, DAS has the potential to greatly influence subsea defense. With a low-cost, low-maintenance, ready-made sensor network already in place throughout the world's oceans, DAS will likely soon find its way into the defense inventories of friends and adversaries alike.

Source

† Railey, K; DiBiaso, D; Schmidt, H. An acoustic remote sensing method for high-precision propeller rotation and speed estimation of unmanned underwater vehicles, The Journal of the Acoustical Society of America. 2020, 148, 3942.

SUBSEA POWER AGNOSTIC

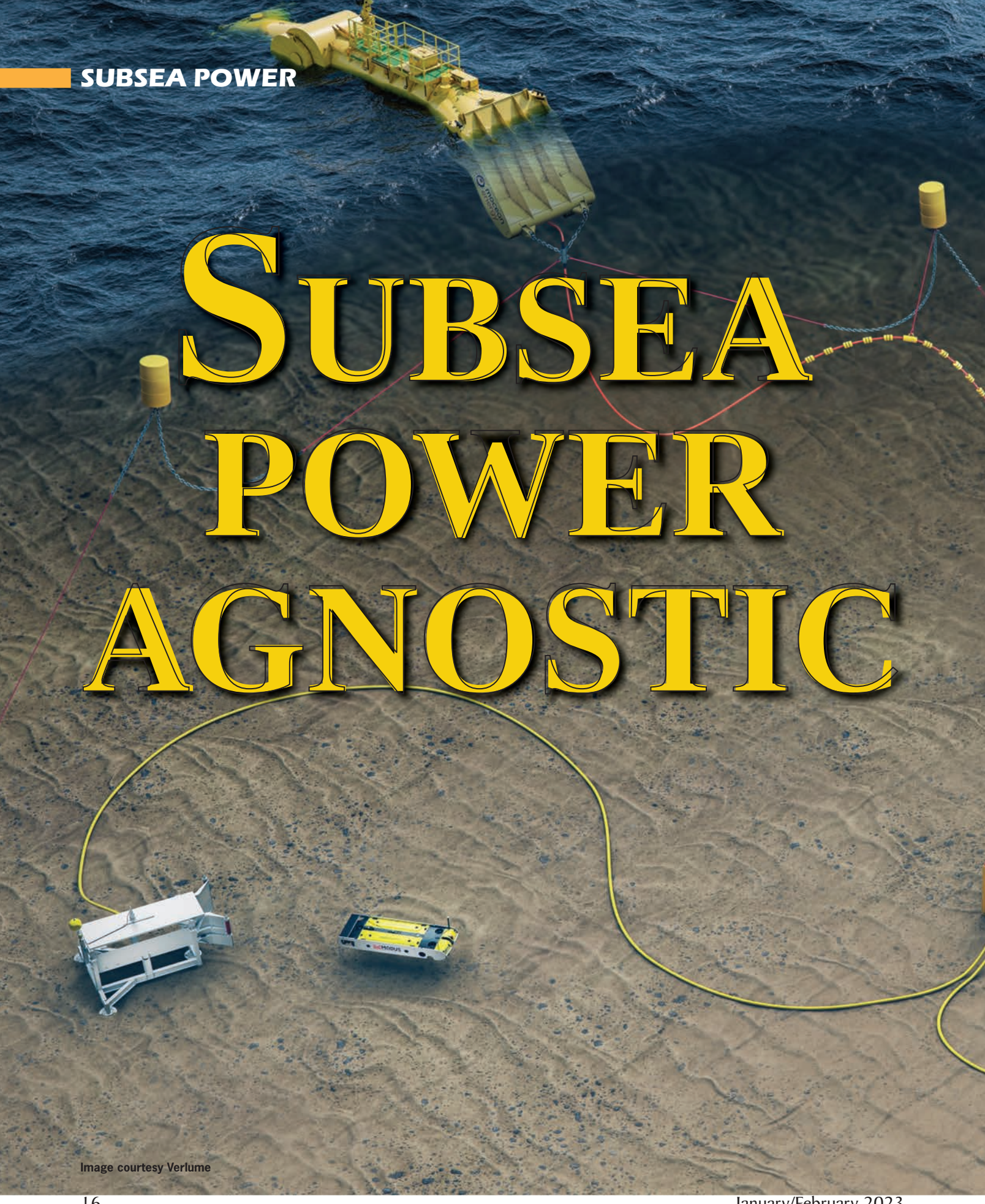


Image courtesy Verlume

Using renewable energy to power critical subsea infrastructure needs power management. It's a capability Verlume will soon be proving off the Orkney Islands – and Hawaii. ***Elaine Maslin*** *takes a look.*

Integrating offshore renewables into offshore operations has become a major goal for oil and gas companies. A remote power supply could improve project economics for long step-outs, where they replace long power cables. Powering facilities from a nearby offshore wind park could help reduce the carbon intensity of oil and gas production. But how do you balance that power – ride out intermittency – to provide a stable supply to what could be critical applications?

It's a challenge many, from navies to offshore wind parks hoping to integrate vessel charging, are mulling and one Aberdeen, UK, based engineering firm Verlume is offering to solve.

The company has come a long way since it was founded in 2013. One of its goals then was to develop a tidal energy-based solution that could supply local power to subsea infrastructure, removing the need for power umbilicals.

Indeed, the company launched its own kW-scale subsea Powerhub concept in 2017, comprising three of its own vertical axis tidal/ocean current turbines, connected to direct drive DC power generators and in turn batteries to store power.

ENERGY AGNOSTIC

Today, as focus on transitioning to renewable energy has ramped up, Verlume's sights are much broader.

It's now energy generation agnostic, says Paul Slorach, the firm's chief technology officer, who has been working with Verlume founder Richard Knox since the firm started, meaning it's happy to work with any renewable energy technology, and it's also looking a much wider range of power users.

Providing power for brown and greenfield subsea production infrastructure was the initial goal. But before the end of this year (2022), Verlume will be starting demonstrations involving two different wave energy devices, from third parties, working with US defense organizations as well as oil and gas operators and service companies in Scotland and Hawaii. The company is also working with wind energy developers, an underwater robotics technology developer, and more.

It's all about delivering power. Slorach says there are a number of energy sources – including even degraded power umbilicals – but they are largely variable and or intermittent, so there needs to be a good way to connect them to users that need a constant power supply available.

That's now Verlume's niche – to be the middleman via energy storage and management. It also means that the company can select an appropriate power source for specific use cases or particular site characteristics.

HALO

Its core technology is its Halo energy storage system, which includes its Axonn intelligent energy management system. Halo is a modular (scalable), battery-based energy storage and management system.

It takes in power from a variable or intermittent producer, such as a wave energy converter, and stores it in batteries – currently lithium ion, as they're the most reliable and advanced in the market for the scale they're operating at, explains Slorach.

Verlume both manufactures its own battery modules from standard cells and buys third party modules – used for EVs like the Nissan Leaf, as well as trains, buses and even JCBs – assembling them into packs that then form its systems.

A key part of Halo is the Axonn, which ensures reliable, stable power to multiple payloads, via software, firmware, and hardware. This includes an output management system, for autonomously managing multiple power outputs.

In simple terms, it's the bridge between intermittent renewable energy production and power users that need reliable, stable power, says Slorach, whether that's low power over long periods, short duration high power use, or fast-charging of subsea vehicles. In-built into the system is wireless communications for applications where an umbilical has failed or for communicating with subsea vehicles.

RENEWABLES FOR SUBSEA POWER PROJECT

Two demos are currently imminent. Last December, one of its Halo units was deployed offshore Orkney, Scotland, alongside a wave energy converter (WEC), subsea controls infrastructure, and an underwater vehicle, as part of the Renewables for Subsea Power project. The project is supported by the Net Zero Technology Center (NZTC) in Aberdeen, Harbor Energy, Serica, and Mocean Energy (the WEC provider) and Transmark.

This will see wave energy firm Mocean Energy's 20m long, 56-tonne, 10kW rated Blue Star 10 wave machine coupled with Verlume's third Halo system to demonstrate the ability to work reliably with subsea systems, such as oil and gas wells, carbon capture and storage sites or even subsea vehicles.

The project includes testing these systems with Semstar5 subsea electronics equipment from Baker Hughes (although not connected to any live facilities), with which Verlume and Mocean have a non-exclusive memorandum of understanding on these types of projects, and Norway-based Transmark Subsea's ARV-I autonomous underwater vehicle (AUV).

Verlume has already proven the ability to power a commercial subsea control module (SCM) through trials in 2019 using lithium-ion batteries and Verlume's energy storage and intelligent energy management system.

Slorach says, "This trial is not proving we can provide power, it's proving we can provide the right uptime to support a subsea production system. It's proven we can provide power, that the batteries can provide power, it's how to keep on station, the connection to systems and communicating with it. Those are the unknowns."

TESTING IN HAWAII

The firm is also working with C-Power in the US on a dem-

Images courtesy Verlume

(Top left) Halo during wet pit testing.

(Top right) Halo under construction.

(Bottom left) Right - Halo before being moved into housing on the left

Robert Heron, Product Manager for Verlume's Axonn

Image courtesy Verlume

onstration at the US Navy's Wave Energy Test Site (WETS) in Hawaii, also due to go in the water as we go to press. There, C-Power's 2kW SeaRAY** surface-based wave energy converter is due to be moored and connected to a 55kWh battery capacity Halo system via a single combined communications and power cable/mooring system down to the seabed. This project will see a number of payloads connecting to the Halo for power (max ca. 3kW), including a Sabertooth AUV in untethered mode, a BioSonics sensor package, and a Franantech leak detection device. Two-way communications to the beach will be via the WEC at the surface.

For the Hawaii demonstration, they're using dual chemistry batteries. This means that different packs within the system can be used according to the requirement – i.e. longer use with a low load or shorter term higher load – alongside an auxiliary pack.

MICROGRIDS

Verlume also has two projects with the NZTC. One is looking at sustainable subsea microgrids with Glasgow Caledonian University, aimed at supporting the UK's Innovation and Targeted Oil & Gas (INTOG) program – a targeted leasing round that encourages the use of wind energy to power offshore oil and gas infrastructure. Combining offshore wind with gas turbines in a micro-grid creates control system logic challenges, says Slorach, which they're trying to resolve.

It's also working with German utility RWE after winning the operator's first international innovation competition in July this year. Several use cases are being explored, including recharging vessels, e.g. crew transfer vessels and potentially service operation vessels (SOVs), within an offshore wind farm. "Black start" (i.e. when wind turbines are not yet producing power but need some to get started) and load balancing for electrolyzers are other potential use cases.

Another opportunity is to be a buffer for short-term ramp events. This is when the wind does an about-turn, and the power generation drops through that turn.

"It's a huge problem for the renewable grid," says Slorach. "Providing a level of storage at a turbine level could balance that out." This would be particularly beneficial in floating wind, he says, where it would be cheaper to put the storage and management system on the seabed, he says, where it also has the right environmental conditions for operating (natural cooling).

Verlume is also working with Oasis Marine Power to look at what an offshore 'fuelling' station could look like, for vessels and subsea vehicles.

ROBOFISH

It's also supporting an underwater robotics project, RoboFish, that's targeting offshore wind inspection work. This is a biomimetic AUV initially devised by researchers at the University of York, Department of Electrical Engineering, and the University of Strathclyde, Department of Naval Architecture, Ocean & Marine Engineering, with grant support from the EPSRC Supergen Offshore Renewable Energy Hub. Verlume is advising on the underwater power system for charging, as well as an integrated intelligent battery management system.

"(Seabed residency) is getting closer to becoming accepted by operators," says Slorach, particularly with the example

Image courtesy University of York

being set by Equinor. But oil and gas operators are not the only ones eyeing this technology, he says. "Within the defense community, there's been a much higher level of interest over the last 24 months," says Slorach. "The projects we're doing now are being watched by offshore wind, oil and gas, and defense."

There's a lot going on. As well as all of these projects, the company recently moved into a new 20,000 sq ft facility (six times the size of its previous operational base) in Aberdeen, giving it space for manufacturing, development, and testing. The (power) umbilical may finally be about to be cut, and much more besides.

*Mocean is also working on Blue Star 10 – a 10 kW machine based around the Blue X design, which will begin commercial trials in 2023. In parallel, it's developing its next-generation Blue Star 20, a 20 kW machine based on a new optimized geometry, which will include solar panels and a novel direct-drive generator, with trials and rollout targeted for 2024-25.

**SeaRAY is configurable from 750W to 25kW. C-Power also has a StingRAY design, for utility-scale power, and TigerRAY, a "next generation SeaRAY", built for the University of Washington Applied Physics Lab to conduct a US-Navy sponsored project to investigate at-sea charging of unmanned underwater vehicles.

Image courtesy Exail

BIG DATA: The New Maritime Fuel

By Tom Ewing

DriX being deployed from NOAAs Thomas Jefferson hydrographic survey vessel.

As the maritime and subsea communities collectively work toward integrated, multi-domain marine autonomy, 'Big Data' and all that is wrapped in that short, simple [and somewhat overused] phrase starts and ends with the data itself. Apps, big data, tech, software and cutting-edge innovation were hallmarks at last year's **Sea Tech conference in Brest, France**. During one session, for example, on electronic charting, the speakers made reference to "data as fuel." For vessel operations, data was called a resource just like diesel or LNG or lithium batteries. The reference was usually to big data, i.e., almost boundless information flowing like a gusher from a firehose, the new force driving applications to set routing, monitor fuel efficiency, optimize speeds, maximize safety and communications and allow real-time vessel controls and, critically, provide new social and entertainment possibilities for crews and families, not to mention emergency information. Looking for ways to exploit big data was an imperative for Sea Tech participants. Here are three businesses taking advantage of big data.

Exail

iXblue was another company participating in last September's Sea Tech conference and showcasing important advances in maritime technology, particularly pertaining to subsea operations and autonomous vessels and subsea positioning.

In October, iXblue, made a big change, merging with the ECA Group to form a new company called Exail. Exail has more than 1500 employees specializing in cutting-edge robotics, maritime, navigation, aerospace and photonics technologies. Its work is well known among offshore oil and gas companies and national oceanographic agencies, including NOAA in the US. In July, for example, NOAA took delivery of then-iXblues' uncrewed surface vessel DriX, equipment giving NOAA new abilities to operate over the horizon, strengthening its work on the "National Strategy for Ocean Mapping, Exploration, and Characterization."

Ludovic Bazin is Exail's Subsea Solutions Manager. In a session at Sea Tech on Navigation and Control of Underwater Vehicles Bazin presented a discussion on autonomous vessel navigation and research data.

In interviews, Bazin was asked about his company's work to help maritime operations become smarter and greener. He referenced new opportunities in artificial intelligence, miniaturization and, of course, fuel efficiency. He specifically mentioned equipment like DriX, noting that it is smaller and lighter than crewed vessels and therefore uses less fuel. It can maintain operations in rougher, more dangerous conditions, possibly, therefore, avoiding additional future deployments.

Bazin noted that advancements among existing products are increasing safety and accuracy but not requiring additional resources. He mentioned new developments in subsea positioning, at depths of 6000 meters. This technology is critical for energy infrastructure, from oil and gas to offshore wind. Exail's acoustic positioning system requires just one transponder, instead of three, thereby reducing vessel time operations and the amount of equipment that needs to be deployed on the seabed.

Renderings of the Hyke ferry

Images courtesy Hyke Ferry

SeapiX-C is one product that exemplifies efforts to maintain development and find new ocean based markets. SeapiX-C is 3D volume sonar originally developed for the fishing industry. The newest iteration offers wide coverage (up to 10,000 m2 at 30m range) and real-time georeferenced static bathymetry capabilities to marine works operators for instant monitoring and decision-making. It provides seabed mapping that is more efficient, flexible and safer than previous applications. Exail writes that it will be increasingly valuable for dredging and deploying jack-up barges, two types of vessels critical for offshore wind projects.

Maneuverability is extremely limited with jack-ups. It's important to know exactly where the platform legs are positioned. Currently, placement is a challenging undertaking because the legs are deployed blindly using seabed information found on pre-lay survey maps and the ocean floor could have shifted since those maps became available.

SeapiX-C enables an operator to directly see, in real time, where the jack-up legs are being set. New software displays bathymetric information and information from the barge platform. Additional indicators display information such as the distance between the platform legs and the seabed.

With dredging, this new sonar enables real-time monitoring of construction or maintenance. This can prevent ineffective or out-of-spec work. The new app does not require a specialized surveyor, and all acquired data is integrated and displayed within existing software.

Hyke Ferries and Swarm Technology

"Swarm technology" was part of a discussion titled "New Propulsion Systems For Low-Carbon Shipping." The phrase was used by Jason McFarlane, Chief Technology Officer, Hyke, based in Norway. Hyke is working on "the next generation of waterborne mobility." Its goal: to "upgrade ferries into the modern world."

Hyke's ferries are solar-powered electric vessels designed with intelligent dockside charging solutions and autonomous technologies. Hyke's eventual goal is for completely autono-

mous operations. These efforts, the company writes, "embody what mobility in a smart city is all about."

"Swarm technology," McFarlane explained, is the capability of an autonomous ferry fleet to network, communicate, respond and act together as market conditions demand.

"Swarm intelligence," McFarlane said, "is the collective behavior of decentralized, self-organized systems, also referred to as swarm robotics. In our application of swarm principles, the idea is that when operating in a fleet each ferry will collect information about its own state and situation in relation to both environment and passenger movements. The information from each ferry will be shared across the fleet and collectively the ferries will have the capability to dynamically adjust their routes to enable the most effective transport of passengers and goods with respect to waiting times and energy effectiveness."

Big data in the driver's seat.

Once the passenger surge declines, swarming ends, and each vessel reassigns itself, but staying in constant contact with, and responding to, supply and demand across the fleet and operating territory.

McFarlane said Hyke is on schedule to launch the first new ferry in Fredrikstad, Norway in 2023. Covid caused some program delays, particularly with deliveries of equipment and materials. The Norwegian Maritime Authority will give final approval for passenger operations; that safety review has started.

Hyke's goal is to provide autonomous operations in 2024. McFarlane said autonomy is a high priority, but the first goal is to get underway. Startup is important for Hyke's larger business plan, McFarlane noted, because "there are many cities that do not have any urban city ferries, so we are in a way creating the market and we have a viable business case without autonomous operations."

Importantly, though, autonomy provides operational opportunities and lowers costs. In addition, McFarlane commented that "it addresses a growing problem – the lack of trained crews." He said that last

eOdyn surface currents (streamlines) superimposed with optical images from satellites in the Sicily Channel

Images courtesy eOdyn

summer one Norway ferry company in Oslo reduced routes because of crew shortages.

Also important is that the autonomous ferries will still have a crew member on board. That human could intervene in case of an emergency, either with the vessel or among the passengers. McFarlane said the crew member "would not take direct control over the vessel. Rather, they would have an interface to interact with the vessel by issuing specific commands and communicate with a remote operations center."

Swarm technology is expanding. Hyke was one of three groups chosen to deliver and operate four ferries along the Seine River during the 2024 Paris Olympics and Paralympics. The ferries will connect the municipalities of Juisy-sur-Orge, Ris-Orangis and Soisy-sur-Seine in the region Grand Paris Sud. (Hyke was named as one of Time Magazine's best inventions of 2022.)

eOdyn: The Ocean in Motion

"Why install sensors aboard, when the ship itself can be the sensor?"

Sea Tech's theme in 2022 was "Towards Smarter and Greener Solutions." Safety and efficient operations are fundamental priorities for maritime companies and agencies, from research to defense. Now, concerns about fuel and carbon add new complexities and pressures to decisions about voyages and at-sea operations.

Vessel routing has critical environmental issues. The most efficient course will likely require less fuel. Taking advantage of real-time ocean surface currents offers new possibilities for efficient navigation.

eOdyn is a maritime software company based in Plouzane, Brittany, near Brest. During Sea Tech week, Yann Guichoux, eOdyn's CEO and co-founder, met with a select group of journalists to present and describe how eOdyn uses big data to provide new capabilities delivering measurable benefits to shipowners and to the planet.

eOdyn's technology – in a product called SeaWaze – analyzes ships' AIS (automatic identification system) data that is automatically uploaded to satellites. (100,000 vessels are at sea every day.) eOdyn has built what Guichoux refers to as "Omni-Situ" (OS) technology. For SeaWaze, each ship is an ocean-based sensor. A machine learning algorithm takes the satellite data to create a high-resolution, spatiotemporal ocean surface current map that presents information in near real time and at global scale.

"With SeaWaze," Guichoux explained, "we can provide customers with services that help reduce the environmental footprint of their activities and mitigate risks at sea." Shipping accounts for about 3% of global greenhouse gases. With SeaWaze a vessel can reduce fuel consumption by an average of 5%, Guichoux said.

Historically, ocean currents have been measured using buoys, which are difficult to place, or altimetry satellites, a limited resource since there are only seven in orbit. OS technology generates current information anywhere there are ships – importantly, anywhere there is human activity, e.g., submarines, emergencies, and oil spill response.

"Ocean currents provide information about conditions that affect the performance of sonars used to locate submarines," Guichoux explained, adding that eOdyn "validated our data with the French Navy in 2022 and qualified it for military use."

Additionally, SeaWaze data can improve drift predictions for a person overboard, helping to target search areas. Data on ocean currents can help track pollutants at sea to better prepare cleanup operations.

(US agencies use a network of coastal high frequency radars for this kind of tracking.)

eOdyn's OS technology is completely digital and provided in SaaS ("software as a service") mode. Guichoux said new service capabilities are planned for 2023, including development of an onboard system called eObox to deliver the real-time ocean currents data to ships at sea.

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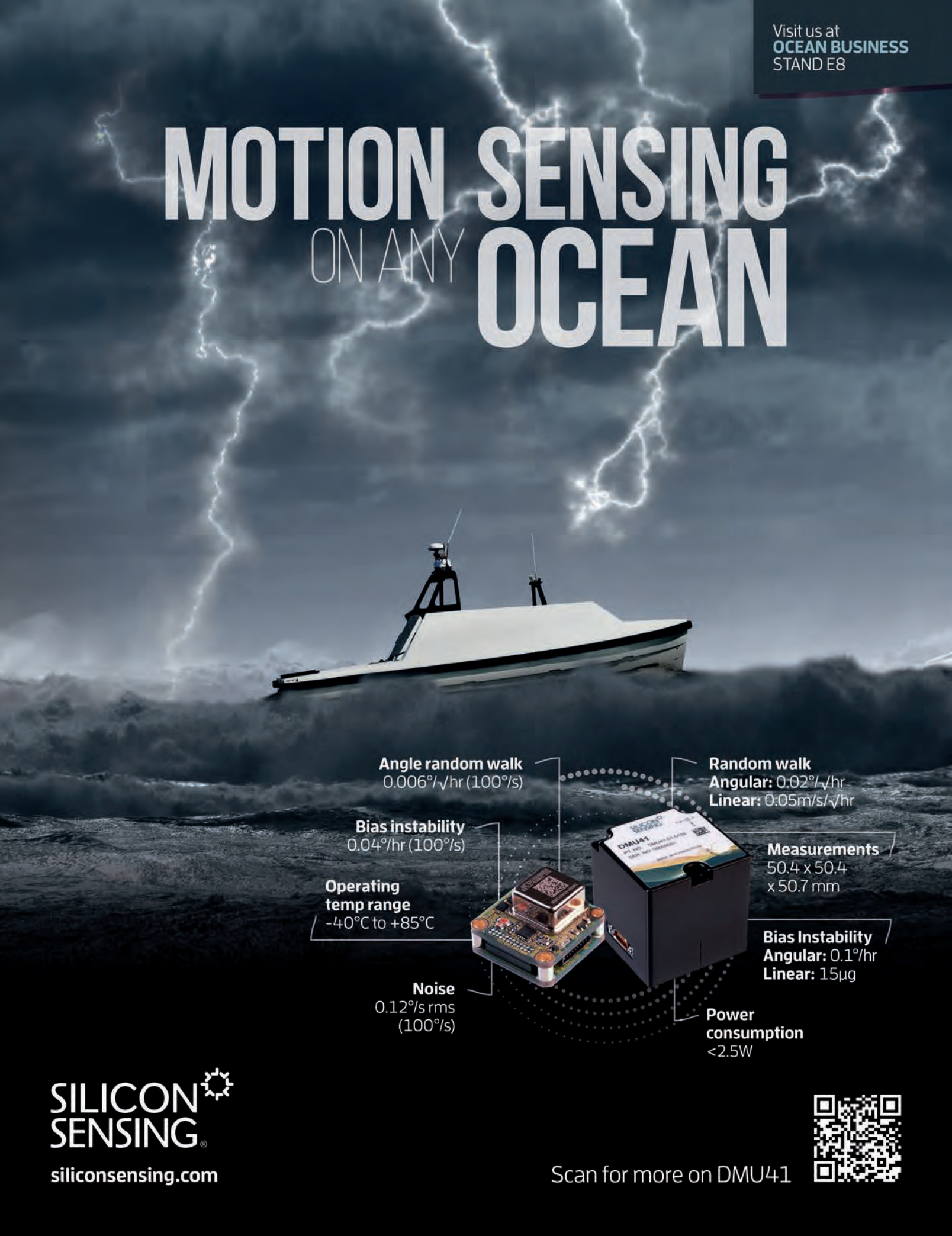

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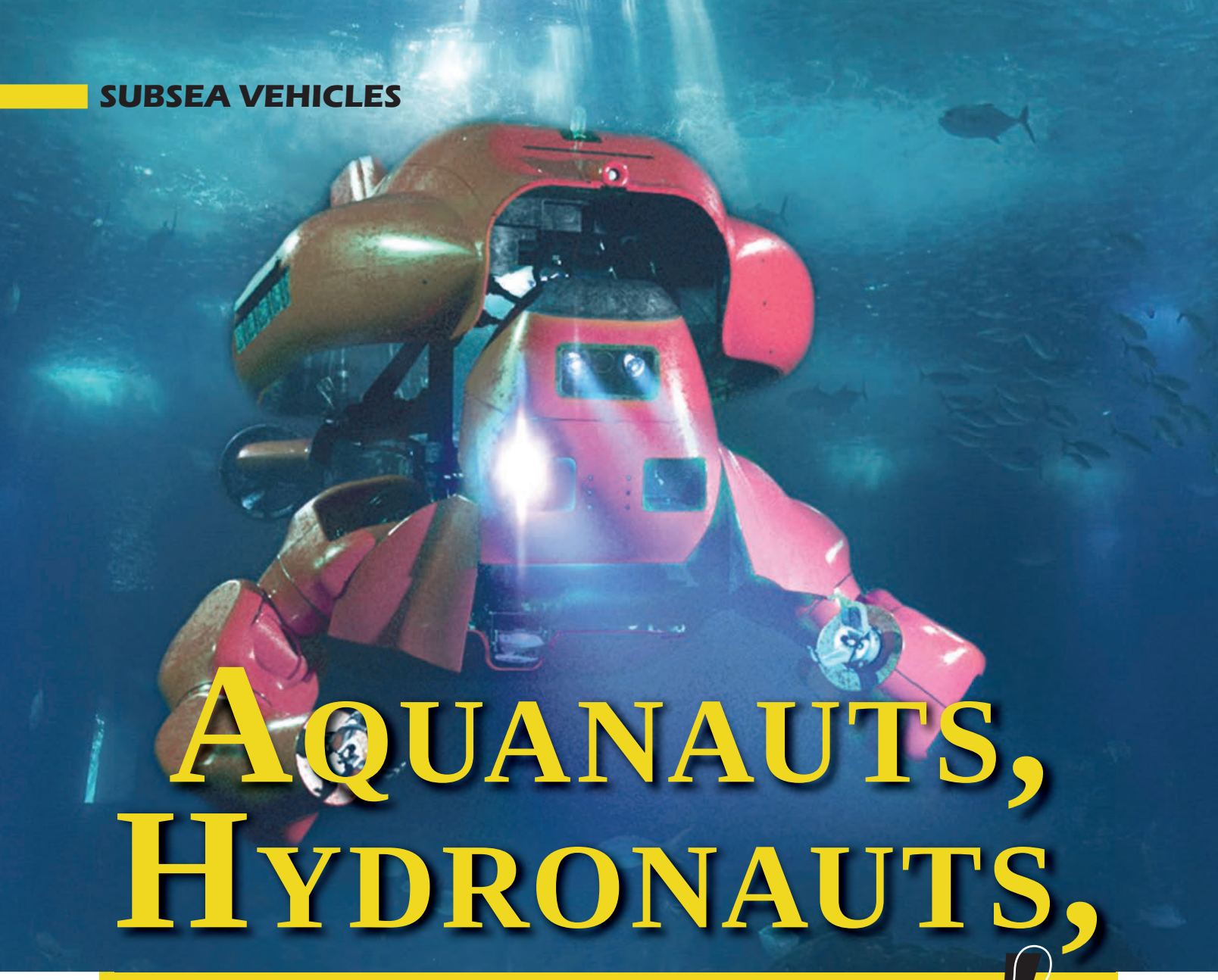
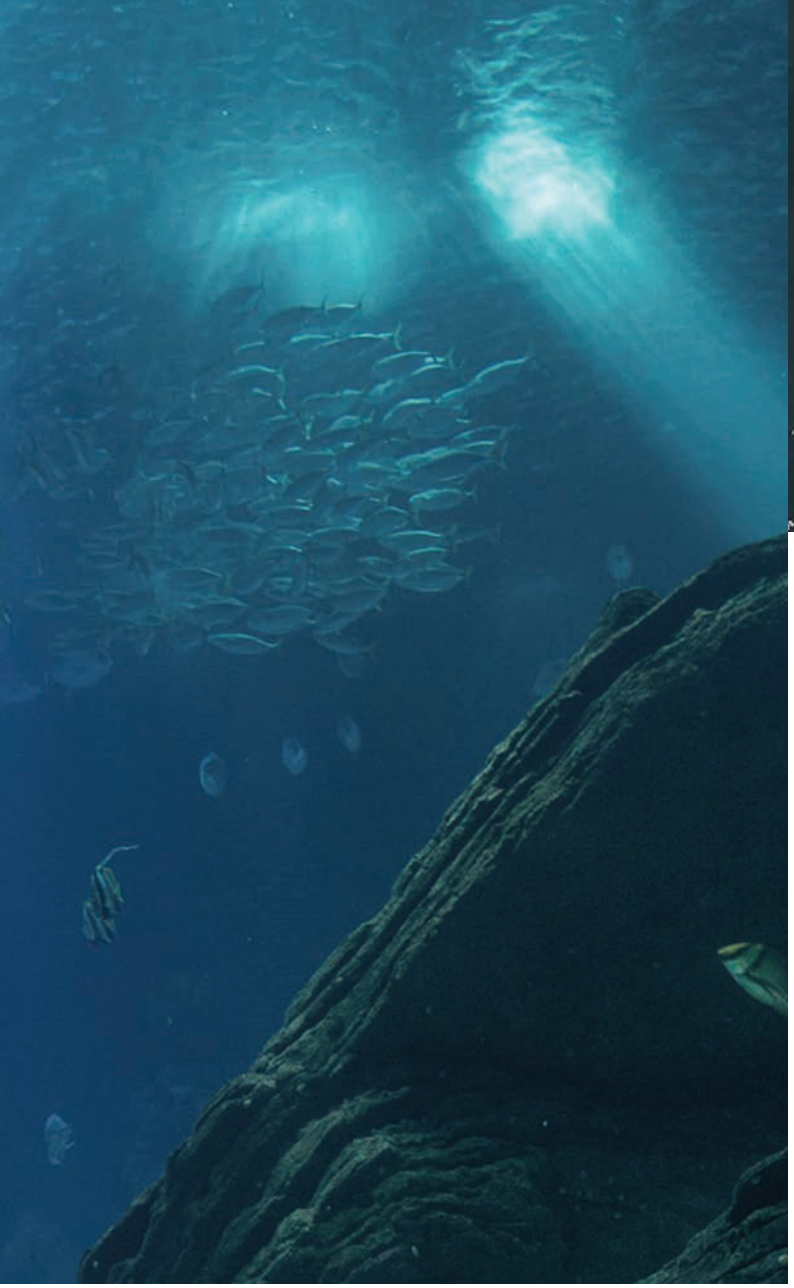
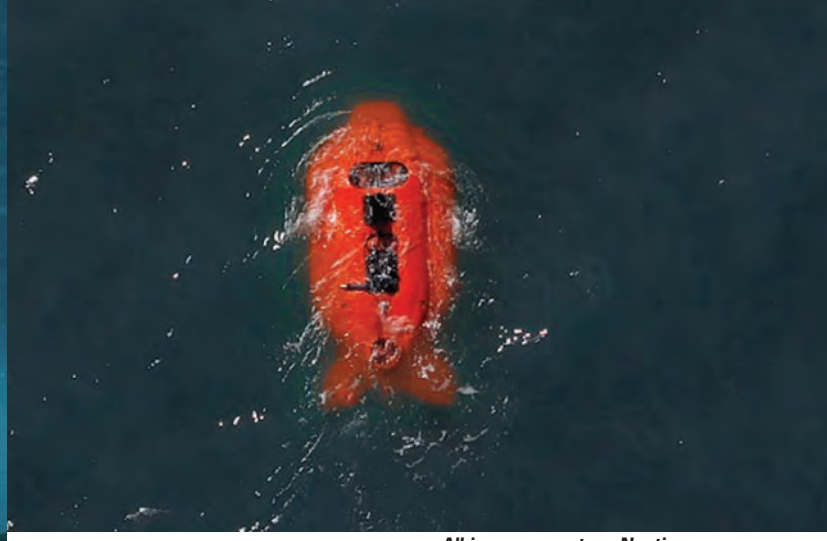


AQUANAUTS, HYDRONAUTS, ROLL OUT!

*In 2023, Houston-based Nauticus Robotics' first production Aquanauts and Hydronauts will head into the wild and closer to full commercialization, with testing planned in Norway and in the Gulf of Mexico. Elaine Maslin caught up with founder and **CEO Nicolaus Radford** on what's been a busy few years for the tech start-up.*





All images courtesy Nauticus

It's been a relatively fast journey for Nauticus. Set up in 2014 (as Houston Mechatronics Inc), the company has been a bit of an outsider in the offshore industry, against incumbents offering (for the most part) more traditional looking underwater robotic systems.

However, the third quarter of 2022 saw the company (whose investors include Schlumberger (SLB) and Transocean) complete a business combination with CleanTech Acquisition Corp., netting it nearly $60 million to fund its first fleet of ocean robots; list on the Nasdaq exchange; agree a trial with energy giant Shell; win a contract with the U.S. Defense Innovation Unit; and agree a defense related partnership with tech giant Leidos.

It now has three of its second-generation Aquanauts in build in Vancouver, which will be used on trials in the Gulf of Mexico and offshore Norway, and two Hydronaut uncrewed surface vessels (USVs), which will act as launch and recovery systems and surface gateways to Aquanauts, in-build in the UK.

CEO Nicolaus (Nic) Radford, who set up the firm in his living room eight years ago, doesn't hold back his ambition. Innovation has been "mind numbingly slow" in the offshore industry, he says. Part of Nauticus' ambition is to "put an adrenaline shot" into it, by taking robotics technology developed for space flight into the ocean.

"My dream is to have a network of Aquanauts and Hydronauts out there working, a whole Navy of them, being controlled by control centers around the world, out there 24/7 doing their thing. That's the core of the business. There's an ocean of opportunity to take advantage of," he says, from fisheries to countering global security threats, which have heightened recently, with increased underwater surveillance to protect critical infrastructure, such as pipelines and communications cables.

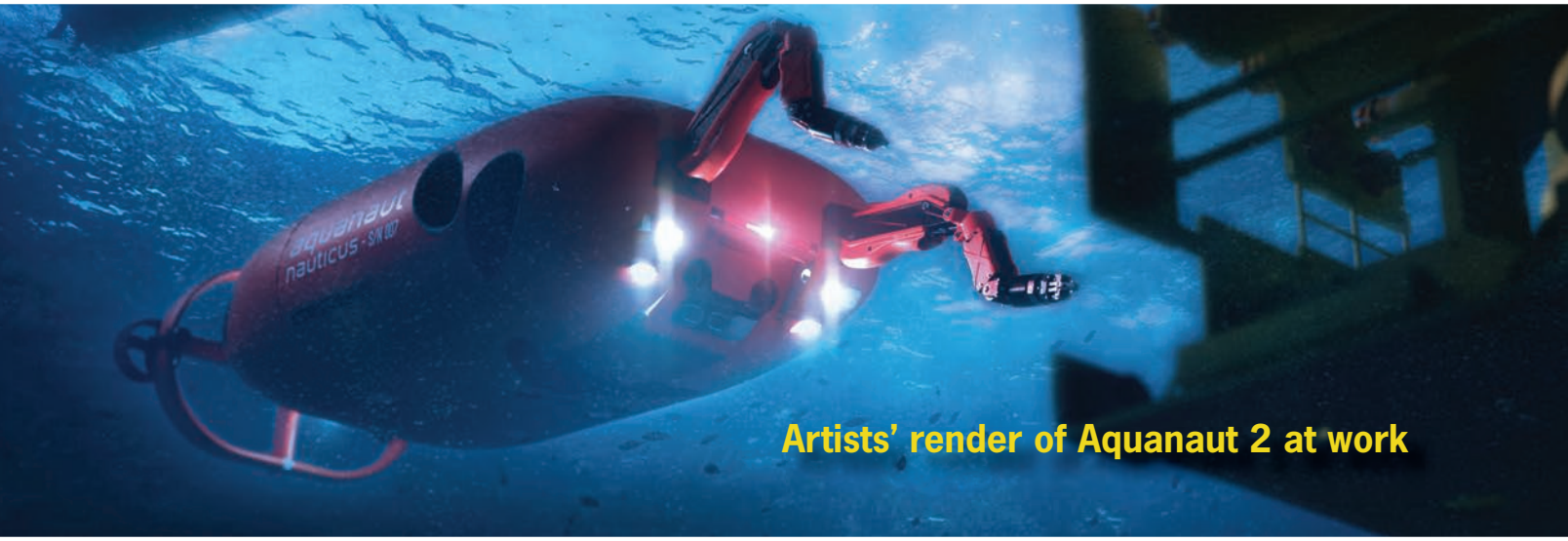
"I'm fired up as you can as you can possibly get about this industry and I think there's so many different facets to move into," he says. "Frankly, it's huge. It's enormous, it's completely front and center right now. It's the epicenter for all of our resources, right? Food, minerals, energy."

That adds up to an estimated $2.5 trillion marine economy, of which some $30 million could be addressable the types of ocean robotics it's building, according to Nauticus.

Born in Illinois, Radford graduated with a Bachelor of Science in electrical and computer engineering then joined NASA's Johnson Space Centre and pretty much went straight into robotics, including DARPA sponsored programs, before moving to Houston, working with United Space Alliance and then Oceaneering Space Systems as a contractor to NASA, again in robotics.

"At NASA I learned a ton of stuff, but uncovered this idea that there was meaningful change to be made in the ocean domain," he says. "I had had some exposure to the ocean world before and remember the first time I saw an ROV I was like, OK, that's cute, but we can do so much better. Then you realize they don't want to do any better."

A part of the problem is incentives and the ability to disrupt. "Some of the big incumbent players have very successful businesses, but it ties them to certain incentive structures," he says. "When you're paid by the hour, you do not want fewer



Artists' render of Aquanaut 2 at work

"My dream is to have a network of Aquanauts and Hydronauts out there working, a whole Navy of them, being controlled by control centers around the world, out there 24/7 doing their thing. That's the core of the business. There's an ocean of opportunity."

Nicolaus Radford, Founder and CEO, Nauticus Robotics

hours. So, Schlumberger (who he'd worked with at NASA) sort of challenged me, what would you do about this? I said we need to create a hybrid vehicle. We need to be able to have an AUV turn into an ROV, because we actually don't need an umbilical. It was a flash in the pan idea, and so you know we garnered some investment."

Radford had also been working with Transocean on some drilling software and they were interested in the idea too; so they had their first investors. Since then, US government contracts, from the Navy, especially, have been a strong driver. It's meant that, over the past four years, Nauticus has developed and tested a significant amount of technology – most of which they've not been able to publicize, says Radford.

"My proudest moment was when we did a fully autonomous demonstration and I was taken to the side by our customer and they basically said 'that was the most advanced stuff they'd ever seen'. We essentially had an autonomous mission that occurred over about 20 minutes of action where the robot was able to pick up a tool, assess it, figure out a way to operate it, figure out a way where that tool could be operated on. We just put the robot in the water, we hit the on switch and sat watching with cups of coffee and it worked. We were almost crying! It was incredible." That was two years ago in a test tank environment – they've not been able to share the video, he says.

Since then, testing has been in the real-world, including Lake Travis in Austin, but also coastal areas. "We have some milestones coming up which will stress that (capability proven two years ago) probably by a factor of 10," says Radford. The Aquanauts are also getting closer to commercial work. Three (second generation) production Aquanauts are in build at International Submarine Engineering in Vancouver. A couple of them are due to head to the Tau Autonomy Center in Norway to qualify "certain actions" for a couple customers. One will be doing some pilot work in the Gulf of Mexico in mid-2023.

They'll go out with a lot of autonomous capability under their belts, says Radford. "That work (with the US Navy) has meant being able to build up thousands of kilometers and hours of dive time on their autonomy software," says Radford. It's also meant building a commercial and defense variants of Aquanaut. "Those two platforms are in the water every single day, diving, collecting data, building out behaviors, to deploy to the production systems, so we don't have to wait till they come up the assembly line to build out their usable action. It's a library we've been building for years now."

The offshore pilot with Shell, planned for mid-2023, will focus specifically on testing Aquanaut's ability to deploy a robotic tool, for carrying out inspections on pipelines. Currently, this tool can only otherwise be placed with an ROV, for which a fully crewed ROV vessel is needed, which "would be overkill" for the work it's doing. Part of the qualification work for this tool deployment includes supervised autonomy and tool control using Nauticus' acoustic communication networking technology.

This is wrapped in with wider over the horizon communi-

Artists' render of Hydronaut

cations – terrestrial and underwater – to support the ability to operate without an umbilical. While satellite communications are there, the rollout of the likes of Starlink will provide more inexpensive ways to transmit more data to the surface, says Radford. For through-water communications, Nauticus has been working with Schlumberger, from whom Nauticus has licensed use of an underwater modem previously tested from a DriX USV to receive video from an AUV. It's also been work with Singapore-based Subnero.

Subnero has been developing software defined underwater acoustic modems for communications, networking, navigation and monitoring, which it calls Wireless Networked Communications (WNC). Recent testing with Nauticus has included the ability of their WNC to dynamically adapt to provide the best performance in a given environment.

Concurrently, Nauticus is building, through Diverse Marine in Cowes, UK, an 18 m, aluminum-hulled, SMART-Gyro (from Golden Arrow) stabilized USVs called Hydronaut, which will act as a transport, recharge and communication gateway for Aquanaut. Nauticus has an agreement with Diverse to build 20 Hydronauts, with the first two initially scheduled for completion in Q1 and Q2 2023. The rest are expected to include Jones Act compliant builds via Diverse Marine's USA-based shipyard partners.

The Hydronauts will have a Guardian Autonomy package from Marine AI, in Plymouth, UK, a launch and recovery system from Kongsberg and through-hull deployment for transducers and other acoustic communications systems. It will be initially flagged to MCA Workboat Code and optionally uncrewed, because "we don't want to be limited by any regulations," says Radford (an approach others are also taking with many countries having different regulations), "so it has accommodation for four crew. That will allow it to travel about 160 nautical miles from a safe harbor with its crew."

The firm is also commercializing the manipulator it designed for Aquanaut as a standalone product to sell. "Building Aquanaut was like a moon shot engineering activity and there was a bunch of spin out technologies that are finding their own independent revenue streams, whether it's the software stack called Toolkit that runs everything or all the way down to just the manipulator," says Radford. "There weren't really any electric manipulators in the market, so we decided to fill that gap made our first delivery to IKM (in Norway)." That's been through some development work with IKM and now the first production batch has now started, he says.

Earlier this year the firm also agreed to work with Stinger AS, a specialist underwater technology firm, also in Norway. The details of that are being worked on, says Radford. Nauticus also had an agreement with Triumph Subsea, a new company that had announced various plans for a new breed of greener offshore vessels. There is still a contract with them, but delivery dates have been pushed out, he says Radford.

While there have been delays – building the Hydronauts has been hit by delays getting hold of aluminum – Radford is fired up. "We are here to make the biggest impact in the ocean economy through the deployment of this robotic navy," he says. "Now we've also transitioned to a public facing entity, we're on the NASDAQ and everyone here is fired up about it."

He also hopes that Nauticus' investment will be part of a wider surge in investment in the ocean space, which spending has been dwarfed by other sectors, not least space technology. There are also barriers to entry – the cost to develop ocean technology, for example. But Radford hopes to overcome that, finding both funding and willing partners.

A column about the Technologies, Strategies, and Use of Ocean Landers

Photo by Kevin Hardy

SPLICING UNDERWATER ELECTRICAL CABLES

By Kevin Hardy, Global Ocean Design LLC

Underwater electrical cables and connectors provide system designers flexibility, opportunity to reconfigure at-sea, and ease of maintenance.

This article will focus on the narrow topic of splicing electrical cables used for transmitting power or signals.

The definition of a splice, as given by 3M, is "two or more conductors joined with a suitable connector--reinsulated and rejacketed with compatible materials--applied over a properly prepared surface.

To further narrow the scope of this article further, the SubConn catalog says, "the majority of SubConn® connectors are supplied with chloroprene cables…". Chloroprene is also known by the DuPont trade name "Neoprene," a term that has since become generic.

ABOUT NEOPRENE

Neoprene can withstand temperature extremes (-20° to +90°C) and rugged environments. Neoprene has excellent abrasion and chemical resistance.

The construction of Neoprene rubber jacketed cables, even with jute fillers, are by nature pressure tolerant. The soft jacket merely compresses around the inner jacketed conductors. The jacket is easy to bond to. Neoprene jacketed cables have been used in ocean trenches, below northern ice caps for a year's duration, and mid-depth in the North Pacific Ocean for periods of a year, sometimes longer.

Cable splicing and sealing options can be divided into six types:

1. Cold Splice
2. Potted splice
3. Hot vulcanized rubber splice
4. PBOF (Pressure Balanced Oil Filled)
5. Marine grade heat shrink splice
6. Overmolded thermoplastic

Custom Neoprene cables can be made in-house, or ordered from manufacturers. The processes for cable splices from manufacturers are predominately potted or vulcanized. The processes for end-users are predominantly cold splice or potted.

A Cold Splice is a field installable overmold that uses three layers of 1-part materials to encase the soldered and heat shrink terminations. Chief-of-the-Boat bathyscaph Trieste Master Chief E. John Michel described how he used this technique to repair 32-conductor electrical cables underwater using crimps instead of solder, and electrical black tape instead of heat shrink. That was typical John Michel.

A Potted Splice uses a pourable 2-part polyurethane or epoxy to encase the soldered and heat shrink terminations.

HOT VULCANIZED RUBBER SPLICE

Cable vulcanizers provide pressure through mold clamping and temperature through an electric heating element to vulca-

Figure 1
A potted Y-splice cable from MacArtney Underwater Technology. The polyurethane casting (bottom right), is wide on the left side to allow for two cables and a cathode, and stepped down on the right side for a strain relief. Each cable has a locking sleeve installed before assembly. The cable on the right plugs into a single bulkhead on the command control sphere of an ocean lander. A QC tracking s/n is attached to the cable on the upper right.

nize and fuse raw rubber to a neoprene jacketed cable.

PBOF in-line connectors are open backside pressure rated. The connecting wires are soldered to terminals on the back side, stuffed inside a soft rubber tubing, which is then oil-filled. The oil is non-hazmat, but messy. They are a little bulky. However, PBOF connectors can be reconfigured or repaired in-house by project personnel prior to a mission or at sea. They are fairly common on high-end ROVs and manned submersibles.

Marine Grade Heat Shrink splice relies on the inner adhesive lining for a bond to the outer jacket. Clark Synthesis and AK Industries offer a splice kit based on this.

An overmolded thermoplastic splice is a transfer mold of thermoplastic materials, such as vinyl and urethane, using a machine such as the Morgan Press <**www.morganindustriesinc.com**>.

It should be emphasized that any splice by any means is dependent upon three key factors that must be present in all splice work. These are:

1. Craftsmanship and procedures
2. Proper materials
3. Proper equipment and tools

Working directly with a connector company (see list "Underwater cable and connector manufacturers" below) provides the elegance of eliminating the "hot dog" or barrel splice joining two pigtails together in the center. (See Figure 2.) A connector is soldered on to each end of the specified length cable, then overmolded with vulcanized rubber. The cost is reasonable, but it can take upwards of 2-3 months to get into a busy production queue.

For faster speed, with a higher cost, the more labor-intensive job of a potted splice may be used. Most connector manufacturers can do this, but the queue can get long, predictably around the end of the year and beginning of the next.

MacArtney, for one, has simplified their customer interface for custom cables by using a single project sheet that includes connector and locking sleeve call-out, pin-to-pin wiring, length of pigtails, continuity test, insulation resistance test between wires and to seawater, and visual inspection criteria.

When working with a large firm, check that the estimated delivery on the Quotation and the Order Confirmation are the same, then follow-up on a periodic basis to be sure your order is progressing on schedule. Getting a tracking number means it


Photo by Kevin Hardy

Figure 2
Two cables with the same function but made differently. The top cable has a "hotdog" splice joining two pigtails together in the center. The lower cable was made at the SubConn plant, with connectors soldered to the ends then overmolded, making a clean assembly.

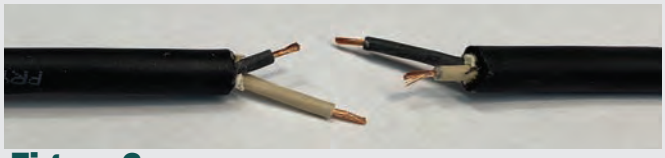


Figure 3
The jute filler is removed, and the wires are prepared for splicing such that the two solder joints will be offset, providing additional protection against shorts.

Figure 4
The solder joints are made and the marine grade heat shrink is placed over the solder joints.

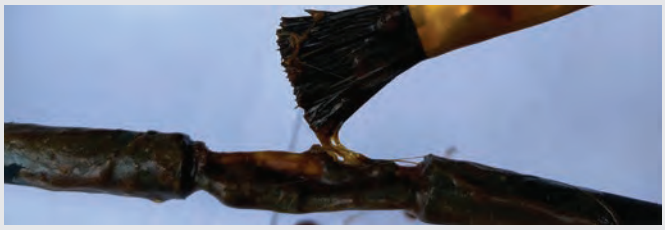


Figure 5
Apply the Scotchkote liberally over the splice, on the open ends of the cable, and about 1" on the exterior jacket of the cable. Allow to dry

Figure 6

Wrapping Scotchfill over the splice. Start in the center to build up the diameter to the original jacket OD, then one last wrap that covers the splice plus an inch over each cable end.

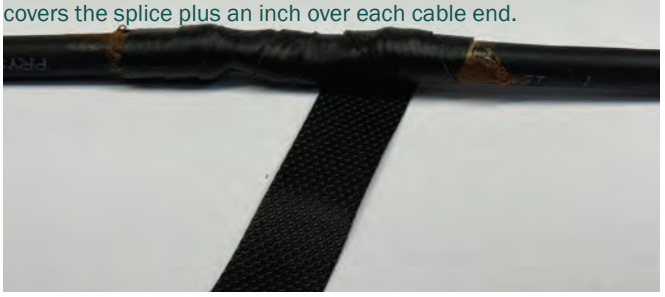


Figure 7

The completed cold splice, capable of working in any ocean at any depth. MacArtney locking sleeves can be added to BH and MCBH connectors after the splice is made.

did ship, and you can watch for the package heading your way.

When specifying a custom cable, allow extra length for a circuitous cable run and a final bend radius to mate to a bulkhead connector. Any excess length can be coiled and secured within the lander frame. Better a little too long than not long enough.

There are small service shops here and there who may do potted splices as a sideline to support their customers. They can do good work, but they have to play up to the level of the big companies, including post-production QC.

Still, it's a fair bet that a cable will get mangled at sea and a field repair will be necessary. A group can be ready for unforeseen events by developing an in-house splicing capability. "Don't miss the boat" is a real thing in our industry. Be prepared with cold splice materials, and have practiced before you need to do it when it really matters.

COLD SPLICE

What is needed:

Diagonal cutters

Wire stripper

Heat shrink gun

Marine grade heat shrink

Small size for individual wires

3M™ Scotchfil™ Electrical Insulation Putty

3M™ Super 33+ Vinyl Electrical Tape

3M™ ScotchKote™ Electrical Coating FD Putty

Scripps seagoing personnel have utilized a technique known as "cold splicing" to make or repair underwater electrical interconnect cables. It requires the use of three 3M products: Scotchkote electrical coating, Scotchfil electrical insulation putty, and Scotch Super 33+ black tape.

The technique for an unshielded 2-conductor SOO cable is as follows:

1. Strip back the outer jacket from the end ½" for each conductor. If present, a braided shield counts as one conductor. For a 2-conductor unshielded cable, strip 2 x 1/2", or 1", of the outer jacket off the end of each cable. I use small diagonal cutters to get underneath the outer jacket without nicking the insulating jacket on the conductor.

2. Clip out the cable bulk filler material, like jute.

3. On one cable end to be spliced, cut the black conductor to 1/2", and leave the white conductor a full 1" long.

4. With the second cable end to be spliced, cut the conductor lengths the opposite, that is, what was longest on the first cable is the shortest on the second. In this case, cut the white conductor to ½" long and leave the black conductor at 1". This procedure offsets the two solder joints from each other so they are not located side-by-side, preventing solder spikes from inadvertently pressing through the insulation under pressure and shorting to a neighboring solder joint. The overall diameter of the finished splice is also reduced.

5. Strip ¼" of the insulation off the end of each of the wires. Tin each of the four bare ends with a soldering iron.

6. Starting with the black wire, place approximately 3/8" long marine grade shrink tubing on the long wire before soldering. Marine grade shrink tubing comes is shrink ratios of 2:1 (default), 3:1, and 4:1. Pick an appropriate size for the task.

7. Solder the black wires together. Inspect the solder joint for good flow and that the wires are parallel and in close contact. Give each solder joint a light tug to be sure it is fused well.

8. Center the 3/8" long heat shrink over the joint, and use a heat gun to shrink the tubing. There will be about 1/16" overlap onto the wire jacket on either side of the solder joint.

9. Perform a continuity check to be sure the conductors go where you expect them to by testing each pin 1-1 and 2-2. Also check for shorts by testing 1-2.

10. If needed, tie the wire bundle with kite string to keep the wire splices close to the center and away from the outer surfaces of the overmolding.

11. Using 100-grit sandpaper, rough the outer cable jacket 2 inches to either side of the splice.

12. Using isopropyl alcohol, clean the outer cable jacket 2 inches to either side of the splice, as well as the spliced wire jackets and heat shrink. Let dry completely.

13. Using the brush attached to the inside of the lid, or an acid brush, paint the entire cleaned jacket area with Scotchkote. Using the brush bristles, encourage it to flow into every nook and cranny. Do this over cardboard because it will drip. Let the Scotchkote dry completely. This is a primer that

improves adhesion of the Scotchfil to the cable jacket.

14. Cut a 6" length of Scotchfil putty. Remove backing tape, and stretch putty to ½ its original thickness. Wrap the Scotchfil tape around joint, pulling to create an elastic stretch, covering the entire splice area and 1-1/2" over each cable jacket end. In this example, the overall splice length is then approximately 4-1/4 inches long. Press and massage the Scotchfil into a roughly uniform diameter slightly larger than the original cable jacket.

15. Using Scotch 33 black vinyl tape, and starting ½" beyond the Scotchfil on the cable jacket, begin wrapping the black tape over the joint, pulling so as to create an elastic stretch, and overlapping the tape 50% on each turn. When completely covered, cut the tape from the roll with a knife or scissors rather than pulling and breaking the tape. This keeps the bitter end from curling up.

16. Perform a final ohm sift to be sure the connections are still fine.

POTTED CABLES

RoboticOcean (https://www.roboticocean.com/product-category/underwater-splice-kits/) produces 2 Underwater Cable Splice Kits. They have produced an educational video that goes into detail of how to make a potted splice.

FURTHER READING

To see an extended paper "Lander Lab #6: Splicing Underwater Electrical Cables_Extended", including thoughts on selecting specific potting materials, please go to Global Ocean Design <**www.globloceandesign.com**> "Knowledge Base".

CONCLUSION

The cold splice is the one to rely on for at-sea fixes. It is also possible to make potted splices at sea, too, that look nice, handle multiple breakouts, and function really well. Commit to learning this important maritime skill. Practice makes perfect. Be ready to save the day at sea!

COMMERCIAL SOURCES OF POTTING COMPOUNDS AND SPLICE KITS

AeroMarine Products
https://www.aeromarineproducts.com/
AK Industries, HydroSplice
http://ak-ind.com/hydrosplice.html
Blue Link https://blue-linked.com/cable-splice-kits
Clark Synthesis https://clarksynthesis.com/underwater-splice-kit-installation-guide
Epoxies Etc (Meridian Adhesives)
https://www.epoxies.com Bulletin 20-2180
Masterbond
https://www.masterbond.com/products/urethane-modified-epoxies-bonding-sealing-coating-potting
MG Chemicals https://www.mgchemicals.com/category/potting-compounds/polyurethane-resins/
Polymer G https://www.polymer-g.com
RoboticOcean https://www.roboticocean.com/product/cable-field-splice-epoxy-mold-kit/
3M Splices https://www.3m.com/3M/en_US/p/c/electrical/splices-accessories/
McMaster-Carr https://www.mcmaster.com/potting-compounds/cable-repair-resins-4/

UNDERWATER CONNECTOR MANUFACTURERS WHO MAKE CUSTOM CABLES

AK Industries ak-ind.com
Birns birnsaquamate.com
Dragonfish Mfg dragonfishmfg.com
Glenair https://www.glenair.com/underwater-connectors/index.htm
PMI Industries pmiind.com
TE Connectivity (SeaConn) www.te.com/seacon
Teledyne Marine Interconnect http://www.teledyne-marine.com/subsea-connectors/
WETechnologies https://wetechnologies.com/

REFERENCES

Christ, Robert, and Wernli, Robert, The ROV Manual, Second Edition, Oxford, UK, Elsevier, 2013, ISBN 978-0-08-098288-5 (Chapter 8: Cables and Connectors is a well written general discussion of underwater cables and connectors intended for a professional and scholarly audience.)

Busby, R. Frank, Manned Submersibles, Washington, DC, USA, Office of the Oceanographer of the Navy, 1976 (Busby's tome remains a seminal work in the field of undersea vehicles of any kind. Chapter 7 covers "Power and its distribution".)

ACKNOWLEDGEMENTS

Many thanks to Jim Wagaman, WETechnologies, for his careful and thoughtful design philosophy. Ray Hayworth, General Dynamics Electric Boat Division, should have gotten greater credit for the underwater connector and cable design guidelines he authored. Cal Peters, lead product engineer at FalMat Cables, gets a thumb up for his depth of knowledge and pleasant manner.

READER FEEDBACK

Let us know what you think. We'd like this column to be a conversation. Please send your thoughts and photos to: Kevin Hardy <khardy@marinelink.com>.

Tech Files

Innovative new vessels and technologies

Forum Energy Technologies

FET delivers trio of ROVs

Forum Energy Technologies (FET) delivered three of its 200HP Perry XLX-C work-class remotely operated vehicles (ROVs) to Brazil-based OceanPact. The systems will be deployed across two of OceanPact's vessels to support IRM services for Petrobras.

Each XLX-C was supplied with an underslung tooling skid for additional tooling and options fitment, complementing the vehicles high performance. A comprehensive supplementary tooling package including torque tools, verification units and fluid injection systems was also provided.

The ROVs were supplied with active heave compensated Dynacon launch and recovery systems (LARS), as well as associated surface power and control installations.

Sea-Kit International

Sea-Kit Ramps Up, Triples Production Capacity

Sea-Kit International's new production facility for its larger XL-Class Uncrewed Surface Vessel (USV) is now operational, with the first 18m hull being fitted out ready for delivery this summer to Fugro.

The company is off to a busy year, delivering two more of its 12m X-Class vessels, with another two currently being built. In addition, Sea-Kit debuted the XL-Class, which has three times the payload capacity, and it recently was granted patents for its X and XL-Class designs.

"It is great to go into 2023 with the new facility up and running. With the addition of this building, we have tripled production capacity and expanded our R&D area," said Ben Simpson, Sea-Kit CEO. "It gives us more, much-needed space for the ongoing development of launch and recovery systems for ROVs and AUVs, mast gondolas and sensor deployment systems, as well as enhancing manufacturing efficiencies for multiple USV builds."

Sea-Kit officially opened the new building, built alongside the company's existing base in Tollesbury, Essex, UK, on October 1, 2022.

ASI/Saab Seaeye

ASI Deploys Falcon in African Croc Infested Waters

ASI Group deployed a Saab Seaeye Falcon ROV into crocodile-infested waters in East Africa, crocodiles which have been preventing manual inspection of remote inland underwater structures supporting East Africa's power generation. ASI reports that the curious crocodiles soon lost interest in the Seaeye Falcon as the robot ventured into rivers and reservoirs, as well as inside structures and tunnels, to inspect and survey the wide variety of infrastructure supporting five power stations.

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

Areas previously considered inaccessible were surveyed, proving the versatility of the multi-beam sonar system provided by ASI. In one location, the Falcon was lowered over 20m by crane to reach a basin surrounded by jungle.

Photo courtesy USEA

USEA Ocean Data one step closer to Unmanned Ship

USEA Ocean has received preliminary approval to build and operate a 24-m unmanned vessel on Norwegian waters reports Felipe Lima, CEO at USEA Ocean Data. USEA develops a unique technology for seabed data acquisition with help of unmanned vessels and autonomous underwater vehicles. Right after New Year came the preliminary validation that the company needed to build and operate a 24-meter unmanned vessel on Norwegian waters. USEA's proprietary system for recharging and data transfer – the uLARS – is designed to secure fully automated launch and recovery of autonomous underwater vehicles, and also makes it possible for AUVs to connect to the unmanned vessel without the need for recovery to deck, during a seabed mapping campaign. This patented system is designed to enable the integration of autonomous underewater vehicles and unmanned vessels.

U.S. Navy to Name Oceanographic Survey Ship

USNS Robert Ballard

In 2019, Nautilus plied the Pacific waters off the island of Nikumaroro, searching for any sign of Amelia Earhart's lost plane. In the cool, dark control room, we kept a 24-hour vigil.

Image used with permission Gabriel Scarlett/National Geographic Image Collection

The U.S. Navy's next Pathfinder-class oceanographic survey ship will be named USNS Robert Ballard (T-AGS 67), Secretary of the Navy (SECNAV) Carlos Del Toro announced last month. The name selection follows the tradition of naming survey ships after explorers, oceanographers and distinguished marine surveyors. Widely known as a discoverer of the final resting place of the R.M.S. Titanic, Dr. Ballard is a retired U.S. Navy Commander, former director of the Center for Ocean Exploration, and a tenured professor of oceanography at the University of Rhode Island's Graduate School of Oceanography.

"Dr. Ballard's career, explorations, research and focus on teaching the next generation of oceanographers is remarkable, and I am pleased to name T-AGS 67 in his honor," Del Toro said. "One of my enduring priorities is building a culture of warfighting excellence, and that includes lifelong learning amongst DoN personnel. The name Robert Ballard displayed across the stern of this ship will serve as an inspiration to all who see it while highlighting the results of commitment to education and exploration."

In addition, Barbara Earle Ballard, Dr. Ballard's spouse and President of Odyssey Enterprises, has been designated as the ship's sponsor.

The $149 million oceanographic survey ship was ordered from Pascagoula, Miss. shipyard Halter Marine—now Bollinger MS Shipbuilding—in June 2021, and its keel was ceremonially laid in October 2022.

Equipped with a moon pool for unmanned vehicle deployment and retrieval, T-AGS 67 will be a multi-mission ship that will perform acoustic, biological, physical and geophysical surveys, providing much of the U.S. military's information on the ocean environment. The vessel will be over 350 feet long with an overall beam of 58 feet.

T-AGS 67 will be operated by the Military Sealift Command (MSC), which consists of non-combatant, civilian crewed ships that replenish U.S. Navy ships, chart ocean bottoms, conduct undersea surveillance, tactically preposition combat cargo at sea and move military equipment and supplies used by deployed U.S. forces around the world.

"I am humbled to have the U.S. Navy's oceanographic ship, USNS Robert Ballard (T-AGS 67) as a namesake. As a 17-year-old, in 1959, I went on my very first oceanographic cruise, and very early in my oceanographic career, the U.S. Navy placed a central role and continues to do so to this day," said Dr. Robert Ballard. "It is indeed an honor to know that the USNS Robert Ballard will continue to explore the oceans long after I am gone."

Ballard was born in 1942, growing up in San Diego, Calif. After he graduated from the University of California, Santa Barbara, in 1965, he earned an Army Reserve Commission, ultimately requesting and transferring to the United States Navy when called to active service in 1967. Assigned to the Office of Naval Research as a liaison officer at Woods Hole Oceanographic Institution in Massachusetts, Ballard worked extensively with deep-submergence vehicle Alvin (DSV-2). After transitioning to the Naval Reserve in 1970, he completed a Ph.D. in marine geology and geophysics at the University of Rhode Island. He continued to work at Woods Hole, where he was part of a team that discovered deep-sea thermal vents near the Galapagos Rift. Best known for his 1985 discovery of R.M.S. Titanic at a depth of 12,000 feet, Ballard also led other shipwreck discoveries, including USS Yorktown (CV-5), USS Quincy (CA-39) and President John F Kennedy's PT-109. Ballard retired from U.S. Naval Service in 1995. In 1989, he founded the distance learning program the JASON Project, which reached 12 million school children; and the Institute for Exploration in Mystic, Conn, and is also the founder and president of the Ocean Exploration Trust.

Kraken to Provide SAS to HII's New Medium Class UUV

Kraken Robotics said its AquaPix Miniature Synthetic Aperture Sonar (MINSAS) System has been selected as the standard payload offering on HII's new REMUS 620 Medium Class UUV.

HII selected the Kraken Aquapix MINSAS-60 and MINSAS-120 as the standard imagery sonar options due to the Kraken's combination of performance and versatility to suit a wide range of customer needs at a commercially competitive price, said Duane Fotheringham, President of Mission Technologies' Unmanned Systems business, HII, in an interview with MTR for it December 2022 edition. "This sensor provides high resolution interferometric Synthetic Aperture Sonar (SAS) and Bathymetry imagery along with optional real time data processing and Ultra High Definition (UHD) resolution."

Higher resolution imagery directly correlates to the reduction of false positives by both human operators and Automatic Target Recognition (ATR) software, which through advanced capabilities provided by the collaboration of the REMUS 620 and MINSAS Synthetic Aperture Sonar reduces the number of contacts required to be verified. The result is the potential for a significantly reduced MCM timeline. Kraken's SAS products have been integrated to HII Unmanned Systems range of small, medium and large AUVs, offering many opportunities to increase the Mine Hunting and MCM Capabilities of many NATO nations.

The unique system design of the MINSAS makes it an ideal match for the REMUS 620's modular payload and battery architecture as it can provide both 60 cm and 120 cm array offerings based on the customer's requirements, making room for additional sensor or battery payloads as needed. Kraken's MINSAS provides out-of-the-box high-resolution, real-time onboard beamforming which supports embedded ATR, enabling smart autonomy features.

HII REMUS 620 with Kraken MINSAS 60 Payload. Images courtesy Kraken Robotics

Image of 7-meter Dory and Anchor Scar taken from HII REMUS with MINSAS 60.

Advanced Navigation

Advanced Navigation debuts the Boreas D70, a fiber-optic gyroscope (FOG) inertial navigation system (INS). According to the manufacturer, the technology is well suited to surveying, mapping, and navigation across subsea, marine, land and air applications. Boreas D70 combines closed-loop DFOG and accelerometer technologies with a dual antenna RTK GNSS receiver. These are coupled with Advanced Navigation's AI based fusion algorithm to deliver accurate and precise navigation. The system features ultra-fast gyro compassing, acquiring and maintaining an accurate heading under the most demanding conditions. While D70 does contain a GNSS receiver, it's not required for gyrocompass operation.

Based on DFOG technology, D70 delivers a 40% reduction in size, weight, power and cost (SWaP-C), when compared to systems of similar performance.

- 0.01° roll and pitch
- 0.1° secant latitude heading (gyrocompass)
- 0.01° /hour bias instability
- 10mm position accuracy

Silicon Sensing

Silicon Sensing Systems Ltd. is a leader in silicon MEMS gyroscopes, accelerometers and inertial measurement systems, focusing on products delivering high performance, ultra-reliability and affordability. The company has supplied over 25 million MEMS sensors to thousands of customers worldwide and has a heritage in inertial sensing that can be traced back to the birth of the gyroscope over 100 years ago. Silicon Sensing has a number of new products suited to the rigors of the maritime environment. The DMU41 is a 9 degrees of freedom (DoF) inertial measurement unit (IMU). Measuring 50x50x50mm and weighing 200g, its volume is 54% lower and weighs 42% less than its predecessor the DMU30. For those looking for a single axis gyro, the company's latest CRH03 high-performance/low-noise gyroscope consumes 30% less power than its predecessor and incorporates improvements in both micro electro-mechanical systems (MEMS) and electronics - with new drive electronics and improvements to the sensor head. CRH03 is available in five rate ranges, including a new option of 10 degrees per second. It is highly tolerant to external vibration, delivers excellent bias instability and angle random walk and can be delivered as a packaged unit or an OEM item.

SBG Systems

SBG Systems offers a product family designed to help uncrewed vessels effectively, efficiently and safely navigate.

One example is Navsight INS used for Multi-Beam & Laser Survey Onboard USV, providing motion compensation and geo-referencing of both LiDAR and Sonar.

On its website, James Williams, Director USS is quoted as saying "Navsight Apogee provides exceptional performance when used in our nearshore and offshore surveys. Combined with its low power, small installation footprint and short initialisation times it's the perfect solution for all USV operations."

Based in the UK, Unmanned Survey Solution (USS) created the Accession Class USV, which incorporates a modular design which offers three variable boat lengths depending on the desired application. The base boat length of 3.5m can be extended to 4.25m or 5m by adding additional hull sections.

The standard USV Hydrographic payload includes the highest industry standard sensors to meet IHO special order surveys. These consist of a R2Sonic SONIC 2024 Multibeam sonar, an SBG Apogee Navsight Inertial + GNSS solution, and Valeport MiniSVS & SWIFT SVP for measuring sound velocity. The data is acquired in either Hypack or QINSy Hydrographic software and utilized for mission planning, data acquisition, post-processing, and final products.

Polar POD Project enters Construction Phase in France

Ifremer, Jean-Louis Etienne and the entire Polar POD team announced its construction by the Piriou shipyards in association with 3C Metal, under the direction of the project owner, Ifremer. The scientific program of this international oceanographic "station" is being overseen by the French National Center for Scientific Research (Centre national de la recherche scientifique, CNRS), in partnership with the French National Centre for Space Studies (Centre National d'Etudes Spatiales, CNES) and Ifremer.

Illustration Polar POD © N. Gagnon

What is the Polar Pod?

A cross between an oceanographic platform and a drifting lighthouse, Polar POD is designed to face the "furious fifties" and the highest waves on the planet. It will sail for three consecutive years with no planned return to land, which will require equipment that is easy to use, robust and tested. Environmentally sustainable, the platform will produce all the energy it needs using wind turbines, which will require very strict management of the vessel's energy expenditure. The construction process started on September 1, 2022, and will continue for a period of 2 years. Several sea trials off the coast of South Africa will be required before the scheduled departure of the expedition from Port Elizabeth in South Africa in the last quarter of 2024.

What are the Scientific Objectives?

Little is known about the Antarctic Ocean due to its size, proximity and harsh living conditions. Driven by the Antarctic Circumpolar Current (ACC), the Polar POD will circumnavigate the Antarctic Circle twice, making it three years of an uninterrupted campaign with the following main objectives:

• **Continuous measurement of atmosphere/ocean exchanges,** in particular the CO2 absorption capacity of the planet's main ocean carbon sink.

• **Recording marine biodiversity** by acoustics, from krill to whales.

• **Calibration of measurements made by satellites:** weather conditions, sea states, ocean color, measurement of phytoplankton for spatial monitoring of biological activity.

• **Assessment of current pollution of the ocean:** microplastics, organic pollutants, heavy metals and aerosols.

In the works since 2016 when Ifremer was appointed as the authority in charge of the construction of the Polar POD, the last six years have been spend completing the preliminary design studies with the French marine engineering firm, Ship-ST, to verify the technical and operational feasibility to public investors. Time was also required to develop a scientific program under the leadership of the CNRS, clearly define the specifications of the instrumentation to be integrated on the Polar POD, start the bidding process for potential shipyards and to seek funding.

On August 5, 2022, the Piriou/3C Metal joint venture was selected: Piriou shipyards for the construction of the main deck in Brittany, France, and 3C Metal for the construction of the truss, the torus, the bottom box and final assembly in Cape Town, South Africa.

"Polar POD is certainly the most ambitious expedition that I have worked on since 2010, and I am not afraid to say that it is my masterpiece," said Jean-Louis Etienne. "Therefore, the launch of the construction process of this "vertical ship" is a great moment in my life as a polar explorer; it is the fruit of perseverance, nourished by the enthusiasm of the scientific community and the naval engineering office Ship-ST who have accompanied me on this bold project. To dare is to engage your imagination beyond certainties."

The construction of the Polar POD has received funding from the French government under the management of the National Research Agency (Agence Nationale de la Recherche) under the future investment program integrated into France 2030, an investment plan which focuses on sectors of France's industrial future by the year 2030).

Arctic Rays

Arctic Rays Debuts New Products

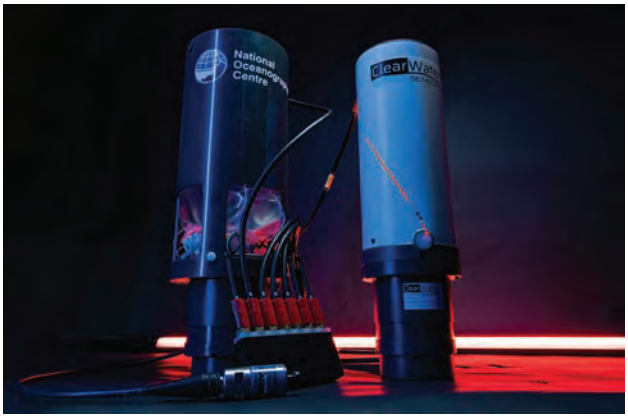
Arctic Rays released four new products in its suite of subsea technologies. Now available are:

- **YellowFin, the machine vision payload for turnkey seafloor imaging,** a fully integrated, turnkey imaging payload for small AUVs.
- **ViperFish:** A dual-channel, compact torch light for low-power or scientific, unobtrusive monitoring applications, rated to 1,000 or 6,000m.
- **Barnacle:** A pressure relief valve for use down to 6,000m, and interchangeable with other popular PRVs.
- **PRV tool, a compact tool for pulling a vacuum on or backfilling a housing:** To complement Barnacle, the new PRV vacuum tool was built to be ultra-compact and fit easily between multiple connectors.

BORAbox helps collect Ocean Data

The BORA Blue Ocean Research Alliance, which includes National Oceanography Center (NOC) and Subsea7, launched the first in a series of remotely operated vehicles (ROVs) that contain the new BORAbox. The sensors are currently collecting data on Subsea7 vessels in the South Atlantic, Brazil, and further launches are planned in Norway and further afield including Australia.

BORAbox, an integrated suite of sensors developed by NOC scientists, will measure an important aspect relating to the health of the ocean by establishing the total alkalinity – a measure of the water's ability to resist a reduction in its pH level. The information gathered by the BORAbox will feed into a global understanding of climate change and its impact on the oceans. As a result, the research will also be used to better predict how the oceans and weather systems will react over the coming decades.



ASI/Saab Seaeye

In Memorium

E. John Michel, MRCM (DV) USN (Ret),
Chief-of-the-Boat, Bathyscaph Trieste

Photo by L. McAuliffe, used with permission

We met in January 1959 when I became the first Officer in Charge of the Navy's newly acquired Bathyscaph Trieste and John was the first USN enlisted man to be assigned to the project. We were based at the Naval Electronics Laboratory in San Diego.

Trieste was unique as there were only two deep diving manned submersibles in the world. The French Navy had the other. Our team learned about the bathyscaph more by 'apprenticeship' than through any sort of formal learning process. Our 'teachers' were the Swiss inventor Jacques Piccard and his Italian mechanic, Giuseppe Buono. Everything was 'one-off', when something was needed we had to design and build it.

This situation was ideal for John, a consummate professional in solving technical problems. We joked that if we wanted something made, we'd just write a general request on a 3x5 card and slip it under the door of his well-equipped shop. Then leave him alone, and in due course the finished piece was delivered.

Not only was John technically brilliant, he was a wonderful shipmate. An 'old world craftsman', he paid no attention to clock or calendar when things needed to be done. From being a diver to boat driver, John was always there. I never saw him in a bad mood even during the most trying days as we tested Trieste prior to our deepest dive in 1960. His upbeat personality, sense of humor and unmatched story telling abilities were great morale boosters for the whole team.

His skills as a problem solver reached new heights when a serious failure with our pressure hull threatened to end the program before our dive into Challenger Deep. John worked out a brilliant field fix and executed it. While it was not 'good as new' it was quite safe for resuming our dive program.

After the fix Jacques Piccard and I made two more dives, one to 24,000 and the other to 35,912 feet. With the latter being to the deepest place in the World Ocean. Literally, we bet our lives on John's work.

We continued to work together with Trieste for nearly three more years. There are many more stories to be told about those days but no room for them here...

I was honored to serve with Master Chief Petty Officer E. John Michel, shipmate and friend. Fair winds and seas as you embark on your last sea duty…

(Remembrance by Captain Don Walsh USN (Ret) US Navy Submersible Pilot #1)

John Michel was born in Brooklyn, New York, July 25, 1933 to German immigrant parents. He learned shop skills from his father and many "uncles" in their close-knit neighborhood. He attended a technical high school to hone his machinist skills. Working in New York City machine shops during and following high school, he learned to manage them: the men, machines, materials, and orders. That served him well after he enlisted in the US Navy during the Korean War. He ran the machine shop of the USS Prairie (AD-15), a Dixie-class destroyer tender. On one of John's deployments, the Prairie circumnavigated the globe. In his new assignment with Project Nekton, he recalled machinery on the Prairie that he was able to acquire to repair the Trieste pressure hull misalignment Walsh spoke of. As a result of solving deep sea mission challenges, John and the USN received a number of patents for his inventions. While in Project Nekton, he attended and graduated from the U.S. Navy Divers School. He had a few close encounters while SCUBA diving to support Trieste. On 24 June 1965, John descended to 3,500-ft (583 fathoms) in bathyscaph Trieste II with then LCDR James B. Mooney, Jr., whom John called "a prince of a man."

John was proud of his German heritage, and spoke the language fluently. When Professor Auguste Piccard, Swiss inventor of the Trieste, came to visit the boat and crew in San Diego, he could speak German, French and Italian, but not English. John became his translator, and accompanied him everywhere as he toured the Point Loma Submarine Base. Auguste was impressed with John's language skills, good nature, and technical knowledge of the bathyscaph.

Those who knew John fondly recall his mischievous chuckle when telling one of his many stories. He was an elite shell collector and passionate student of the topic. John passed peacefully surrounded by family and friends on 14 December 2022. John is survived by his wife, Nola, son, Mark, his wife, Rebecca, granddaughter, Rachel, daughter-in-law, Marilyn, and granddaughters Kristin and Megan. He is predeceased by his youngest son, Neil.

John served as an inspiration to younger crew: demonstrating a commitment to high standards, the willingness to accept extraordinary challenges, and core belief he had the right stuff to solve the most seemingly complex problems, then move them into the "done" column.

A Celebration of Life is planned for February 19 in San Diego. For further information, go to **<bit.ly/3H46DMr>**, or please contact Mark Michel **<spiderlaw@cox.net>**. In lieu of flowers, John's family requests donations be made to the U.S. Navy Divers Memorial at Miramar National Cemetery, San Diego ,***www.navydivermemorial.org***>.

(Remembrance by Kevin Hardy Scripps Institution of Oceanography/ UCSD (Ret))

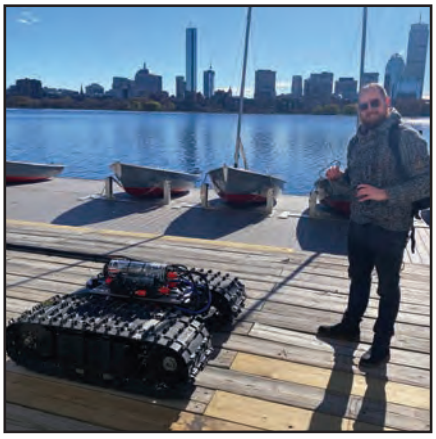
Who's News?

Latest People & Company News

Bruggaier

Poroy

Shea



Hess

Greensea PM Team led by Laura Krahn.

Bruggaier named Acteon CEO

Dr. Bernhard Bruggaier was appointed Group CEO of Acteon Group Ltd., succeeding Dr. Carl Trowell. Bernhard joined Acteon's subsidiary MENCK in 1994, became its Managing Director in 1998 and joined Acteon's executive management team following the acquisition of MENCK in 2003.

Reid takes the helm at Kraken

Kraken Robotics announced that Karl Kenny, Founder, President and CEO, will be appointed Executive Chairman of Kraken and transition the President and CEO role to Greg Reid. Reid joined Kraken more than seven years ago as CFO and since 2019 has been COO.

The company also said that David Shea, EVP of Products, will take on the additional role of Kraken's CTO.

Poroy named CEO at SRS

General Oceans appointed Omer Poroy as CEO of Strategic Robotic Systems, one of its four operating companies. Poroy brings more than 25 years of experience in the ocean technology space.

Bayonet Ocean Vehicles appoints Hess

Bayonet Ocean Vehicles appointed Dylan Hess as Sales Engineer. Hess began his career with the US Navy, working on computer and electronic equipment systems, following which he gained years of experience as field service technician in the autonomous underwater vehicle market.

Greensea Team Grows

Greensea Systems announced several additions to the team, and its implementation of a more agile delivery methodology for its Program Management (PM) team, led by Laura Krahn. She said: "We've added several new Program Managers. Jeff Guyette has joined to lead the OEM program, working alongside new PM hire, Mark Cerbo on the OPENSEA Program. I've been able to bring some key employees onto my team, including David Pearson, who has stepped up from Senior Robotics Engineer to Program Manager, Autonomous Systems, and Niels Huisman as Program Manager, Science and Academic Vehicles. We recently hired Andrew Papin into the PM group. Rounding out the additions to staff, we were able to bring Dennis Doan onboard through the DOD SkillBridge program, which connects military service members with participating businesses to provide a smooth transition from military to the private sector.

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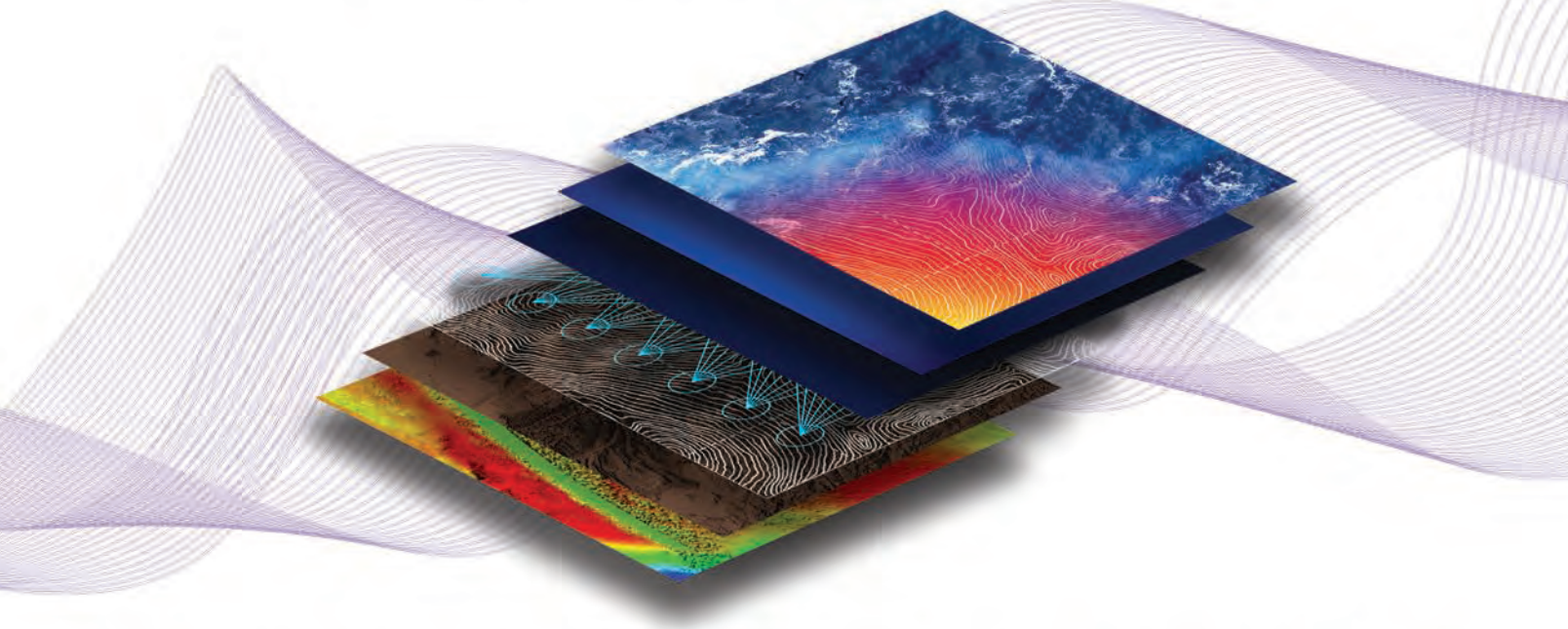

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