MARINE TECHNOLOGY REPORTER

November/December 2020

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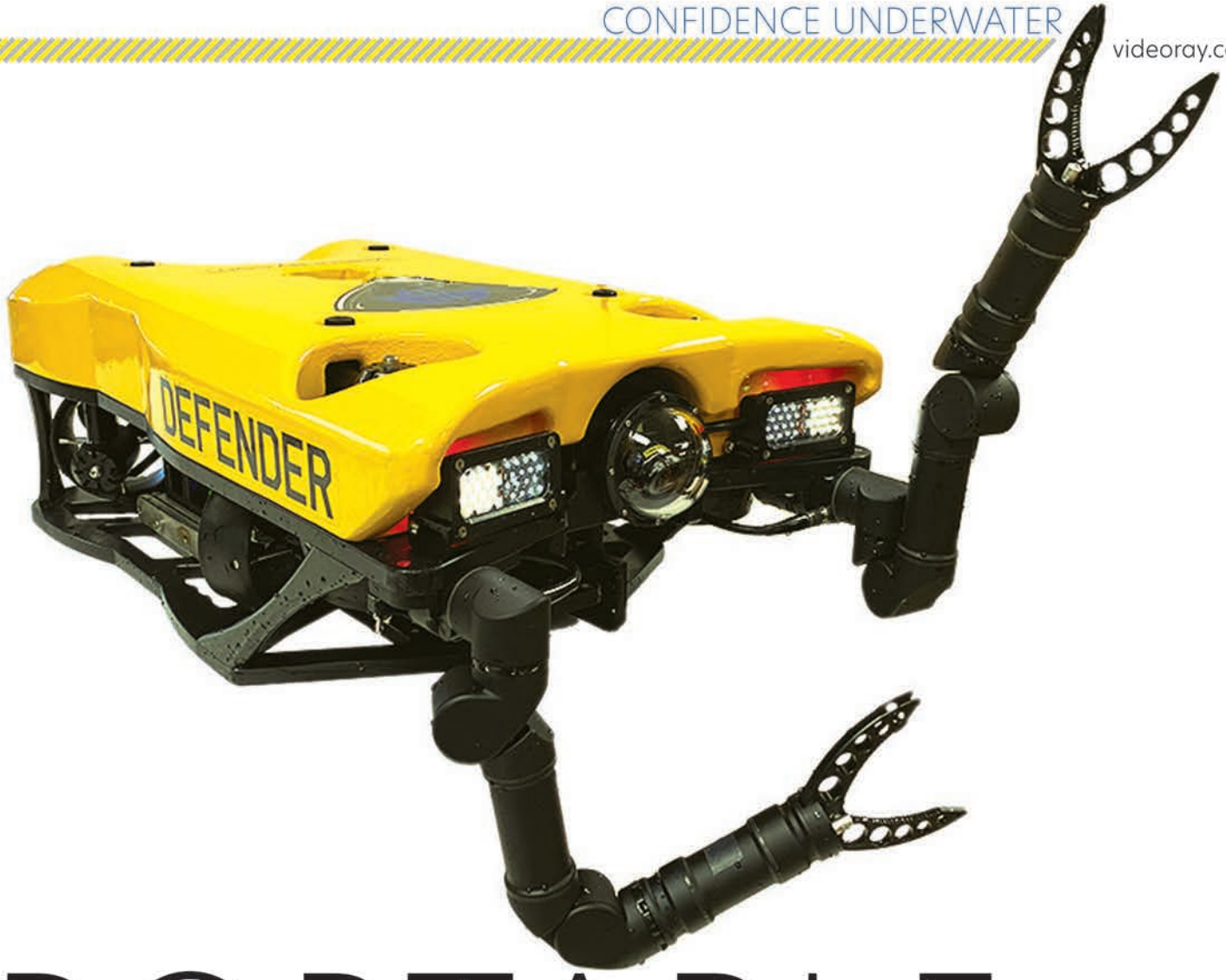
What happens when one unmanned system can deploy another?

Interview
Steve Hall, CEO, SUT

DeMass SPFF Fish Farm
Offshore Farm Installed at an Open Ocean Locale

Coast Guard RDC Trials
Equipment in the Arctic

Volume 63 Number 9



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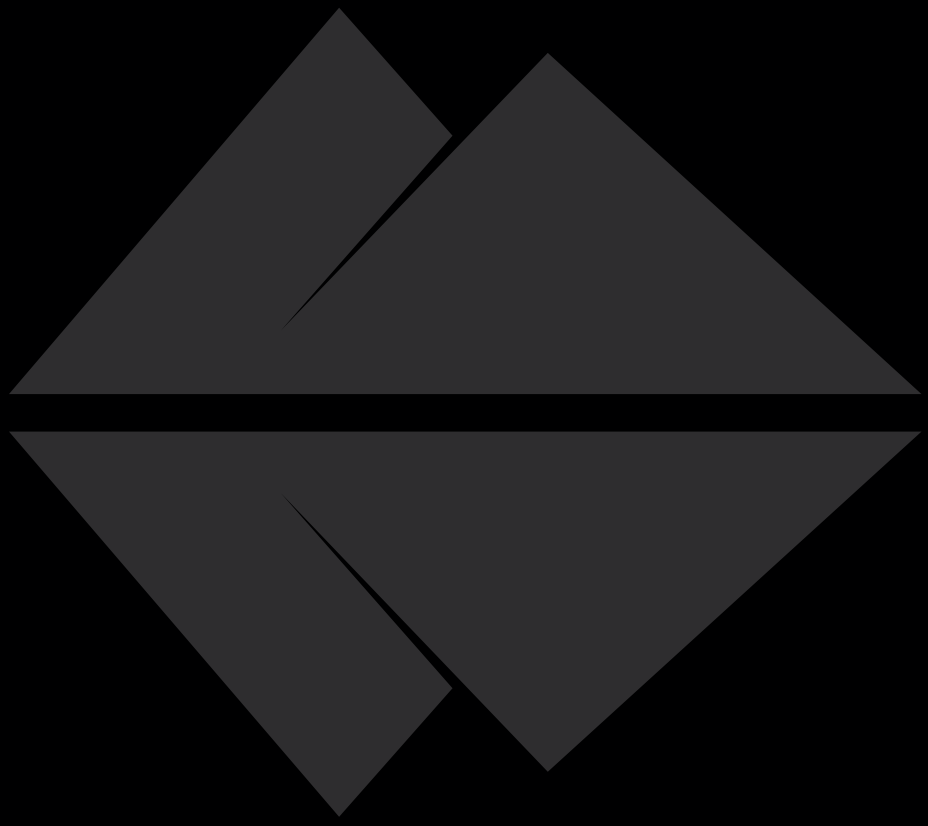

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November/December 2020
Volume 63 • Number 9

Contents

U.S. Coast Guard photos by SN Kate Kilroy

Steve Hall

DeMass

On the Cover

The AutoNaut Caravela wave propelled unmanned surface vessel with its SeaGlider payload.
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NEW YORK
118 E. 25th St., New York, NY 10010
Tel: (212) 477-6700; Fax: (212) 254-6271

FLORIDA
215 NW 3rd St., Boynton Beach, FL 33435
Tel: (561) 732-4368; Fax: (561) 732-6984

PUBLISHER
John C. O'Malley
jomalley@marinelink.com

Associate Publisher & Editor
Gregory R. Trauthwein
trauthwein@marinelink.com

Contributing Writers
Justin Manley, U.S.
Elaine Maslin, Aberdeen
Tom Mulligan, Ireland
Claudio Paschoa, Brazil
William Stoichevski, Oslo

Production Manager
Irina Vasilets
vasilets@marinelink.com

Production & Graphic Design
Nicole Ventimiglia
nicole@marinelink.com

Corporate Staff
Manager, Marketing
Mark O'Malley
momalley@marinelink.com

Accounting
Esther Rothenberger
rothenberger@marinelink.com

Manager, Information Technology Services
Vladimir Bibik
bibik@marinelink.com

Circulation
Kathleen Hickey
mtrcirc@marinelink.com

Advertising
Vice President, Sales and Marketing
Rob Howard
howard@marinelink.com
Tel: (561) 732-4368 • Fax: (561) 732-6984

Advertising Sales Manager
Mike Kozlowski
kozlowski@marinelink.com
Tel: (561) 733-2477 • Fax: (561) 732-9670

Editorial

With this edition, we bring to a close what is undoubtedly one of the longest and more bizarre years in the 54 that I have ridden this third rock from the sun. I find it hard to properly put in perspective the year 2020, as it has presented a seemingly endless array of obstacles and challenges. We are located in New York City, which served as the initial epicenter for COVID-19 in the U.S., and we have effectively been working remotely since early March. While there is an incredible amount of disruption and uncertainty in life, business and personal, I fall back on one very simple premise: *We are still here working hard to deliver the latest, best information on the subsea sector.*

Despite the volume and duration of noise generated this year, innovation in the subsea space continues at pace across multiple sectors as you – our readers in print and at **marinetechnologynews.com** – sit at the epicenter of some of the world's most pressing problems. I had the opportunity to visit with **Steve Hall**, CEO of the Society for Underwater Technology (SUT) on a Zoom call for a recent video interview. As many of you know, Steve's tenure at SUT is coming to an end shortly as he moves on to the top spot at Pembrokeshire Coastal Forum at the end of 2020. The end product video interview (found here: **bit.ly/3kZSnbm**) is the antithesis of what you might expect from a media video clip today, as it is anything but short & sweet, running nearly an hour long. I cut this interview down personally, and at the end of the day, little was left on the cutting room floor other than my own foibles! When you have some time though, I highly recommend that you log on and listen, as Steve provides incredible depth and insight to the pace and trajectory of subsea markets and technologies. We captured the essence of the interview in our Q&A with Steve starting on page 25.

As we head to 2021 and beyond, the *MTR* team will be there with you to discuss and present the breadth and depth of your work in the world's most hostile environments. As always, we welcome you comments, questions and suggestions for coverage across our various media platforms.

Gregory R. Trauthwein
Associate Publisher & Editor

MARINE TECHNOLOGY REPORTER
www.marinetechnologynews.com
Vol. 63 *No. 9*
ISSN 1559-7415
USPS# 023-276
118 East 25th Street,
New York, NY 10010
tel: (212) 477-6700
fax: (212) 254-6271

Marine Technology Reporter (ISSN 1559-7415) is published monthly except for February, August, and December by New Wave Media, 118 E. 25th St., New York, NY 10010-1062. Periodicals Postage Paid at New York, NY and additional mailing offices.

POSTMASTER: Send all UAA to CFS. NON-POSTAL AND MILITARY FACILITIES send address corrections to Marine Technology Reporter, 850 Montauk Hwy., #867, Bayport, NY 11705.

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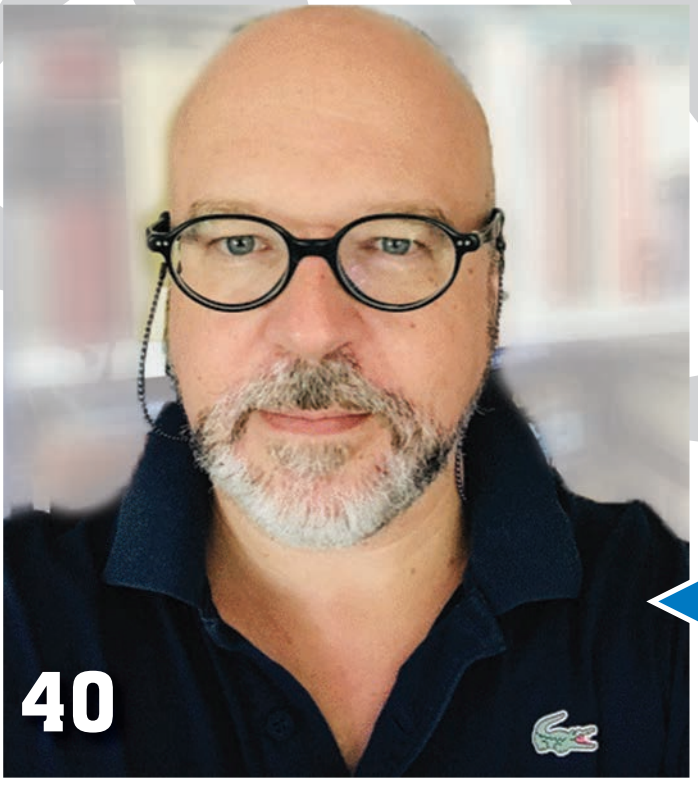
"Even if CO2 had no effect whatsoever on (the earth's) temperature, we know it's changing the acidity of the oceans, we've got to tackle that. And then you have all those associated things like sea level rise, which is going to end up killing an awful lot more people than temperature rise will."

Steve Hall, CEO, SUT



"Essentially the market is being developed alongside upgrades in technology. As in the oil and gas industry, each offshore farming unit requires tailoring for local environmental conditions, farming practices that relate to the various species and market conditions."

Philip Schreven, co-founder, De Maas

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BP fleshes out what net zero in 2050 means for its upstream business

By Keith Myers, President of Research at Westwood

BP followed up the release of its Energy Outlook with a 'BP Week' of strategy presentations intended to flesh out its 'Net Zero in 2050' ambitions announced in February this year, by the new CEO Bernard Looney.

A key ambition is to be 'net zero on an absolute basis across the carbon content of our upstream oil and gas production by 2050 or sooner.'

This makes BP one of the most radical IOCs when it comes to adapting its business to the Energy Transition. Investors have been waiting for the detailed plans behind the ambition, so what did BP reveal recently about how its E&P business that produced 3.8 million boe/d in 2019 plans to achieve net-zero emissions from the production and consumption of the hydrocarbons it produces?

BP's Oil and Gas Demand Scenarios

According to BP's 2020 Energy Outlook report, the 'Net zero' scenario is consistent with 1.5ºC of warming and 'Rapid' is consistent with less than 2oC of warming.

'Busines as usual' assumes the continuation of current policies.

Under the Rapid and Net Zero scenarios, liquids consumption has already peaked and will fall from 100 million bbl/d in 2018 to 52 and 31 million bbl/d in 2050, respectively. Gas consumption in the 'Rapid scenario', on the other hand, grows until 2035 before falling back to 2020 consumption levels in 2050. In the Net Zero scenario, gas consumption falls by a third by 2050.

BP's upstream production guidance to 2030

BP's guidance for its equity production is that it will fall by c. 40%, from 2.6 mmboe/d to 1.5 mmboe/d in 2030. It plans to sell 600 mboe/d of production by 2025 of which 200 mboe/d is in deals which have been agreed already. BP's 19.75% stake in Rosneft contributes 1.1 mmboe/d and is not included in the targets above. Rosneft looks increasingly peripheral to BP's central aim of achieving carbon neutrality and becoming an

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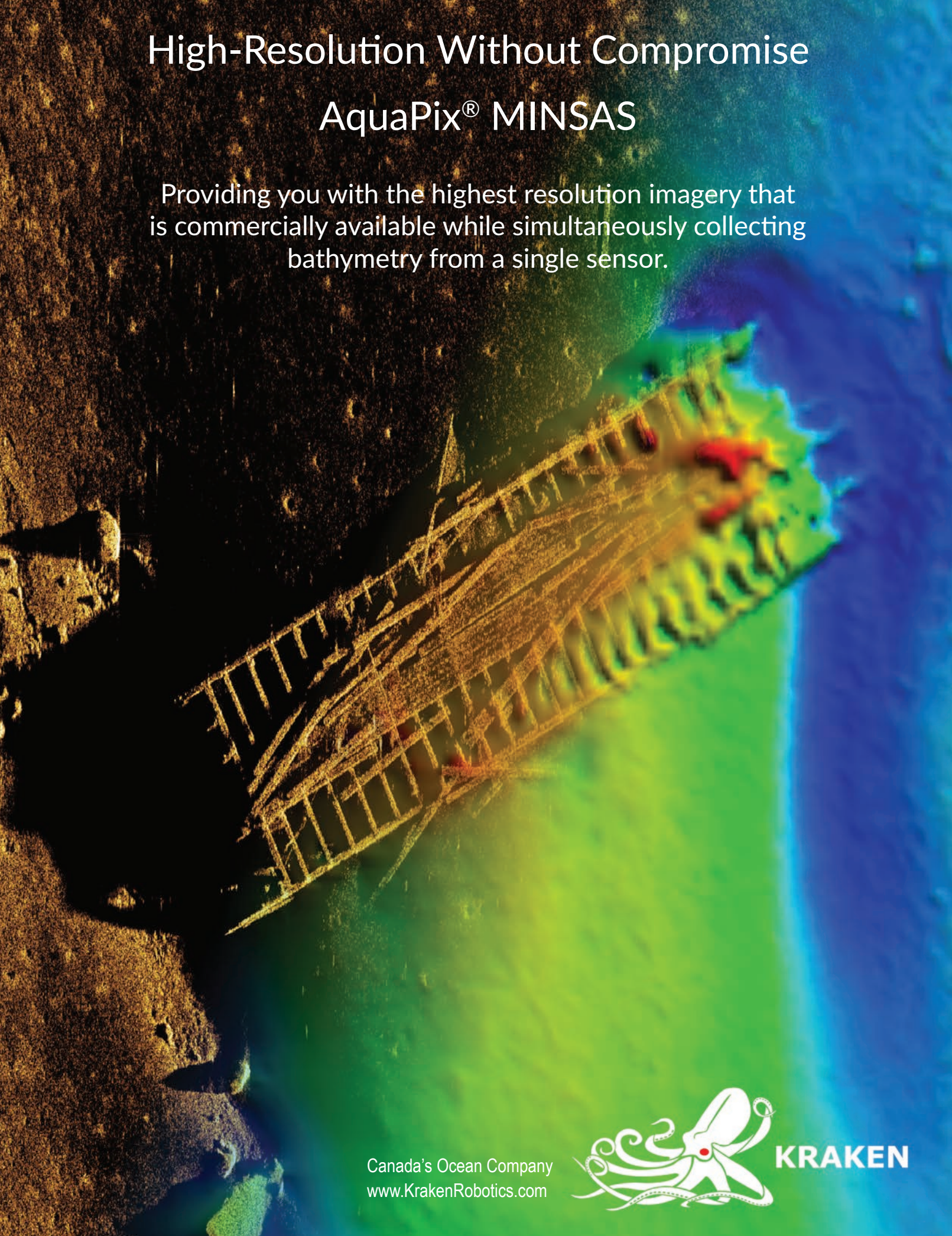

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International Energy Company, rather than an IOC.

The chart below shows that BP's planned cuts to its oil and gas production are far greater than the implied fall in global demand in its own scenarios even under a world on track for 1.5°C of warming.

Implications for the E&P business

The scale and speed of the transition BP is undertaking is without precedent. Ignoring Rosneft, the cut in production from 2.6 to 1.5 mmboe/d means that BP will be producing 400 million fewer barrels of oil equivalent per year in 2030. BP indicated that it would 'manage the R/P ratio down to 8 years'. R/P ratio was around 11 years at end 2019.

BP has indicated that it will cut E&P capex from ~$12bn in 2019 to ~$8bn in the 2021-2025 period. Oil projects will need a payback period of <10 years and gas projects <15 years to be sanctioned. Average point forward development costs are estimated at $9/boe.

BP would produce 8 billion barrels of oil equivalent over the next 10 years, excluding Rosneft, assuming a linear decrease in production to the 1.5 mmboe/d target in 2030. This compares to reported net proved developed reserves at end 2019 of 6 bnboe. An R/P ratio of 8 in 2030 with production of 1.5 mmboe/d would imply proved reserves of 4.4 bnboe. BP stated it had 16 bnboe of 'resources' in the strategy presentation, therefore, in theory only 6 bnboe of this resource would be need to be moved to reserves over the next 10 years.

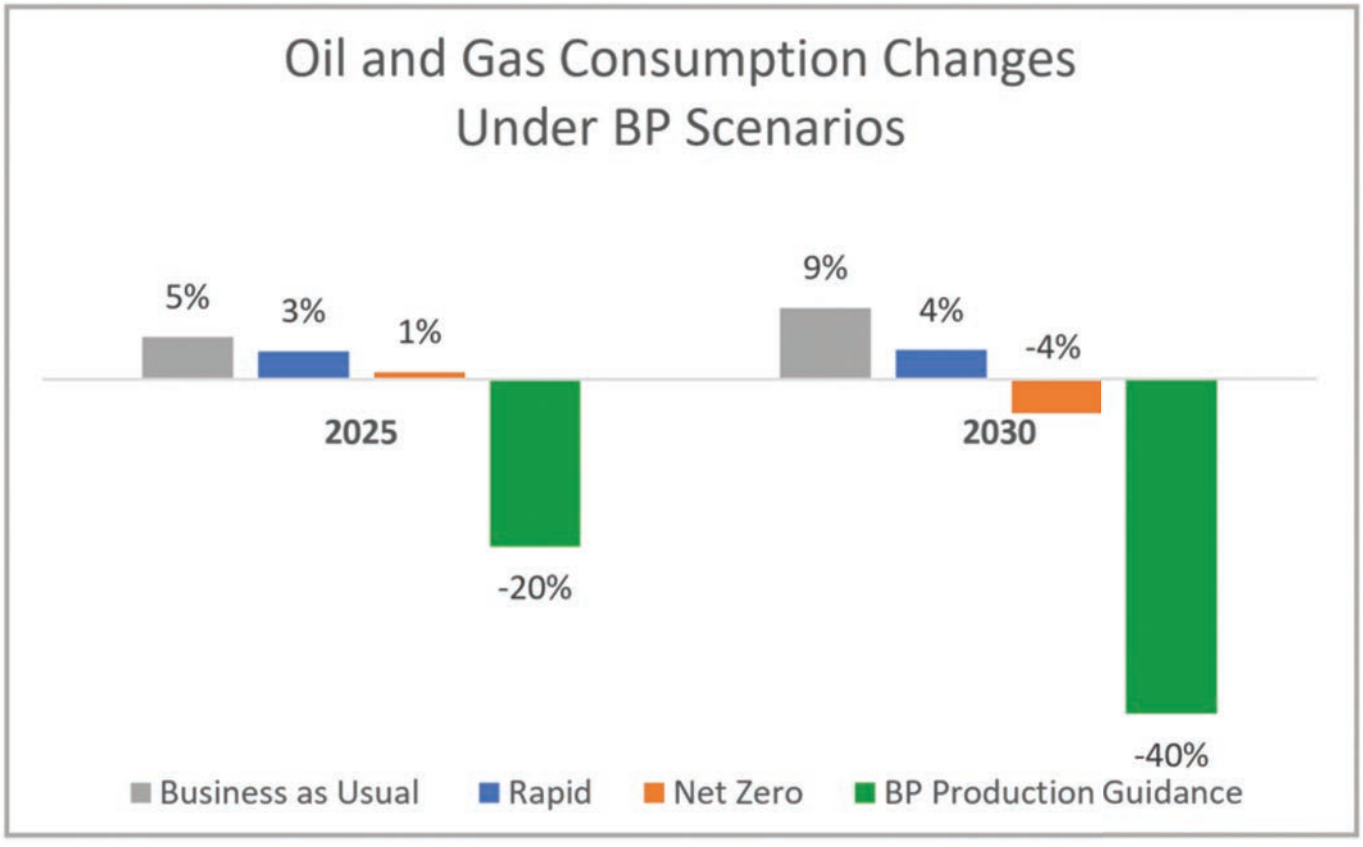
BP, therefore, has currently more than enough discovered resource to replace reserves without exploration.

Exploration spending will be cut to $350-400 million per annum with a focus on new hubs in existing areas.

The strategy appears to be to maintain a hopper of 400 million boe risked volume net to BP. Examples of near-term drilling that fit this description include the Ironbark gas prospect on the NW Shelf of Australia, the Shafag Asimam gas prospect in Azerbaijan and the Galapagos Deep frontier oil prospect in the Gulf of Mexico which have been on BP's books for many years. There will be no new country entries and presumably also exits from acreage that no longer fits the strategy. In 2019 BP reported spend of $1.3bn of E&A ($800m exploration only) and said exploration and acreage access capital peaked at $4.6bn in 2010. This a significant chunk taken out of the global exploration budget and marks the end of BP as a major player in exploration.

Investor reaction?

BP's share price has fallen by 53% in the last 12 months and is second-worst only to Shell of the five Supermajors. ESG investors may be celebrating the pivot in strategy but the wider investor community has not yet rewarded BP for its efforts. So far, the cuts to dividends announced by BP and Shell have seem-



ingly outweighed ESG considerations in the minds of investors.

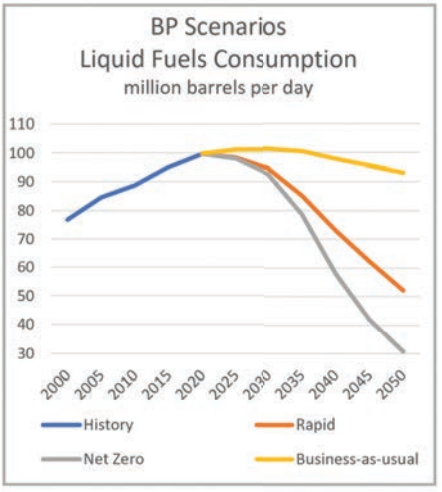
There are skeptics who wonder whether the sums add up.

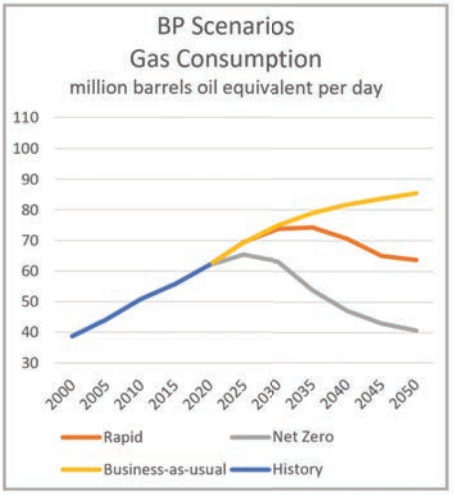
BP intends to cut production at a faster rate than its own scenarios suggest is necessary to align with the Paris Agreement and achieve <2°C of warming.

Also, the 600 mboe/d that it plans to divest by 2025 will not contribute to the Paris goals, as the barrels will still be produced by someone else.

BP's production contributed about $12/boe of net income in 2019 at average Brent prices of $64/bbl. With the change in strategy, it will be producing 400 million fewer barrels in 2030 and so it will need to replenish $4.8bn of annual net income from alternative sources to make up for the foregone production. Asset sales should compensate in the short term, but it is still a lot of profit to find to sustain a business of BP's current scale.

The aims are laudable, and the presentations are compelling, but will the strategy pay off for shareholders, or is BP moving too quickly in its transition from IOC to IEC? Time will tell.





Scienist Discover 500m Tall Coral Reef

Scientists have discovered a massive detached coral reef in the Great Barrier Reef, the first to be discovered in more than 120 years, Schmidt Ocean Institute announced.

Measuring more than 500m high, the reef was discovered by Australian scientists aboard Schmidt Ocean Institute's research vessel Falkor, currently on a 12-month exploration of the ocean surrounding Australia.

The reef was first found on Oct. 20, as a team of scientists led by Dr. Robin Beaman from James Cook University was conducting underwater mapping of the northern Great Barrier Reef seafloor. The team then conducted a dive on Oct. 25 using Schmidt Ocean Institute's underwater robot SuBastian to explore the new reef. The dive was live-streamed, with the high-resolution footage viewed for the first time and broadcast on Schmidt Ocean Institute's website and YouTube channel.

The base of the blade-like reef is 1.5k m-wide, then rises 500m to its shallowest depth of only 40m below the sea surface. This newly discovered detached reef adds to the seven other tall detached reefs in the area, mapped since the late 1800s, including the reef at Raine Island, the world's most important green sea turtle nesting area.

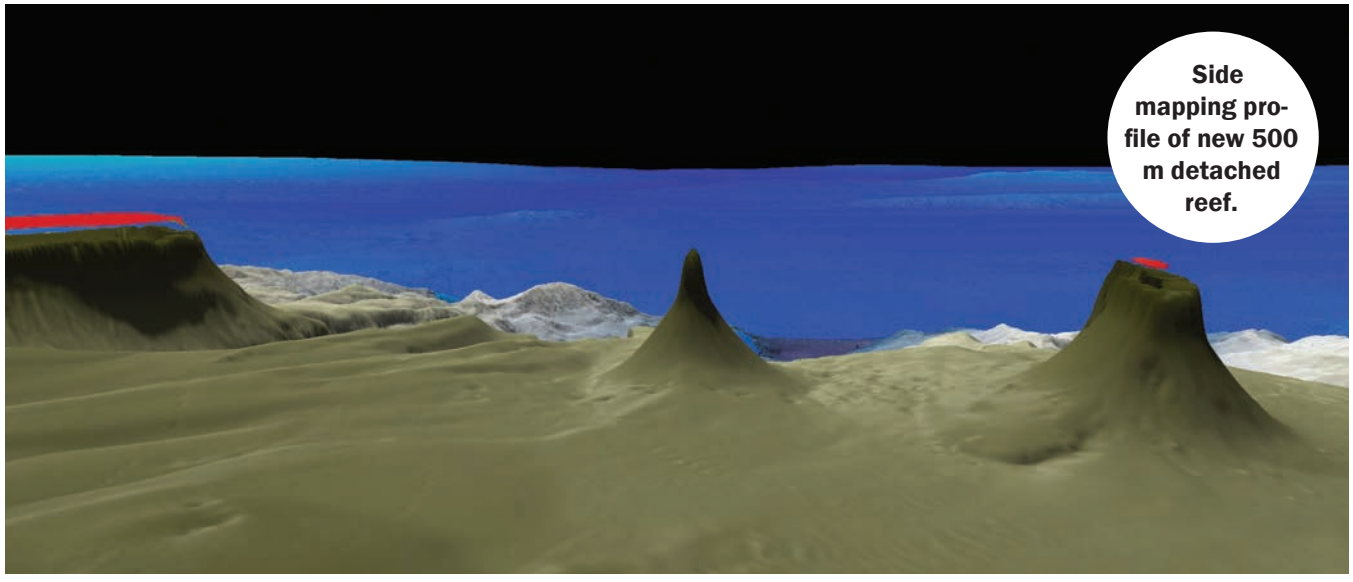
"This unexpected discovery affirms that we continue to find unknown structures and new species in our Ocean," said Wendy Schmidt, co-founder of Schmidt Ocean Institute. "The state of our knowledge about what's in the Ocean has long been so limited. Thanks to new technologies that work as our eyes, ears and hands in the deep ocean, we have the capacity to explore like never before. New oceanscapes are opening to us, revealing the ecosystems and diverse life forms that share the planet with us."

"We are surprised and elated by what we have found," said Dr. Beaman. "To not only 3D map the reef in detail, but also visually see this discovery with SuBastian is incredible. This has only been made possible by the commitment of Schmidt Ocean Institute to grant ship time to Australia's scientists."

The discovery of this new coral reef adds to a year of underwater discoveries by Schmidt Ocean Institute. In April, scientists discovered the longest recorded sea creature, a 45m siphonophore in Ningaloo Canyon, plus up to 30 new species . In August, scientists discovered five undescribed species of black coral and sponges and recorded Australia's first observation of rare scorpionfish in the Coral Sea and Great Barrier Reef Marine Parks. And the year started with the discovery in February of deep sea coral gardens and graveyards in Bremer Canyon Marine Park.

"To find a new half-a-kilometer tall reef in the offshore Cape York area of the well-recognized Great Barrier Reef shows how mysterious the world is just beyond our coastline," said Dr. Jyotika Virmani, executive director of Schmidt Ocean Institute. "This powerful combination of mapping data and underwater imagery will be used to understand this new reef and its role within the incredible Great Barrier Reef World Heritage Area."

The Northern depths of the Great Barrier Reef voyage will continue until Nov. 17 as part of Schmidt Ocean Institute's broader year-long Australia campaign. The maps created will be available through AusSeabed, a national Australian seabed mapping program, and will also contribute to the Nippon Foundation GEBCO Seabed 2030 Project.



Side mapping profile of new 500 m detached reef.

Credit Schmidt Ocean Institute

Damen Completes OceanXplorer Rebuild

Damen Shipyards Group completed the rebuild of research vessel OceanXplorer at Damen Shiprepair Rotterdam. As OceanX's new flagship, she is equipped with a series of submersibles, sonar arrays, manned submarines, an ROV and AUV.

OceanXplorer's research facilities are paired with Hollywood quality filming and media studios – developed in partnership with filmmaker James Cameron. With this, the vessel's findings can be live-streamed to audiences worldwide at the exact moment of discovery. The project required Damen to rebuild the vessel – a former offshore survey ship – in essence from the main deck upwards by stripping the existing accommodation and adding a complete new and much larger accommodation to house the new laboratories, workshops and submarine hangar.

The ship is unique in its combining of up-to-the-minute research facilities – courtesy of renowned naval architects Skipsteknisk – and top-of-the-line interior accommodations, designed by Christina Fallah. The vessel's additional interiors as well as its exterior were styled by Steve Gresham.

Ocean-Xplorer in the fjords of Norway.

Credit Damen Shipyards Group

In the News

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Palau's Coral Reefs: A Jewel of the Ocean

The latest report from the Khaled bin Sultan Living Oceans Foundation finds Palau's reefs had the highest coral cover observed on the Global Reef Expedition—the largest coral reef survey and map-ping expedition in history.

Scientists at the Khaled bin Sultan Living Oceans Foundation (KSLOF) have released their findings on the state of coral reefs in Palau. Their research, based on extensive underwater surveys, found Palau's reefs had the highest live coral cover of all the reefs studied on the Global Reef Expedition, a scientific research mission to assess the health and resiliency of coral reefs around the world. The Global Reef Expedition: The Republic of Palau Final Report summarizes the Foundation's research on the status of coral reefs and reef fish in Palau and provides conservation recommendations that can help preserve these outstanding coral reefs for generations to come. Over the course of five years, KSLOF's Global Reef Expedition circumnavigated the globe collecting baseline data on coral reefs to address the coral reef crisis.

In 2015, the Global Reef Expedition came to Palau, where an international team of scientists and local experts spent nearly a month at sea surveying coral reefs in ten states across the country. Working together, they conducted over 1,800 standardized surveys of the benthic and fish communities on coral reefs in Palau.

They found Palau's coral communities to be in excellent condition compared to other reefs in the re-gion. The average live coral cover recorded in Palau was over 45% and reached 60 or 70% in some ma-rine protected areas.

This coral cover is very high, even among the world's best coral reefs. "Palau's coral cover is truly ex-ceptional," said Alexandra Dempsey, the Director of Science Management at KSLOF and one of the report's authors. "It indicates a robust benthic coral reef community with high coral cover and species diversity."

These coral reefs have likely benefited from Palau's efforts to conserve their natural marine heritage. Palau has a long history of marine conservation. Key is the traditional policy of "bul"—a moratorium on catching particular species or fishing on certain reefs to protect habitats that are critical to the commu-nity's food security.

Conservation of the country's reefs was further boosted in 2015 by the establishment of the Palau Na-tional Marine Sanctuary, which delivered one of the world's largest protected areas of ocean. "Unsur-prisingly, this longterm commitment to marine conservation has delivered some of the most vibrant reefs the Foundation encountered on its Global Reef Expedition," said Dr. Sam Purkis, KSLOF's Chief Scientist

as well as Professor and Chair of the Department of Marine Geosciences at the University of Miami's Rosenstiel School of Marine and Atmospheric Science. "Given that Palau's efforts are yielding tangible conservation results, the country might serve as a role model to other countries in the South Pacific and beyond."

Despite a thriving coral community, Palau's reefs had fewer and smaller fish than would be expected for a healthy coral reef ecosystem. Reef fish communities in Palau were similar to those surveyed in other nearby countries in the south and western Pacific. Many of the biggest fish appeared to be miss-ing.

Signs of overfishing were also observed on some of Palau's nearshore reefs despite existing regula-tions, particularly on reefs near population centers. "Fish are a critical component of a robust coral reef community. They're important not only ecologically, but for the people who depend upon the reefs food or income," said Renée Carlton, Marine Ecologist at KSLOF and lead author on the report. "We saw some warning signs regarding reef fish communities, but are also hopeful that by expanding current fisheries management regulations and establishing more no-take no-entry areas, Palau's reef fish communities could become some of the best in the world.

The commitment Palauan's have made to conserving their reefs is highly commendable and I hope they're able to use the findings in this report to continue preserving their natural resources for future generations."

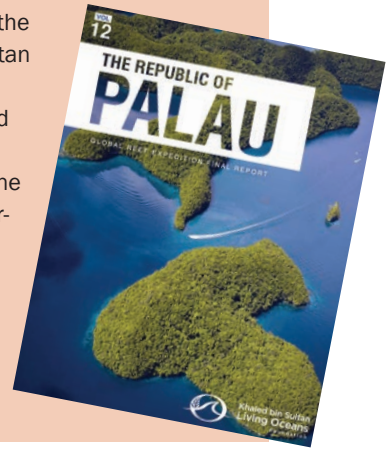
For more photos visit:
bit.ly/2TAzdwv

Read the Study

"Global Reef Expedition: The Republic of Palau Final Report" was published online on October 19, 2020.

The study's authors include Alexandra Dempsey and Renée Carlton from the Khaled bin Sultan Living Oceans Foundation, and Sam Purkis of the Khaled bin Sultan Living Oceans Foundation and the Rosen-stiel School of Marine and Atmospher-ic Science at the University of Miami.

lof.org



Revival of Saginaw Bay's Marine Ecosystem

Saginaw Bay's warm waters serve as nursery grounds for many fish species and support the fisheries of both Saginaw Bay and the main basin of Lake Huron. Historically, inner Saginaw Bay contained rock reefs that provided critical habitats, spawning grounds, and juvenile areas for many native fish species. This includes Walleye, Smallmouth Bass, and Suckers during the spring and Lake Whitefish, Cisco, Lake Trout, and Burbot in the fall.

As human development increased in Michigan, this critical habitat was largely lost due to sedimentation resulting from land use changes such as logging and agriculture. The loss of inner Saginaw Bay's rock reefs contributed to the 1940s collapse of Saginaw Bay's Walleye fishery and negatively impacted local populations of Lake Whitefish, Lake Trout, Burbot, and other species. The reefs were determined to be in dire need of restoration to bring back the ecosystem that once thrived.

The results of a multi-year assessment found that conditions in the inner-bay were suitable for restoration, with the Coreyon Reef identified as a priority restoration site. With financial support from the EPA and Saginaw Bay Watershed Initiative Network, the collaborative reef restoration team began moving forward with the design, permitting, construction, and restoration of the Coreyon Reef.

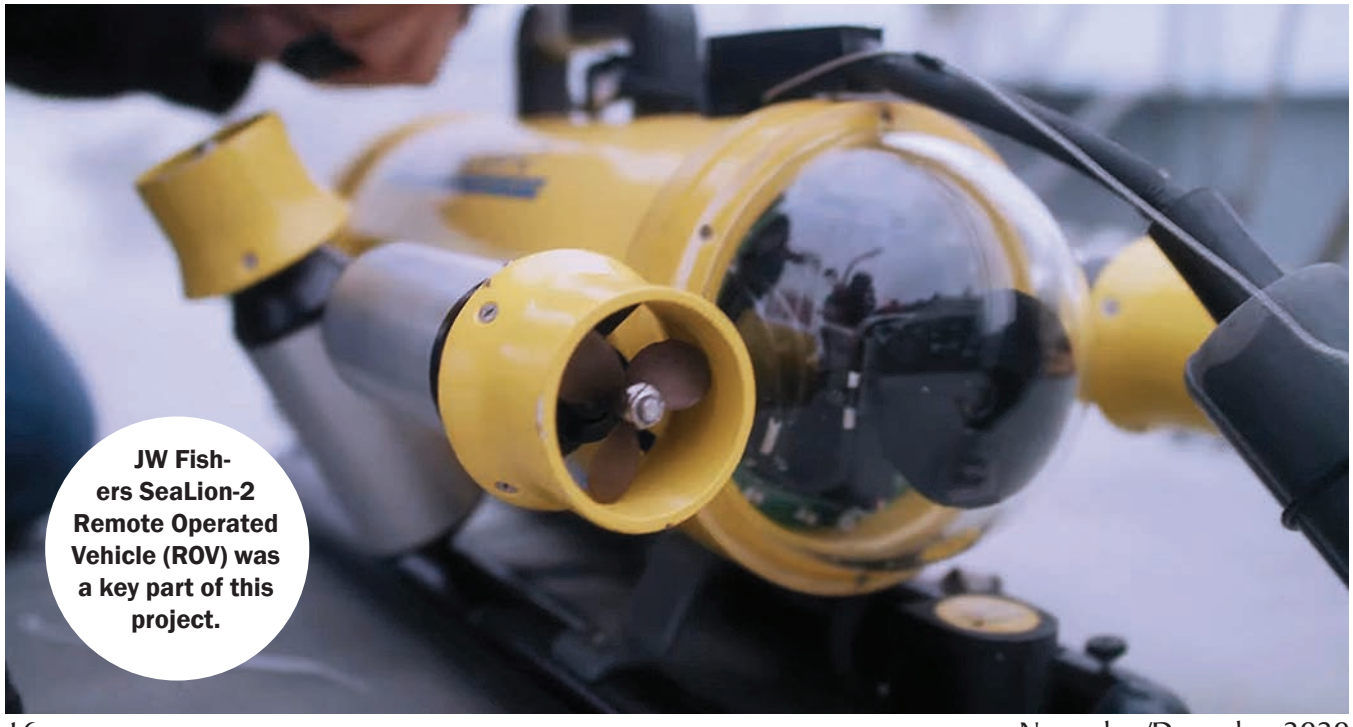
The project was approved and funded by a Great Lakes Restoration Initiative (GLRI) grant of $980,000 and a grant of $25,000 from Saginaw Bay Watershed Initiative Network (Saginaw Bay WIN). The total project is just over $1 million. In the end, two acres of reef habitat were restored.

There are several project partners for the restoration project, but the principles are the Michigan Department of Natural Resources (Michigan DNR) Fisheries Division and the Michigan Environmental and Great Lakes & Energy Department (Michigan EGLE), Remediation Division.

Construction began in early 2019 and completed by the fall of 2019. The process was recorded and a documentary was filmed featuring the initial post-construction examination work. The documentary premiered at the Thunder Bay International Film Festival in January 2020.

JW Fishers SeaLion-2 Remote Operated Vehicle (ROV) was also a key part of this project. The ROV was used as a visual aid to ensure that the rocks were placed correctly and it was also used to monitor the new reef's activity. "We did also use our JW Fishers' SSS-dual frequency side scan sonar for additional assessment but unfortunately the filming didn't capture that," said Dr. David Fielder, Michigan DNR. "On the whole, JW Fishers' equipment played a central role in that habitat work. We will be going back out there at 'ice out' to take another look (with hopefully better visibility)." Ice out, as Dr. Fielder mentioned, is when the Spring thaw allows for sufficient melting to continue operations.

A link to feature length documentary can be found at bit.ly/3mDKatt



JW Fishers SeaLion-2 Remote Operated Vehicle (ROV) was a key part of this project.

Credit: JW Fishers

The Search for Abandoned Crab Pots

The University of Delaware has participated in a state program which supports rescuing abandoned crab pots from the seabed, and researches technologies to make the search process more effective. It has advanced sonar surveys from a boat with further map storage and processing in SPH Engineering's ATLAS AI-powered platform. The evaluations proved to be time-effective and more accurate in comparison to the detections of human annotators.

The university got a shareable webmap with located crab pots in ATLAS and a report with georeferenced spots in GeoJSON. This approach helped a detector to work much faster and more consistently than the human annotators to support guided detection and recovery of ghost pots.

Arthur Trembanis, Professor of Oceanography at University of Delaware School of Marine Science and Policy, explained that with the threats ghost pots present to the environment, it is critical to detect crab pots efficiently and completely in order to help guide clean-up efforts. "Annotating side-scan sonar mosaics is very tedious and time consuming for human operators especially when we have such a high abundance of targets and large areas to cover," said Trembanis. "Our initial training and testing with ATLAS has been encouraging. The ATLAS interface was easy to use and within about 30 minutes of annotation, the system was able to train and then operate over our entire map domain."

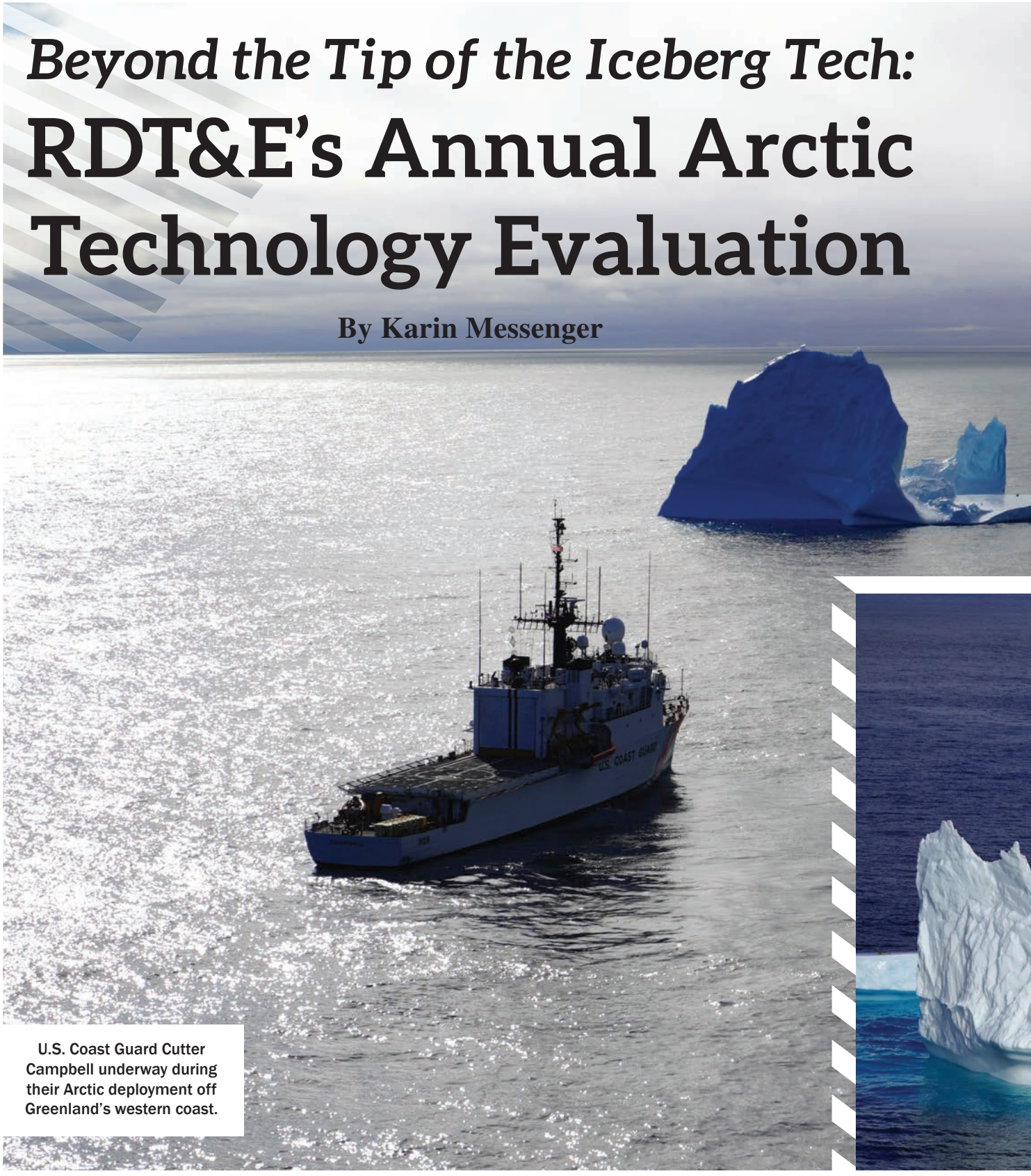
SPH Engineering/ University of Delaware

This project was supported by grant funding from Delaware Sea Grant, the School of Marine Science and Policy, and the NOAA Marine Debris Program.

The sample dataset can be found at bit.ly/2TDcAaB

Beyond the Tip of the Iceberg Tech: RDT&E's Annual Arctic Technology Evaluation

By Karin Messenger



U.S. Coast Guard Cutter Campbell underway during their Arctic deployment off Greenland's western coast.

U.S. Coast Guard Cutter Campbell engages In joint Arctic exercises with the Royal Danish Navy vessel HDMS Knud Rasmussen near the Jacobshavn Glacier in West Greenland.

U.S. Coast Guard photos by SN Kate Kilroy

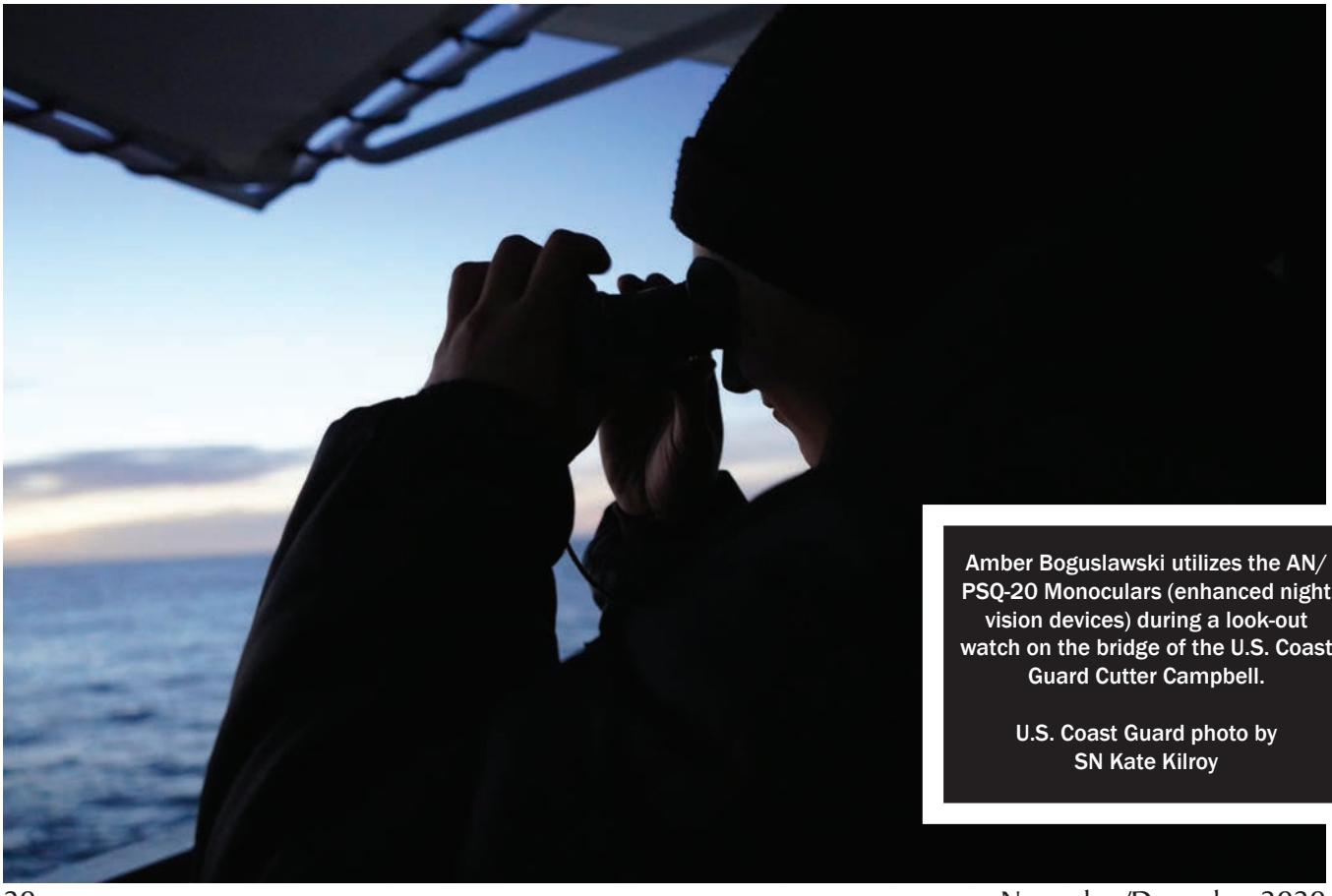
The Coast Guard Research and Development Center (RDC) teamed up with Coast Guard Cutter Campbell's crew this summer to evaluate five technologies as part of the RDC's annual Arctic Technology Evaluation. The Campbell crew conducted the evaluations during their two-month deployment supporting joint Arctic operations off Greenland's western coast, returning to their Kittery, Maine, homeport on Sept. 29, 2020. "Testing various technologies by cutter crews for operation in cold and Arctic environments provides highlights on what works and what may need improvement, and can help influence tactics, techniques and procedures," said Brian Dolph, who heads the RDC's Surface Branch. "This work directly contributes to two lines of effort in the Coast Guard Arctic Strategic Outlook: 'Enhance Capability to Operate Effectively in a Dynamic Arctic' and 'Innovate and Adapt to Promote Resilience and Prosperity.' "

The RDC adjusted its testing approach because of the COVID-19 pandemic; typically, at least one RDC staff member would be onboard the cutter as the lead scientist during testing. The year the RDC relied on detailed user manuals and technical reports produced for training and remote connectivity with the Campbell during testing. Matthew Lees served as the RDC demonstration director while Lt. Mathew Lara, Campbell operations officer, assigned duties aboard the ship.

The technologies selected for evaluation:

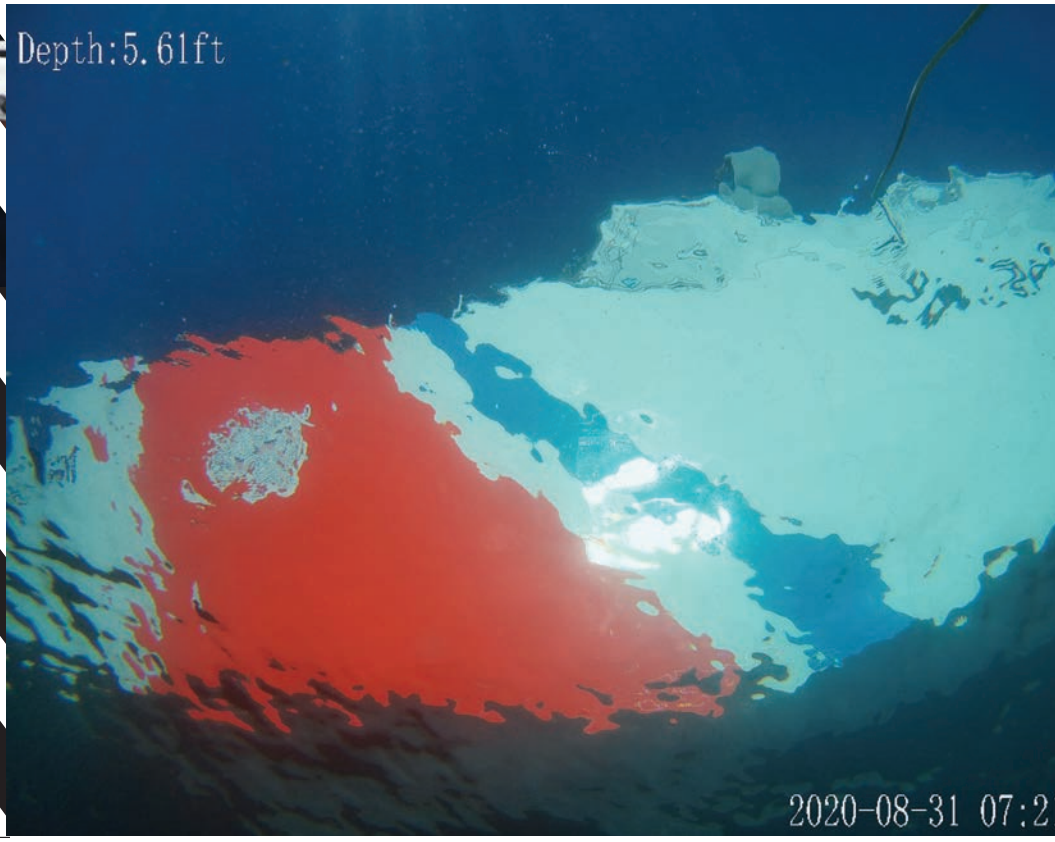
- Insight Mini Thermal Monocular (MTM) and AN/PSQ-20 Monoculars (enhanced night vision devices) for improved law enforcement and ice detection.
- Handheld Glare Helios laser for stand-off hailing capabilities.
- FiFish Remotely Operated Vehicle for underwater inspections in cold weather.
- Long Range Acoustic Device 500X-RE for enhanced communication with vessels at longer distances.
- Iridium Certus Terminal, which helped provide internet access for the crew to maintain communications with Atlantic Area.

ARCTIC TECH ON TRIAL: MONOCULARS



Amber Boguslawski utilizes the AN/PSQ-20 Monoculars (enhanced night vision devices) during a look-out watch on the bridge of the U.S. Coast Guard Cutter Campbell.

U.S. Coast Guard photo by SN Kate Kilroy



Above:
ENS Liam Middleton, LT Stephen Hills and ET1 Douglas Locklear run the FiFish Remotely Operated Vehicle (ROV) to inspect under the waterline of the CGC Campbell.

Right:
Screen grab from the FiFish Remotely Operated Vehicle (ROV) looking up at the CGC Campbell from below the water line.

U.S. Coast Guard photo by SN Kate Kilroy

MONOCULARS

The AN/PSQ-20 fused monoculars were evaluated on their ability to determine ice edge and targets of interest during normal watch operations; the technology was successful, especially at night. This technology allowed crew members to sight an iceberg quickly and give accurate data on size and shape.

The MTM was integrated via adapter cable to broadcast to the Campbell's displays to support law enforcement and flight operations. "These tools functioned well to identify land, shipping and icebergs at night, providing detailed images of objects. Highly recommend future use," said Capt. Thomas Crane, Campbell commanding officer.

HANDHELD GLARE HELIOS

The Glare Helios laser was tested in both day and night operations using a manned over the horizon (OTH) boat. During daylight hours, crewmembers onboard the OTH small boat detected the laser up to 8,000 yards from Campbell. During night hours, the laser was even more effective and could been seen over the horizon (approximately nine nautical miles). The Arctic environment did not hinder the operational ability of the Glare Helios.

The OTH crew reported it was immediately apparent the laser was pointed at them and believed the laser would be a valuable part of a boarding kit, especially when pursuing non-compliant vessels.

FIFISH REMOTELY OPERATED VEHICLE (ROV)

The Coast Guard recently authorized the use of low-cost ROVs to enhance the effectiveness of the fleet; this demonstration proved this technology is also viable in polar environments.

The demonstration highlighted maintenance efficiencies by reducing the number of crew-hours and risk to personnel required to perform time-consuming dives and providing on-demand inspection of hulls and piers.

LONG RANGE ACOUSTIC DEVICE (LRAD) 500X-RE

Underscoring the challenges faced during Arctic operations, weather conditions were generally not favorable for small boat operations, but the LRAD provided clear hailing and communication to small boats up to 500 yards away.

ARCTIC TECH ON TRIAL: LRAD

ENS Jordan Solseth runs a test for the Long Range Acoustic Device (LRAD) 500.

U.S. Coast Guard photo by SN Kate Kilroy

IRIDIUM CERTUS TERMINAL

One of the biggest challenges for polar operations is effective communication. The Iridium Certus Terminal was used in this evaluation to provide a communication method every day, allowing for the easy transmission of multimedia messages and even the establishment of phone communications within the contiguous United States for the crew. "We tested this frequently throughout the patrol to analyze and document the operational suitability. Integrated into the shipboard telephone system, it provided clear communications for command and crew to make operational and emergency calls. It also proved to be highly effective as a back-up internet option when our high latitude operations challenged other technology," Crane said.

Final results from these five technology evaluations are due at the end of the year.

Campbell also deployed 13 scientific research buoys ranging from the eastern shore of Nova Scotia to the Davis Strait. Daily images of icebergs were provided to the International Ice Patrol to validate and improve satellite reconnaissance. This effort allowed for real-time tracking and iceberg avoidance. "Varied scales of the operation area were readily available and provided over weekends, holidays and after work hours. This well-received, detailed, exceptional support greatly assisted in our operational planning and was critical to mission success," Crane said.

Campbell's crew also contributed to joint search and rescue exercises with the French and Royal Danish navies, facilitated key diplomatic engagements, and supported National Oceanic Atmospheric Administration and International Ice Patrol iceberg research during the 11,500-mile deployment. Campbell became the first 270-foot medium endurance cutter to earn the Arctic Service Medal.

"This effort strengthens international partnerships and provides a foundation for standard operations in the rapidly developing Arctic maritime environment," said Vice Adm. Steven Poulin, commander U.S. Coast Guard Atlantic Area. "As interest and maritime traffic in the area increase, the importance of the U.S. Coast Guard's interoperability with allied partners becomes more critical to ensuring we protect national and shared security interests. Exercising our unique blend of polar operational capability, regulatory authority, and international leadership across the full spectrum of maritime governance is vital to the future of the Arctic."

All Photos Courtesy Steve Hall, SUT

Steve Hall

Chief Executive, Society for Underwater Technology

Last month MTR interviewed Steve Hall, Chief Executive of the Society for Underwater Technology (SUT), for his insights on the growth, pace and direction of subsea technologies. Nuclear powered and nuclear armed AUVs? It's all on the table for Hall as he looks back on his career and tenure leading SUT, and ahead to his next chapter as the CEO of the Pembrokeshire Coastal Forum at the end of 2020.

By Greg Trauthwein

All Photos Courtesy Steve Hall, SUT

Steve, to start us off, can you give us a brief personal and professional background?

I suppose mine was fairly untypical background. I received a marine science degree back in the 1980s intending to join the Royal Navy. But with various defense cuts, that never happened. So, I found myself working as a surveyor in coastal surveys. I then became a customs officer, working as a specialist to oil refineries, supervising pipeline installations and tank integrity at large oil refineries. After three or four years of being a customs officer, my wife saw a recruitment advert for the "James Reynolds Center for Ocean Circulation."

I discovered it was a project called the World Ocean Circulation Experiment which has been put together by the International Marine Science Community. So I sent in my CV, and they got in touch and said, "Customs officer with a marine science degree, there must be a way we can use you." And the next thing I knew, I found myself working for the UK's Natural Environment Research Council. I ended up doing spectrometer work, gas chromatography work and going off to sea, usually the Southwest Indian Ocean, skirting around the edge of Antarctica out there in the Roaring Forties and the Fearsome Fifties, learning about what it is to sort of hang onto your bunk so you don't roll out at night. At the same time, I learned firsthand that incredible comradery you get from working with a small group of men and women in these research ships.

Yes, those are the sorts of destinations that, today, people will spend a lot of money to visit on a small expedition cruise ship.

(That's right) and (when you're our there) you're thinking, "Hey, I'm getting paid for this," as you wake up to the penguins on the iceberg. I did that for quite a long time. I worked for the research council right through to 2017. I supervised the move to the new National Oceanography Center when that opened. I ended up doing a long stint with the Autosub, autonomous underwater vehicles program as a project manager there. Then I moved more into the climate change side of work. My last decade in public service (was spent) on the policy end of the spectrum, helping governments draft laws and policies, developing the UK's Marine Spatial Planning system, contributing to the UN system on how we look after resources in areas outside national jurisdiction, and also the law as it pertains to marine autonomous systems.

> ***And the other industry which I think is going to be absolutely vast, and we're just at the very beginnings of it now, is hydrogen.*** *That is going to be massive. Whether it be blue hydrogen, the hydrogen that's being derived from natural gas, and then you capture the carbon and put it back into the rocks, or whether it's the green hydrogen, hydrogen that's been electrolyzed from sea water using renewable electricity.*

In 2017 the opportunity to join SUT as the chief executive, so I applied for and got the job.

Obviously I assume our readers know SUT well, but can you give to us an overview, a "by the numbers" look at SUT today?

We are an international marine learning society formed in 1966. Many of the original members of SUT were Royal Navy, mine clearance divers, military divers for the most part who in their off-duty hours were out (diving and) discovering. One of the reasons they formed a society was so that instead of just going out, having a dive and coming home, they could actually write up what they had seen.

As that group went on to do other things (many of them ended being the first generation of hard-hat divers in the North Sea), SUT quickly moved on from its original scientific diving/marine archeology/defense diving side into being a society, still very diving dominated but increasingly moving into the oil and gas sector, particularly as the North Sea expanded. So the society carried on growing through the 1970s and 80s, budding off into other countries, particularly where there's a strong oil and gas sector.

Is SUT still focused primarily on offshore oil and gas?

There are other part of the membership; you have a London branch focused on oil and gas, but also other things like marine autonomous systems and marine spatial planning. Increasingly, there are new people from other sectors, such as insurance, law, finance, coming in. And then we have branches in Newcastle that are much more interested in the offshore renewables side, (an area) which is growing rapidly in our membership. There is quite a significant defense interest as well, and the major marine universities tend to have membership too.

Like similar societies, we have a number of special interest groups. So you have groups interested in things like salvage and decommissioning, broad underwater technology, in diving and manned submersibles, even things like hyperbaric medicine. And there's a small but very active group of media divers, the sort of people that make James Bond movies.

The "Hollywood" end of the business sounds, pardon the pun, entertaining!

One of the most popular annual trips we do is to go down and visit Pinewood Studios near London with some of our media divers, who show our members how they work, how they stage these extraordinary scenes. There are many wonderful stories of well-known Hollywood actors and actresses who may not have ever done a day's diving in their life who are suddenly expected to do quite a dangerous stunt. They have to keep them in the tank with the mouthpiece in until the last possible moment and hoist them out and stick in the stunt person, lest they accidentally bump off their multi-million dollar actor. An interesting bunch of people, and some real characters, some that have been with us literally from the start.

Really, members since SUT was founded in 1966?

We still have some that joined us in the 60s, some of whom are still diving, still making discoveries. We've got one guy – Dr. Nick Fleming – who lost the use of his legs years ago in a road traffic accident. He's still out there in his 80s diving, making scientific discoveries, he's really interested in drowned landscapes, the places where humans used to live that have been lost to sea level rise over the centuries. You meet characters like that, and they're truly inspiring human beings that make you think, "Wow, I hope I can still be as fit and active and interested as that when I get to their age." SUT has a terrific heritage.

When you look at the last three years you've spent there, what do you count as the society's greatest achievements?

I'd say to me it's increasing our footprint in new territories. That's been significant. We're growing well now in China, we have the new branch out in the Middle East, and this one that's just starting in Canada.

For the first time, we're sponsoring

PhD students; we never did that before, and it's been done through the generous help of the Sonardyne Foundation.

And the other thing, which is literally just starting, that I think will go a long way is that in partnership with Marine Technology Society and with the Institute of Marine Engineering, Science and Technology, we've now introduced the possibility for our members to pursue chartered status. So the first cohort of volunteers, the Guinea pigs, as it were, are going through at the moment.

So when you start looking ahead, where do you see opportunities for growth in the sector.

We have already seen that there's this huge take-up of offshore wind, which is now transitioning to being offshore floating wind. In China, I've seen the first examples of floating solar, and I think that's going to end up being a huge industry as well. We're seeing this massive take-up of autonomy both from things like the offshore survey systems, but also in the defense field. And the other industry which I think is going to be absolutely vast, and we're just at the very beginnings of it now, is hydrogen. That is going to be massive. Whether it be blue hydrogen, the hydrogen that's being derived from natural gas, and then you capture the carbon and put it back into the rocks, or whether it's the green hydrogen, hydrogen that's been electrolyzed from sea water using renewable electricity.

And I suspect that by the time we get to 2030 the offshore hydrogen industry is going to be massive. Hydrogen, I think, is going to be key to being able to decarbonize things like locomotives, ships, trucks, for example. The small private automobile is going to be fine running on batteries, but fuel cells is where it's going to be at for large-scale, heavy duty use.

The push for decarbonization is driver in many sectors?

Even if CO2 had no effect whatsoever on (the earth's) temperature, we know it's changing the acidity of the oceans, we've got to tackle that. And then you have all those associated things like sea level rise, which is going to end up killing an awful lot more people than temperature rise will. There's some very serious issues as you start melting Antarctica and Greenland. And we're not just talking 30, 40 centimeters of sea level rise, we're talking meters. We'll still need oil for all those 1,001 other things that you use oil for, we'll still need gas, but probably not in the quantities we need them today. And I think the other big area we'll see a lot of development in is aquaculture.

Aquaculture?

You could say that the way we look after the ocean is like we never evolved from "hunter gatherer" mode.

In land use centuries ago, folks figured out how to plant a crop and to not bother chasing mammoths around the savannah anymore. But in the oceans, we still pretty much behave like those cavemen. We're sending out these ships, catching all the animals, and of course there's no big fish left anywhere. And I think one of the other big cultural and societal changes we will see over this next half century is a gradual shift from wild-caught fishing into managed aquaculture-based systems, maybe on a really large scale, ocean ranching rather than fishing.

It requires changes in the law, changes in ownership models, but we'll see a lot of this. And there's some fantastic work being done, particularly in the U.S., companies like BlueNalu and Finless Fish doing some fantastic work now using in-vitro technologies, cellular agriculture to be able to make fish without the thing ever having swam in an ocean, just making fish flesh.

So there are lots of changes and crossover between all of the different marine technology sectors, because the technology used on one side will be a

value to somebody else as well. I don't think we'll see quite so much of this kind of 'silo mentality' in the future where folks land (and stay in) just one sector. I think we're going to see a lot more flexibility, particularly from the kids as they come through and maybe spend some years in industry, then go across to academia, maybe then over into government, then back into industry throughout a long career.

It's one of the valuable roles the learning societies and professional bodies play is acting as perhaps that spine that follows them through that long career. So we're going to see a lot of changes, and that will be where publications like Marine Technology Reporter have an important role as well in maintaining and building that community as people spread out into such a wide range of other interests.

There are a lot of organizations and professional societies, there are also a lot of distractions for people today ... everyone is busy. When you look at SUT, what makes it unique? What do you taut as the chief value of being a member?

I'd say the chief value of SUT is the networking, meeting people who don't do exactly the same thing as you, but

> ***"We care about what our colleagues are doing, whether they're out in the South China Sea or if they're off the coast of Africa or in the middle of a North Sea storm ... everybody is facing those same hazards, the same beauty, the technical challenges.***
>
> *How do you anchor a wind farm in turbulent waters? Is it possible to extract manganese nodules or ferromanganese crusts from the deep sea bed without completely destroying the local ecosystem? We're all aware of these challenges. And even after all of these years, there's so little of the deep ocean floor that we've really explored."*

All Photos Courtesy Steve Hall, SUT

> *So here we are in the first quarter of the 21st century, and we're* ***still using a 1907 piece of legislation which was never intended to apply to a nuclear robot with a whopping grade thermonuclear nuclear warhead on the end of it.*** *And I think both in the defense sector and also in things like autonomous shipping, we really need to start getting our grips not just on the technology, which is moving ahead at a fantastic pace, but make sure that our policy and legal frameworks are keeping pace with how the technology goes.*

they're operating in the same medium. People united simply by their use of underwater technology. And it might be something like filming a James Bond movie, or it could be about capturing and storing carbon dioxide, or it could be learning about how we're going to safely and sustainably mine the sea floor in the future. And the only kind of common denominator that ends up linking all those people is they're working in this kind of cold, corrosive, dangerous environment that's also extremely beautiful and quite an inspiring place.

Very few people who ever go to sea who are lukewarm about it. They either love it to bits or they hate it, and never go back again. I tend to find that a lot of the people who work in marine, even if they're doing a job which folks might think of as kind of a 'dirty and polluting' job, they care deeply about that marine environment. I've never met an oil worker who wants there to be an oil spill. They learn to value that space that they work in, and they care very much about it.

The other thing which is very noticeable is the lack of national boundaries; people think of themselves as mariners first. It's like how back in the Cold War, the first people to be horrified when they heard about the sinking of a Russian submarine or something would be the service men working on the U.S. or the Royal Navy submarines.

I think you find that in our community full stop; we care about what our colleagues are doing, whether they're out in the South China Sea or if they're off the coast of Africa or in the middle of a North Sea storm ... everybody is facing those same hazards, the same beauty, the technical challenges. How do you anchor a wind farm in turbulent wa-

> *So I think it is a challenge for society as a whole to encourage people to understand that there is one planet, one ocean, that we're all interconnected.* ***And that ocean that used to divide us all is actually the thing now which unites us.***

ters? Is it possible to extract manganese nodules or ferromanganese crusts from the deep sea bed without completely destroying the local ecosystem? We're all aware of these challenges. And even after all of these years, there's so little of the deep ocean floor that we've really explored.

I was privileged to be talking online to Don Walsh recently, who of course famously went down to the bottom of the Marianas on the Trieste in 1960. Don is an inspiring guy because he helps remind you that, until very recently, more people have walked on the moon than have ever visited the deepest parts of the ocean. There are still enormous gaps in our real knowledge about what's happening down there in the depths. Now, we're constantly having surprises discovering creatures we never knew about, geological processes that are new to science, and there's still an awful lot to learn.

One of the things that excites me is that the technologies and techniques we're learning on this world will be the things we end up applying in other worlds in the future as well. I'm sure your readers will be very familiar with some of these proposals for missions to Jupiter's moon Europa, for example, and being able to put autonomous vehicles into these waters, getting under the ice, looking at the hydrothermal vent fields that we might find on Jupiter's moons and discovering who knows what down there.

That's really an exciting thing is if you're in your 20s or 30s now, because it's probably going to happen in your working life. If you're doing your doctorate in engineering right now, there's a pretty good chance that before you retire that the vehicles that you helped design may well be exploring the sea bed of other worlds.

This is a transcendent time for the subsea industry with the convergence of drivers and technologies. When you look at the market today, what do you count as the top two or three drivers that are really moving the ball forward?

Although not all countries are taking part, the planet as a whole is moving fast towards decarbonization. And in fact, the countries that don't do it are going to find themselves at a significant competitive disadvantage because they'll find that their competing countries will move to a whole new level of technology, and they're still burning oil. That policy driver, the need to decarbonize, is certainly changing things quickly. And it's not just the technology that is changing, it's things like the investment space. We've seen these divestment campaigns, there's moves to say that unexploited hydrocarbon resource should be shown as a liability rather than an asset on a company's balance sheet, for example.

And it's those big policy changes that are sitting there in the background that I think will end up being a significant driver. When you've got a pension fund worth billions refusing to invest its money in a company because it hasn't transitioned towards hydrogen or wind or solar, that ends up being a significant commercial pressure; that kind of policy finance space almost forces the technology. We've got a pretty good idea how to decarbonize society, but the other big challenge is energy storage, and that's a big one. There's 101 different ways to make energy out of the ocean, lots and lots of different ways of doing it. But how do you store that energy for demand peaks, or for days when the wind doesn't blow or the sun don't shine?

There is one other thing I should mention too. I first started working with marine autonomous systems back in about 1997-98, and they are becoming pretty advanced now, and they're going to get more and more advanced as the years go by.

And we recently saw our friends in Russia deploy the first prototypes of something they call Poseidon, the NATO reporting name Kanyon, which is basically a nuclear powered and nuclear armed autonomous underwater vehicle for military purposes. Now,

that's fine, it's Russia's business if that's what they want to deploy, it's their sovereign right to do that. But in regards to marine law, these things evolved over hundreds of years going back to how far could you fire a cannonball. And as far as I can tell, if you try to look at what laws regulate of what you can do with an autonomous system, I think you're looking at the 1907 Hague convention part eight which regulated rules pertaining to torpedoes and sea mines.

So here we are in the first quarter of the 21st century, and we're still using a 1907 piece of legislation which was never intended to apply to a nuclear robot with a whopping grade thermonuclear nuclear warhead on the end of it. And I think both in the defense sector and also in things like autonomous shipping, we really need to start getting our grips not just on the technology, which is moving ahead at a fantastic pace, but make sure that our policy and legal frameworks are keeping pace with how the technology goes.

I can easily see a situation perhaps 10 years from now where you may have quite significant marine conflict going on with probably scarcity of human sailor anywhere involved.

Obviously SUT has a lot of technology under its guise. Is there one that you see particularly literally important or instructive in pushing this industry forward faster in the coming years?

The general trend is taking humans off platforms, whether it's taking them off oil and gas production systems or whether it's taking them off ships. I think the movement towards putting human crew back into shore bases is going to be one of the most significant changes we see in the next few years. And it might be quite a surprise to our descendants 50, 60 years from now who realize, "Hey, do you know back in the 2020s people still actually worked on oil and gas platforms," or, "they actually went out on fishing boats," or, "they went out on ships?" Perhaps in some ways it's a shame because I think there's a great deal to be said for actually having people out there in that marine environment.

It's easy to forget that we're surrounded on all sides by ocean and that well over 90% of all of our trade arrives on a ship. When you get that shiny new pair of trainers from China, that didn't fly in. A lot of our food is coming in that way, our energy is coming in that way. And I think this general kind of almost marine awareness is dropping out of the population in some ways. And if it's happening in an island country like the UK, you can imagine even more so for folks who live in landlocked places far away. So I think it is a challenge for society as a whole to encourage people to understand that there is one planet, one ocean, that we're all interconnected. And that ocean that used to divide us all is actually the thing now which unites us.

When you use your career as bookends, what do you consider to be the one technology that has most made the business of working under water efficient?

I would say marine autonomous systems in recent years. That's the thing which has certainly transformed the cost base. If you want to get data (from the ocean or under polar caps) relying on ships is doable, but expensive, with a big crew and a lot of technology behind you. Now, you can have almost disposable in the single use systems that can go out there in the midst of a wild storm, gather the data that your farmers and your planners need for better weather forecasting and all of those other things from these little yellow robots that are out there just constantly feeding data in and slowly beginning to make the ocean transparent.

There's a long way to go, there are still massive gaps in our knowledge about the ocean. But the gaps are getting smaller. The robotics, the autonomy side has really changed things in my working life.

One final question: we understand that your time with SUT is coming to an end; what's next for Steve Hall?

I live in South Wales although I work in London and the other SUT centers. And to be honest, you don't often get an opportunity to do really interesting marine science technology and policy job in my own home area, they don't come up very often. So the opportunity came up with an organization called the Pembrokeshire Coastal Forum, which a number of projects, including Marine Energy Wales, which is looking after the introduction of floating offshore wind off the West coast. They're also interested in sustainable coastal tourism. The vision of the organization is basically a sustainable coast and ocean. And the opportunity for new CEO came up with Pembrokeshire Coastal Forum and I thought, "Well, now this one sounds too good to give a miss too," so I applied, and I got it. I'll be starting at the end of December. I won't disappear entirely from the SUT world, as I'm still a member and fellow of the society. So I'll certainly carry on engagement with helping to grow the society internationally there and encouraging our links to MTS, IMarEST and others. I don't disappear completely, but I'll be focused much more on that kind of sustainability piece and the green issues, things like sustainable coastal tourism, sustainable marine energy, aquaculture, sea level rise, adapting coastal regions to a rapidly changing world. That will probably be how I see out the remainder of my full-time working life. And for the first time in, well, I think since 1987, I'll actually have a job in the same country I live in. So I'm quite looking forward to that challenge as well.

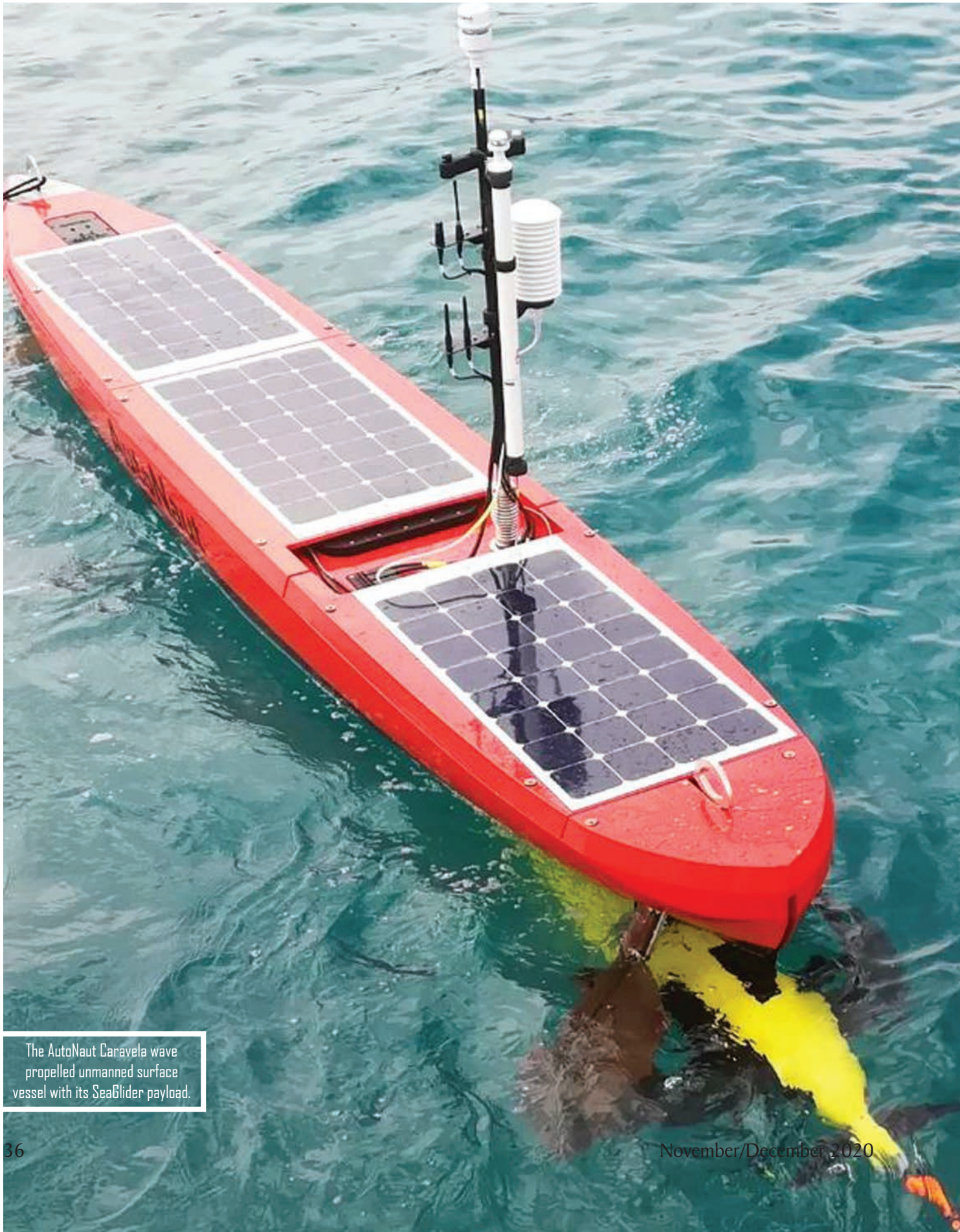
Caravela and her payload before deployment to warmer climes.

All images Autonaut

UNMANNED MARINE SYSTEMS, SQUARED.

Unmanned platforms and underwater vehicles have been providing new ways for ocean scientists to study the ocean in more detail and over longer periods. What happens if one can deploy the other?

By Elaine Maslin



The AutoNaut Caravela wave propelled unmanned surface vessel with its SeaGlider payload.

AutoNaut's Caravela at sea.

All Images Autonaut

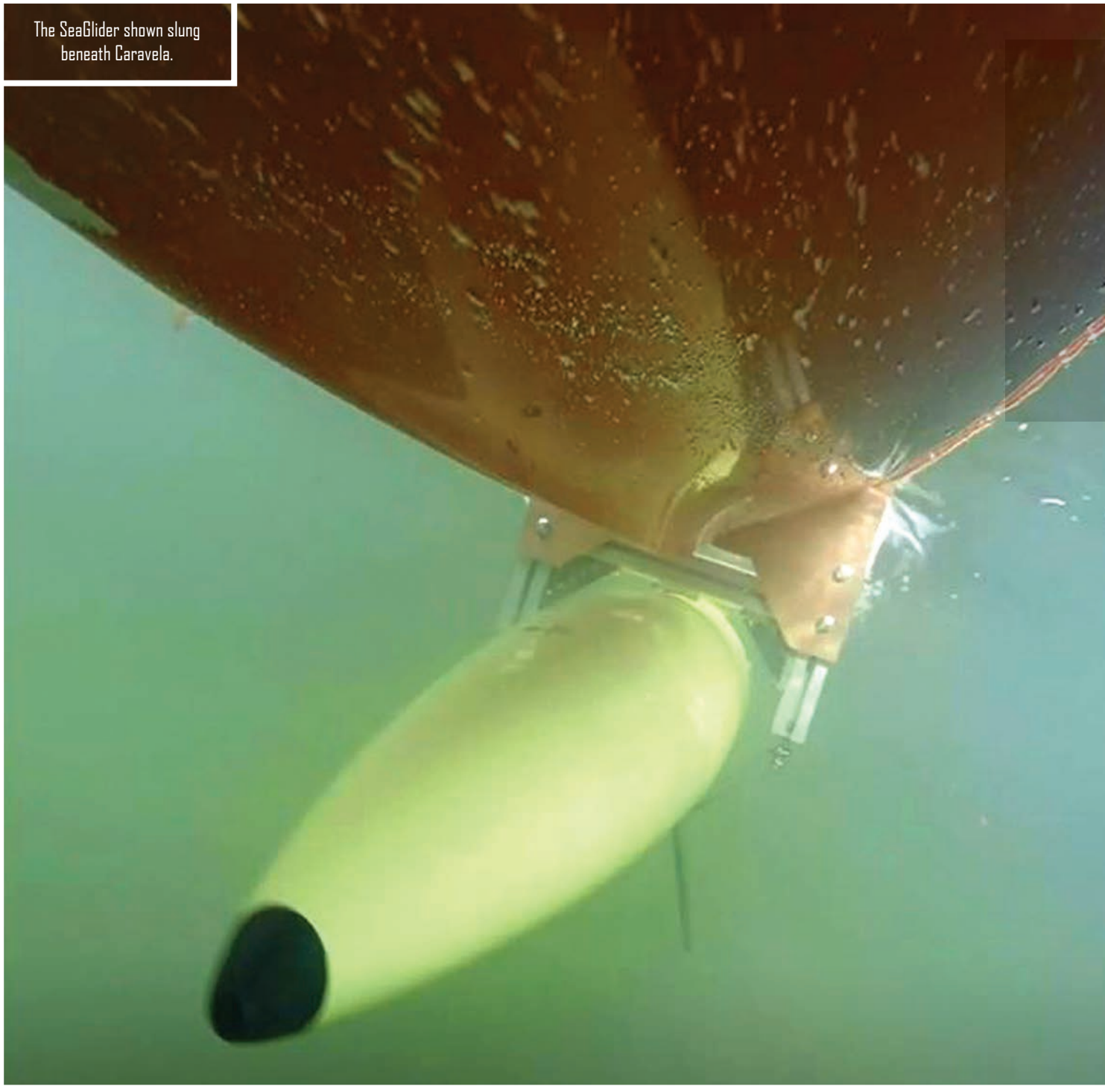
The advantages of unmanned systems deploying others are multiple, not least in our expansive oceans. Deploying a glider (down to 1,000m) using a wave-propelled unmanned surface vessel (USV) means data can be gathered together over long periods at far flung locations without the need for a crewed research vessel to deploy either system, which can be hard to get slots on, let alone funding.

But then, what if you also want to try deploying such a system in high latitudes; the Antarctic, for example? The Universities of East Anglia (UEA) and Exeter (UoE) and wave-propelled USV maker AutoNaut, and other academic partners, have successfully tackled the first challenge and now they're working on the second, through a number of related projects.

"This sort of technology offers a lot of opportunities for us," says Karen Heywood, who leads the glider program at the University of East Anglia (UEA), and who came up with the idea. "It means we can deploy gliders or other vehicles in the middle of the ocean without having to send a ship there. We can be more efficient. We can choose when to deploy it," she told the Marine and Autonomous Technology Showcase (MATS) conference last year. "AutoNaut can sit and wait for a Tsunami, an eruption or spring bloom and can also deploy into places too dangerous to go for a manned vessel. And they can get simultaneous measurements. In Antarctica that's very important."

Gliders, being buoyancy driven so using little power, are long-endurance vehicles so they're great for gathering ocean data. But because they don't travel very fast (average 1 knot), getting to a site of interest can take a long time and once there they're work is beneath the waves, so they can't also gather meteorology data, says Heywood. They're also hard to deploy from inshore, because they need a certain amount of depth to be able to move forward in their seesaw motion. The AutoNaut can travel faster (up to 3 knots) to an area of interest to deploy a SeaGlider, gather surface data and provide a GPS location.

Attaching a SeaGlider to the AutoNaut was a mechanical challenge led by Alastair Nichol, lead mechanical engineer at AutoNaut. It had to be as



The SeaGlider shown slung beneath Caravela.

fool proof as possible, robust and able to cope with biofouling, he says. Ideas such as carrying SeaGlider on top of the AutoNaut and or towing it were set aside. Instead, a way to carry it underneath, mid-aft, in order not to interfere with the AutoNaut's wave propelled propulsion (which relies on the bow moving up and down to an extent), with a release mechanism that could be triggered by a remote pilot, over satellite, was designed. The result is a circular, stainless steel hinged clamp which is loosened, via a linear actuator, which releases a spring, which pushes a rod (the only part that penetrates the hull), opening the clamp enough to allow the SeaGlider out. The SeaGlider's tail fin

"AutoNaut can sit and wait for a Tsunami, an eruption or spring bloom and can also deploy into places too dangerous to go for a manned vessel. And they can get simultaneous measurements. In Antarctica that's very important."

– Karen Heywood, Leader of the glider program at the University of East Anglia (UEA)

slots into a gap in the AutoNaut's stern cone, preventing it moving during transit. As this is where the AutoNaut's single rudder normally goes, a new rudder arrangement had to be designed. Then, to stop the SeaGlider dropping out haphazardly when it's released, potentially damaging its sensors, its nose is guided by a track along the bottom of the AutoNaut as it slides out until it's clear enough to allow more movement.

Earlier this year, the design was put to the test. An AutoNaut USV called Caravela, which had been modified to be able to carry and then deploy a Hydroid SeaGlider, "Humpback", was deployed from the coast of Barbados as part of the multi-platform EUREC^{4}A project. Caravela sailed out to sea and then deployed Humpback, staying out for 35 days, before heading back to shore, with the SeaGlider later recovered by a vessel.

Following the successful deployment of Caravella and Humpback off Barbados, the focus is now on deploying this system in high latitudes, in areas including the Roaring Forties and Furious Fifties, which poses a whole new set of challenges, from icing or hitting ice to harvesting enough energy to continue to power onboard instruments when it's too dark for solar panels. Operations in high latitudes would help fill the dearth of data from the Southern Ocean and Arctic, especially in winter.

For this project, AutoNaut is working with UEA and UoE under an Innovate UK funded AutoNaut for extreme environments project. There's been focus on ruggedization, anti-icing, ice-detection and avoidance, biofouling and energy harvesting, says Phil Johnston, business development manager at AutoNaut. That's included hydrophobic coating testing at the Roland von Glasgow air-sea-ice chamber at UEA and tests by Plymouth Marine Laboratory using three forward looking sonars and a deck mounted thermal camera. The UoE has also developed a pendulum motion energy harvester and Nichol has been redesigning the AutoNaut's wave propulsion system to transfer the energy from its foils more efficiently – trials of which have already proven positive, he says.

One intriguing result of the testing has been that with a thin layer of ice, AutoNaut's solar panels actually see an increase in efficiency, before it deteriorates as the ice thickens. The team has also learned that metal inserts – used all over the USV to hold panels on, etc – work their way out under icy conditions, so needed changing, says Nichol. Instead of more traditional biofouling paints, which leach copper, the project is looking at a type of vinyl, creating a Teflon-like surface.

Increasingly AutoNaut's USVs, including a sensor payload in a fin unit, have been made easier by the use of 3D printing, says Nichol, which not only makes producing parts (mostly with a nylon resin) easier (e.g. moulds don't have to be made to create some parts and the amount of complex machining is reduced), but also allows for more flexible design, i.e. it's not constrained by manufacturing methods. The stern cone, fins and hull mounts have all been 3D printed, for example. However, while 3D printing has been adopted for many AutoNaut components, they're reverting to glass fibre for the foils for the extreme environments USV, mainly for additional strength, says Nichol.

Other work has involved resilience trials – dropping a full-size USV from 5m at "unfair" angles (AutoNaut is already storm proven in the Atlantic, capsizing and self-righting in large breaking waves) and impact testing with blocks of ice. But it's not all about physical characteristics of the USV – there's also been work on neural networks and artificial intelligence to manage and summarise data gathered so data can be transmitted in real time via satellite to shore.

The result – being built at the time this article was being written – is expected to undergo initial trials this October-November.

INSIDE THE DE MAAS' OFFSHORE FISH FARM

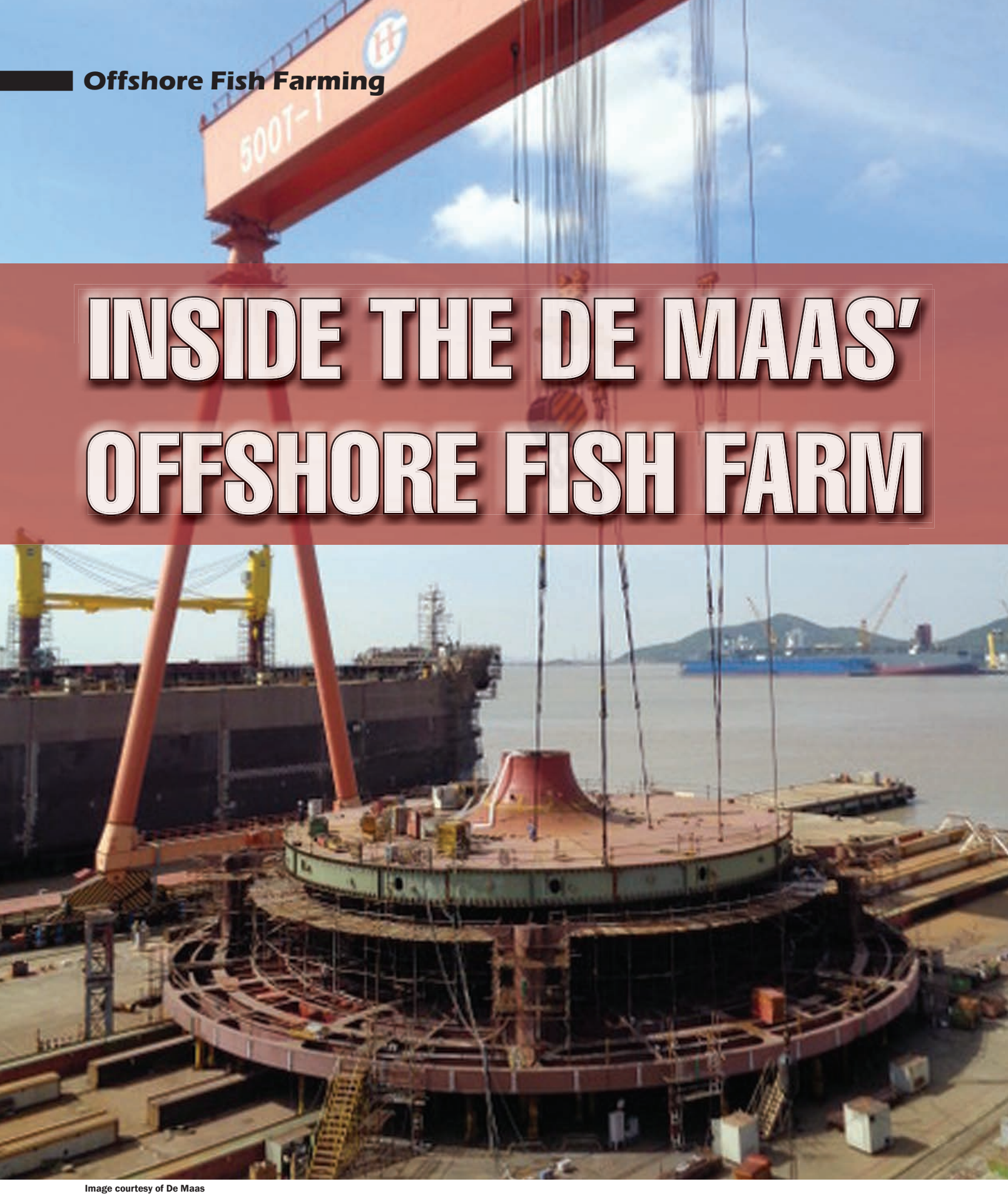


Image courtesy of De Maas

As attention increasingly turns to ocean health and sustainability, an innovative new fish farm solution was deployed earlier this year when the De Maas' Semi-submersible Spar Fish Farm (SSFF) became the world's first offshore farm installed at an open ocean location exposed to tropical storms. MTR recently visited – virtually – with co-founder Philip Schreven for insight on the design and operation particulars of their innovation.

By Greg Trauthwein

Maintenance draft - Straits One with cage fully out of the water

All images courtesy of De Maas

How did you became involved in this unique niche of the maritime industry.

Mark van Leeuwen and I founded De Maas in 2007 as an offshore oil and gas services company. Both Mark and myself did our Master's at Delft University of Technology in The Netherlands. After a short while working in Europe we decided to go to China and, together with many colleagues, were part of building Yantai Raffles Shipyard (today CIMC Raffles) from 2001 to 2007, delivering many first-off support vessels, offshore floating platforms and drilling rigs.

Whereas De Maas' bread and butter business concerns the provision of engineering, quality supervision and project management services to a range of international clients in the oil and gas and renewable energy sector, offshore aquaculture first came on our radar in 2015 when we noticed a Norwegian salmon farmer building their first offshore aquaculture unit in China. This raised our interest and, after doing thorough international market research from both our offices in The Netherlands and China, we decided to start investing in the development of our own solutions.

As most countries do not have a regulatory framework spe-

"As most countries do not have a regulatory framework specifically for the offshore farming unit, we teamed up with ABS to ensure the unit would be fully approved and certified."

– Philip Schreven, co-founder, De Maas (pictured above left with co-founder Mark van Leeuwen, right)

cifically for the offshore farming unit, we teamed up with ABS to ensure the unit would be fully approved and certified. As at the time there were no specific ABS standards for this type of unit so we used the standards for offshore oil and gas units and floating renewable units. At the same time we have been working with ABS to develop a separate guideline and certification for offshore aquaculture units.

Please give us a 'by the numbers' look at your organization today.

The first unit, the SSFF150, was recently installed offshore Fujian Province in China by the EPCI contractor, and for this project we provided a range of services based on our patented technology.

Technical and commercial research and development for further units continued since the first unit was under construction. We are presently preparing for series of units in Europe, the Americas and Oceania for a range of species including salmon. Essentially the market is being developed alongside upgrades in technology. As in the oil and gas industry, each offshore farming unit requires tailoring for local environmental conditions, farming practices that relate to the various spe-

cies and market conditions.

At present we are spinning off our offshore aquaculture team of around 15 people into a newly set-up company, Pan Ocean Aquaculture (POA), that will handle all commercial, marketing and R&D work and is based in The Netherlands. De Maas will continue to provide the construction and delivery of SSFF units and take care of our projects for other industries.

Please provide a detailed timeline for the project, from initial contract through final installation.

The first project was a prototype and for us only covered a part of a total offshore aquaculture development; it is not a typical example. Generally, for the projects we're currently handling, from start of application of an offshore farming license until first harvest would take about 4 to 5 years. A range of factors such as government regulations, existing onshore infrastructure and characteristics of species impact this duration. Although obviously not insignificant, the offshore unit is but one part of a suite of arrangements that have to be in place to get to a first harvest. Purely the EPCI part of the offshore unit of such a project would probably be around 2-3 years alongside many other activities.

We understand that this was a world first "installed at an open ocean location exposed to tropical storms." Were other locations considered, and more importantly, why was this location deemed most desirable.

The location is primarily determined by the species and farming strategy. Environmental conditions dictate whether a certain species will show good growth curves in a certain area. Once a selection has been made it becomes a matter of government approval and you go through similar hoops as for any offshore activity in order to obtain permits. Every country has different arrangements and requirements so this preparatory phase can be quite time consuming as you also have to verify in principle whether the unit can be tailored for the location. The SSFF has been designed such that is can be installed in the widest range possible and accommodate also for a wide range of species. This was one of our boundary conditions

All images courtesy of De Maas

2

3

All images courtesy of De Maas

when developing the original concept.

The location for the first unit was selected by the owner and operator, i.e. the farmer - the species farmed, Large Yellow Croaker, has specific needs in terms of environment and the farmer considers the current location to be optimal. Traditionally, nearshore farming of large yellow croaker takes place along the coast of Zhejiang and Fujian province. Waters further offshore, east and north east of that area are the fish's original natural habitat. Albeit that the wild yellow croaker travels a lot more through the seasons - farmed yellow croaker over the years has adapted to a certain range of conditions.

What were the chief challenges of this project?

Out of the near endless list I'd say that the main challenge was the fact that for every aspect of the project, the project was a first. Legislation, experience of stakeholders, organization, commercial set-up all had to be dealt with for the first time with many stakeholders having different view and motivations.

Who were your key partners, with insights on each expertise and deliverable.

As provider of engineering our main partner has been ABS.

Storm Draft - Straits One with cage submerged

All images courtesy of De Maas

The EPCI contractor was responsible for selecting vendors and worked with mostly domestic partners. For our new projects POA will be the EPCI contractor and so we'd be integrating the main suppliers to a much larger extent into our work. Familiar companies from the oil and gas industry such as Kongsberg, Jotun, Caterpillar, Siemens, etcetera also supply their solutions to the offshore aquaculture industry. ABS will of course remain our partner for all certification and we'll work together to further update standards.

When you look at the potential for the offshore fish farm market holistically, globally, what do you see?

The reason for having invested into this business is because we see a market globally. Apart from certain onshore RAS farms, sustainable seafood of the highest quality can be farmed only offshore. Nearshore capacity has been reached in countries that are currently large producers and overall sustainability of nearshore aquaculture has lead in any case to substantial pollution and other adverse effects on nearshore stakeholders (recreation, renewable energy, etc.). Wildcatch has been declining over the past decades and although it will obviously continue, offshore aquaculture will increasingly be providing a sustainable balance to the mix of seafood supply.

All images courtesy of De Maas

MARINE TECHNOLOGY REPORTER

2021 Editorial Calendar

January 2021

Underwater Vehicle Annual

- Underwater Defense
- Manipulator Arms and Tools
- Autonomous Navigation GNSS MEMS
- Unmanned Vehicle Propulsion
- Hydrophones

Event Distribution:

Subsea Expo
February 23-25 Aberdeen, Scotland
Underwater Defense and Security
March 2-4 Southampton, UK
Ocean Business 2021
April 13-15 Southampton, UK

Digital Edition

MTR E-Magazine Edition:
Oceanographic

March 2021

Oceanographic Instrumentation & Sensors

- Offshore Energy: O&G and Renewables
- Fiber Optic Cables, Connectors & Slip Rings
- Buoyancy Technology
- Scientific Deck Machinery / LARS

Event Distribution:

OTC
May 3-6 Houston, TX
Oceans Europe
May 17-21 Porto, Portugal
Underwater Technology Conference
June 2021 Bergen, Norway

May 2021

Hydrographic Survey Sonar

- Comms, Telemetry & Data Processing Software
- USV Platforms
- Magnetometers & Streamers
- GPS, Gyro Compasses & MEMS Motion Tracking

Event Distribution:

Seawork:
Jun 15-17, Southampton, UK

Digital Edition

MTR E-Magazine Edition:
Hydrographic

July 2021

Autonomous Vehicle Operations

- Subsea Electrification & Residency
- ROV Technology: Work Class to Micro Systems
- Thruster Tech: Underwater Propulsion
- Underwater Tools & Manipulators
- Beacons, Flashers & Tracking Systems

Event Distribution:

Offshore Europe:
September 7-10 Aberdeen, Scotland
Oceans
September 20-23, San Diego

September 2021

MTR100: Focus on 100 Leading Companies, People and Innovations in the Subsea Space

- Interconnect: Underwater Cables & Connectors
- Offshore Inspection, Maintenance & Repair (IMR)
- Underwater Imaging: Lights, Cameras, Lasers & Multibeam Sonars

Event Distribution:

Europort:
Nov 2-5 Rotterdam, Netherlands

November 2021

Ocean Observation: Gliders, Buoys & Sub-Surface Networks

- Acoustic Doppler Sonar Technologies ADCPs and DVLs
- Instrumentation: Profilers, Samplers & Sediment Corers
- Fresh Water Monitoring & Sensors
- Seafloor Mapping
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Underwater Navigation Powered by Sound

Approach could spark an era of battery-free ocean exploration

By Dan Ackerman, MIT News Office

GPS isn't waterproof. The navigation system depends on radio waves, which break down rapidly in liquids, including seawater. To track undersea objects like drones or whales, researchers rely on acoustic signaling. But devices that generate and send sound usually require batteries — bulky, short-lived batteries that need regular changing. Could we do without them?

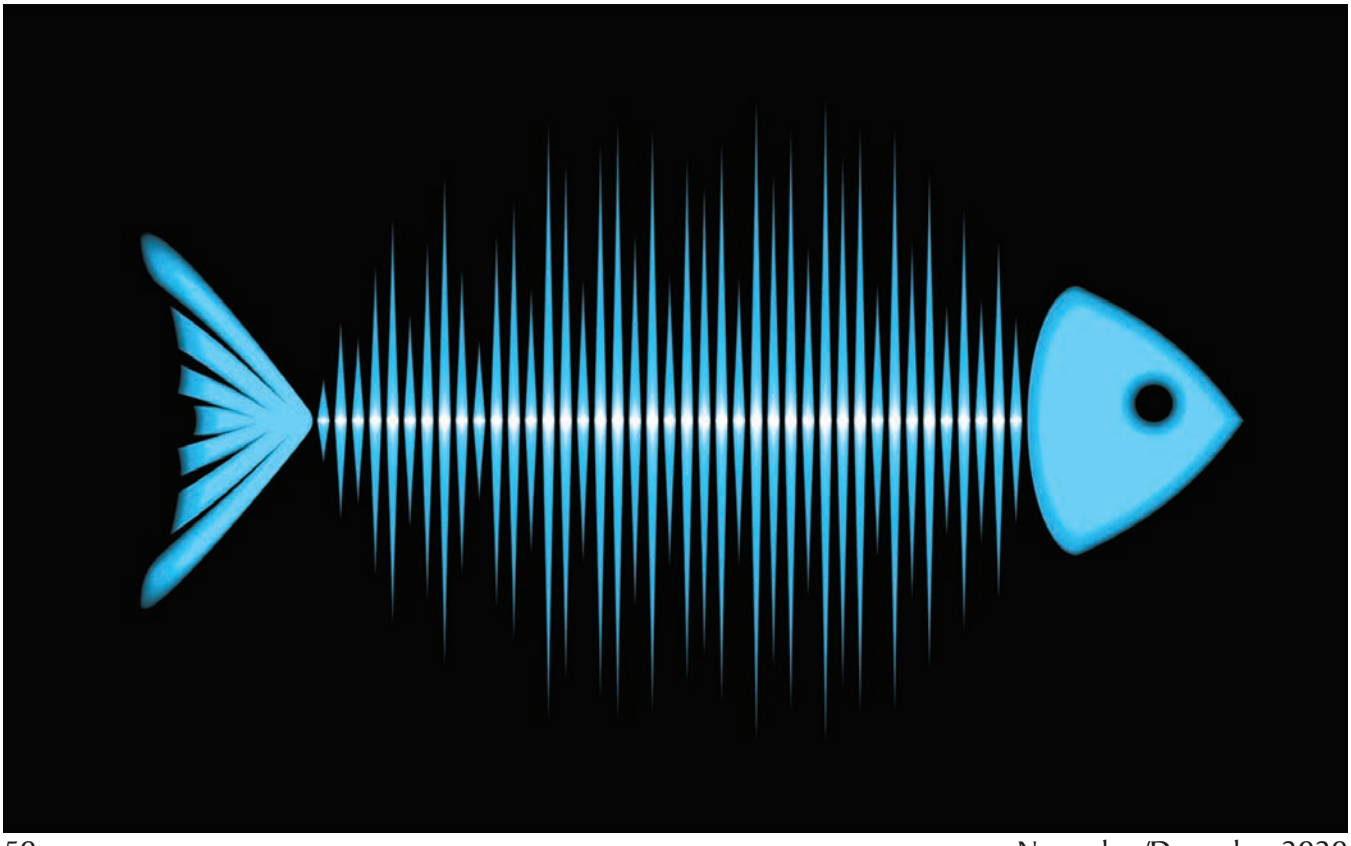
MIT researchers think so. They've built a battery-free pinpointing system dubbed Underwater Backscatter Localization (UBL). Rather than emitting its own acoustic signals, UBL reflects modulated signals from its environment. That provides researchers with positioning information, at net-zero energy. Though the technology is still developing, UBL could someday become a key tool for marine conservationists, climate scientists, and the U.S. Navy.

These advances are described in a paper being presented this week at the Association for Computing Machinery's Hot Topics in Networks workshop, by members of the Media Lab's Signal Kinetics group. Research Scientist Reza Ghaffarivardavagh led the paper, along with co-authors Sayed Saad Afzal, Osvy Rodriguez, and Fadel Adib, who leads the group and is the Doherty Chair of Ocean Utilization as well as an associate professor in the MIT Media Lab and the MIT Department of Electrical Engineering and Computer Science.

"Power-hungry"

It's nearly impossible to escape GPS' grasp on modern life. The technology, which relies on satellite-transmitted radio signals, is used in shipping, navigation, targeted advertising, and more. Since its introduction in the 1970s and '80s, GPS has changed the world. But it hasn't changed the ocean. If you had to hide from GPS, your best bet would be underwater.

Because radio waves quickly deteriorate as they move through water, subsea communications often depend on acoustic signals instead. Sound waves travel faster and further under-



water than through air, making them an efficient way to send data. But there's a drawback.

"Sound is power-hungry," says Adib. For tracking devices that produce acoustic signals, "their batteries can drain very quickly." That makes it hard to precisely track objects or animals for a long time-span — changing a battery is no simple task when it's attached to a migrating whale. So, the team sought a battery-free way to use sound.

Good vibrations

Adib's group turned to a unique resource they'd previously used for low-power acoustic signaling: piezoelectric materials. These materials generate their own electric charge in response to mechanical stress, like getting pinged by vibrating soundwaves. Piezoelectric sensors can then use that charge to selectively reflect some soundwaves back into their environment. A receiver translates that sequence of reflections, called backscatter, into a pattern of 1s (for soundwaves reflected) and 0s (for soundwaves not reflected). The resulting binary code can carry information about ocean temperature or salinity.

In principle, the same technology could provide location information. An observation unit could emit a soundwave, then clock how long it takes that soundwave to reflect off the piezoelectric sensor and return to the observation unit. The elapsed time could be used to calculate the distance between the observer and the piezoelectric sensor. But in practice, timing such backscatter is complicated, because the ocean can be an echo chamber.

The sound waves don't just travel directly between the observation unit and sensor. They also careen between the surface and seabed, returning to the unit at different times. "You start running into all of these reflections," says Adib. "That makes it complicated to compute the location." Accounting for reflections is an even greater challenge in shallow water — the short distance between seabed and surface means the confounding rebound signals are stronger.

The researchers overcame the reflection issue with "frequency hopping." Rather than sending acoustic signals at a single frequency, the observation unit sends a sequence of signals across a range of frequencies. Each frequency has a different wavelength, so the reflected sound waves return to the observation unit at different phases. By combining information about timing and phase, the observer can pinpoint the distance to the tracking device. Frequency hopping was successful in the researchers' deep-water simulations, but they needed an additional safeguard to cut through the reverberating noise of shallow water.

Where echoes run rampant between the surface and seabed, the researchers had to slow the flow of information. They reduced the bitrate, essentially waiting longer between each signal sent out by the observation unit. That allowed the echoes of each bit to die down before potentially interfering with the next bit.

Whereas a bitrate of 2,000 bits/second sufficed in simulations of deep water, the researchers had to dial it down to 100 bits/second in shallow water to obtain a clear signal reflection from the tracker. But a slow bitrate didn't solve everything.

To track moving objects, the researchers actually had to boost the bitrate. One thousand bits/second was too slow to pinpoint a simulated object moving through deep water at 30 centimeters/second. "By the time you get enough information to localize the object, it has already moved from its position," explains Afzal. At a speedy 10,000 bits/second, they were able to track the object through deep water.

Efficient exploration

Adib's team is working to improve the UBL technology, in part by solving challenges like the conflict between low bitrate required in shallow water and the high bitrate needed to track movement. They're working out the kinks through tests in the Charles River. "We did most of the experiments last winter," says Rodriguez. That included some days with ice on the river. "It was not very pleasant."

Conditions aside, the tests provided a proof-of-concept in a challenging shallow-water environment. UBL estimated the distance between a transmitter and backscatter node at various distances up to nearly half a meter. The team is working to increase UBL's range in the field, and they hope to test the system with their collaborators at the Wood Hole Oceanographic Institution on Cape Cod.

They hope UBL can help fuel a boom in ocean exploration. Ghaffarivardavagh notes that scientists have better maps of the moon's surface than of the ocean floor. "Why can't we send out unmanned underwater vehicles on a mission to explore the ocean? The answer is: We will lose them," he says.

UBL could one day help autonomous vehicles stay found underwater, without spending precious battery power. The technology could also help subsea robots work more precisely, and provide information about climate change impacts in the ocean. "There are so many applications," says Adib. "We're hoping to understand the ocean at scale. It's a long-term vision, but that's what we're working toward and what we're excited about."

This work was supported, in part, by the Office of Naval Research.

New Products

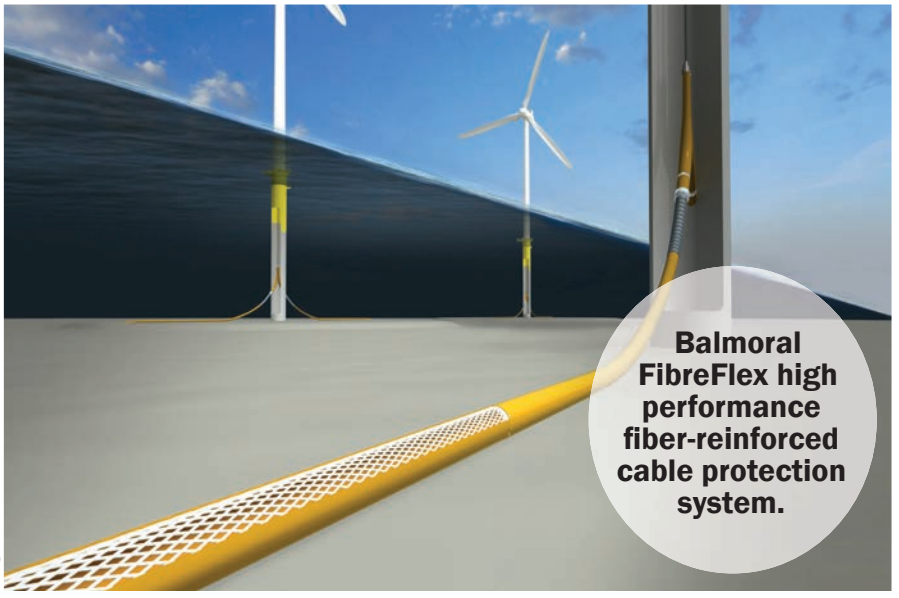
Innovative new products, technologies and concepts

Balmoral FibreFlex Cable Protection System

Much of the technology being used by the offshore wind sector is derived from the traditional offshore energy arena, particularly where subsea-related product solutions are required and, with well documented cable failures eating up substantial resources, both in terms of cash and time. High performance cable protection systems (CPS) can play a key role in failure mitigation.

One company that has taken a different approach to offshore wind cable protection is Balmoral, which has adapted its polyurethane design engineering and manufacturing capabilities to develop a high performing cost-efficient patented CPS solution: Balmoral FibreFlex.

"Our technical and engineering teams have created a unique solution that is designed to provide maximum performance for life of field installations," said Fraser Milne Balmoral's engineering and projects director.



Balmoral FibreFlex high performance fiber-reinforced cable protection system.

Image: Balmoral

The fiber-reinforced system mechanically locks to the end connectors removing the need to rely on PU bonding, which is notoriously unpredictable, while providing train and stiffness levels that are unachievable using traditional solid PU manufacturing methods. These innovations also contribute to greatly increased fatigue life.

"Our system provides an increase in axial tension capacity by a factor of two while controlling axial elongation," said Milne. "It also increases bend stiffness by a factor of 1.5 allowing improved control and reduction in the cable's maximum bend radius within a slimline profile."

Balmoral says FibreFlex's long-term creep performance is a substantial improvement on traditional cable protection while bending and axial stiffness is optimised without having to qualify alternative PU materials.

Balmoral's 40-year track record of providing tried, tested and proven subsea protection products is set to benefit the global offshore wind sector with the company recently achieving the sought-after Fit 4 Offshore Renewables (F4OR) accreditation.

balmoraloffshore.com

OSIL Bags Dredge Monitor Network Deal

Ocean Scientific International Ltd. (OSIL) won a contract for the supply of a network of dredge monitoring buoys. The Tern buoy hull design incorporates a stainless steel sub frame with a moon pool for instrument protection, and its modular manufacture makes the buoy easy to ship and assemble on-site following delivery. The 12 buoys are set up to communicate via Iridium SBD with an onboard GSM option to further reduce operational costs when the buoys are moved closer inshore as the project progresses. These buoys will join a large number of existing OSIL dredge monitoring networks, with more than 500 data buoy systems now installed worldwide.

Osil.com

Image: OSIL

New Products

Innovative new products, technologies and concepts

MacArtney LARS for Asia Pacific RV

MacArtney completed its order of a launch and recovery (LARS) system for Taiwan National University, the fifth Ocean Research Vessel (ORV) in the Asia Pacific region to date.

MacArtney Asia Pacific provided the full launch and recovery system solution for the new 1,000 gt R/V New Ocean Researcher 1 (ORV 1), including slip rings, cables and docking heads.

Behind ORV 1 is the CSBC Corporation, which built the ship for end-user Taiwan National University. CSBC, is the largest shipbuilding company in Taiwan. Now that ORV 1 has passed its Sea Acceptance Test (SAT), researchers from the country's national university can reap the benefits. "Of course, we encountered difficult situations and problems. Whenever this happened, I think of what a Danish engineer, Steen, said to me – 'Not a problem, always a challenge,'" said Mr Liang Hong-yu, the director of the outfitting factory. "In the process of commissioning, he used this sentence to encourage me – to make me face the challenge with a positive attitude, and I remember it clearly even now." The full scope of supply from MacArtney includes:

- One MERMAC stern A-frame (15m);
- Two MERMAC side A-frames;
- Wireless remote control foldable boom crane with 10-ton capacity and active heave compensation;
- Hydraulic power units for A-frame and crane;
- MERMAC storage and traction winch with 6,000 meters of ready spooled stainless steel wire, wireless remote control and constant tension technology;
- MERMAC CTD (Conductivity, Temperature, Depth) winch, including 6,000 metres of armoured coaxial cable and slip rings;
- Portable MERMAC winch with 4,500 metres of hybrid instrumentation cabling, slip ring and spare cable.

The new vessel cements MacArtney's working relationship with the CSBC Corporation, following on from the development of ORV 2 and ORV 3, launched in November 2019. Management of ORV 1 will now be handed over to Taiwan National University.

macartney.com

Left: Mr Liang Hong-yu, director of the outfitting factory

Below: R/V New Ocean Researcher 1 equipped with three full MERMAC LARS solutions.

Photos: MacArtney

Photo: ZX Lidar

New Lidar Tech from ZX Lidars

Siemens Gamesa recently tested a new technology together with ZX Lidars, and based on the results both on the medium range and long range measurements, Siemens Gamesa Renewable Energy (SGRE) approves the use of the nacelle-based Continuous Wave scanning Lidar 'ZX TM' from Lidar OEM ZX Lidars for Power Performance Testing.

In addition, operational 'rotor equivalent' power curves can also be measured with ZX TM's 50 points around the full rotor swept area, particularly important for turbines with larger rotor diameters offshore and on onshore sites with complex veer or shear profiles. This specific Lidar - ZX TM - allows the power curve of SGRE wind turbines to be measured and verified as a function of the Hub Height wind speed and may be, when agreed with the customer, used instead of the procedure described in the IEC61400-12-1:2017 (ed. 1/ed. 2) using a meteorological mast and anemometry installation.

zxlidars.com

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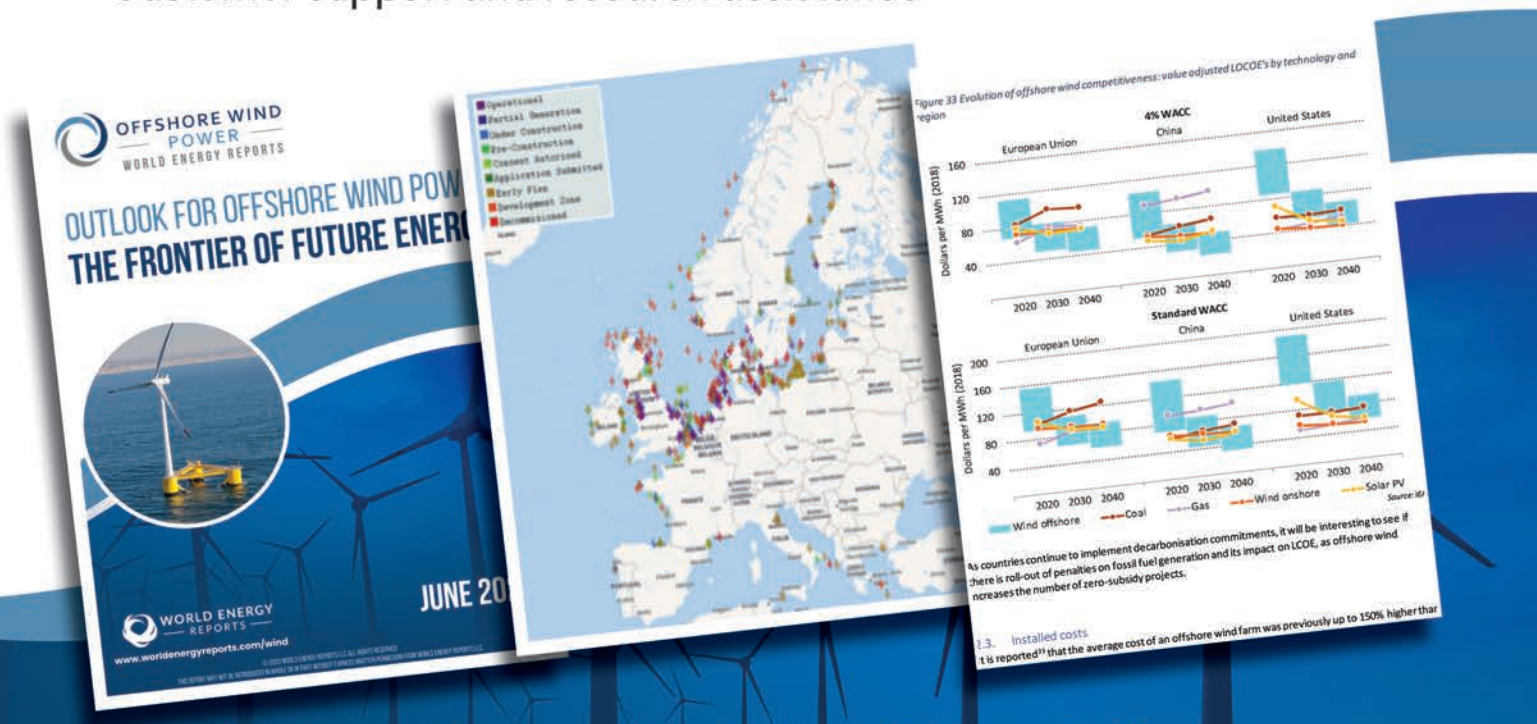

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New Products

Innovative new products, technologies and concepts

Autonomous Pipeline Survey

Ultrabeam Hydrographic teamed up with Unmanned Survey Solutions (USS) to conduct a pair of subsea gas pipeline inspection surveys in Northern Ireland. Both companies are based in the UK and offer unmanned platforms as an alternative to traditional manned survey vessels.

The contract was awarded by Mutual Energy, which wanted experience on how unmanned autonomous platforms can increase the knowledge of their pipelines while reducing risk and overall cost. "Mutual Energy contracted with Ultrabeam Hydrographic in August 2020 to perform inspection surveys of our Larne and Belfast lough crossing pipelines, key components of Northern Ireland's natural gas transmission network," said Shane Rafferty, Group Engineer, Mutual Energy. "In a first for Mutual, an Unmanned Survey Vessel (USV), the "USS Accession", provided by Ultrabeam's project partners Unmanned Survey Solutions, was to be deployed. The project planning phase moved swiftly and seamlessly such that execution of the works commenced only a matter of a few weeks later, and was performed as programmed despite some inclement weather and sea states. We were pleased to see early data capture and quality provide assurance of equal standards to previous surveys, such that the assets could be returned a clean bill of health." The challenges faced by these route surveys were solved by using an Accession Class USV built by USS.

Ultrabeam Hydrographic

This 3.5m USV was fitted out with an R2SONIC 2024 high resolution multibeam sonar, SBG Ekinox Navsight Inertial Navigation System and sound velocity sensors from Valeport.

The data was acquired in QINSy which was also used as the autopilot for the autonomous line running.

Two pipeline surveys were conducted along the Larne and Belfast Loughs using the Accession 350 USV. The weather was marginal, no incidents occurred and the project was completed on time and to budget. The joint venture between Ultrabeam and USS proved that autonomous surveys of inshore pipeline can be conducted safely and cost effectively compared to traditional manned solutions.

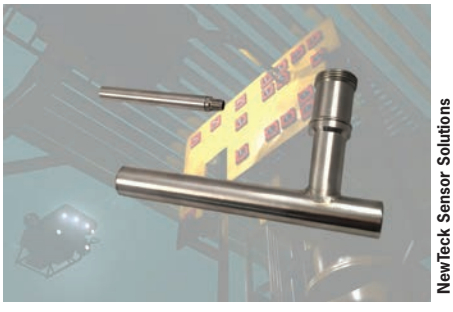
ultrahydrographic.com

Submersible Linear Position Sensors

As offshore drilling goes into deeper depths, NewTek Sensor Solutions offers custom designs of Submersible Linear Position Sensors constructed of special alloys with chemical resistance to water in depths exceeding 15,000 ft or more and with external pressures up to 20,000psi.

NewTek Subsea and Marine Sensor designs are used for measuring the strain on mooring chains that keep ships or platforms stationary and monitoring structural movement and elongation of pipelines, derricks and structural components of an oil platform to a fraction of a microstrain. Position measurements ensure the drilling platform doesn't shift to more than 2 mm to ensure ongoing stability.

The Submersible LVDTs are also used on the valves of Christmas tree chokes to provide position feedback as part of a remote monitoring and control system. NewTek offers these LVDTs with AC, DC or custom digital outputs.


NewTeck Sensor Solutions

newteksensors.com

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New Products

Innovative new products, technologies and concepts

Sonardyne Tech spread for Brazil fleet

C-Innovation (C-I) chose a suite of Sonardyne's underwater positioning and navigation systems to support its operations offshore Brazil.

ROVs onboard six ROV support vessels (RSVs) in the country will be equipped with Sonardyne inertial, gyrocompass and Doppler technologies, as well as hybrid acoustic-inertial systems. Specifically, C-I has ordered SPRINT inertial navigation systems (INS), a Lodestar attitude and heading reference system (AHRS), Syrinx Doppler velocity logs (DVLs) and Sonardyne's hybrid acoustic-inertial underwater vehicle navigation instruments, SPRINT-Nav. C-I has also ordered a quantity of Sonardyne's Compatt 6+ transponders and Wideband Sub-Mini 6+ (WSM 6+) transponder/responders for tracking structures and vehicles.

Most of the vessels (including Bongo, Santos Service, Joe Griffin and Deborah Kay) will be working for Petrobras, and one vessel (Cabo Frio) will be working for Karoon Energy. The scope of work is subsea inspection, maintenance and repair operations (IMR) and ROV support.

Five of the six vessels, which start contracts in Brazil this year, are already equipped with Sonardyne's Ranger 2 Ultra-Short BaseLine (USBL) positioning system, which is used for both dynamic positioning (DP) reference and deep water target tracking.

SPRINT-Nav combines Sonardyne's SPRINT sensor, Syrinx 600 kHz DVL and a high accuracy intelligent pressure sensor packaged in a compact deep-rated housing that's simple to integrate on both remote and autonomous underwater platforms.

The tight integration of inertial sensor and raw acoustic aiding data at a low level enables SPRINT-Nav to regularly exceed the most stringent of positioning specifications, making it an ideal choice for vehicle guidance, station keeping and long endurance navigation.

"We're pleased to continue the relationship we have with Sonardyne, building on a long-standing partnership and with the local technical support that they offer here in Brazil," said Tomás Peixoto, Survey Manager at C-Innovation, an affiliate of Edison Chouest Offshore and its family of companies, says. "With these latest orders, we're ensuring our fleet continues to provide unmatched services to our customers."

sonardyne.com

Photo: Sonardyne

Photo: C-Innovation

Above: The Bongo RSV is one of C-Innovation's vessels being upgraded with Sonardyne technologies.

Left: Sonardyne's hybrid navigator SPRINT-Nav has been chosen by C-Innovation for its ROVs in Brazil.

Photo: Hydromea

Hydromea LUMA X

Hydromea launched a new patent-pending subsea wireless communication modem LUMA X. The LUMA X can beam data using light at up to 10 Mbit/s with a 120-degree cone. With that, the LUMA X ena-bles real-time streaming of HD-quality video and 4K images wirelessly through water – allowing the operators of autonomous underwater vehicles to monitor its interventions from the comfort of its control rooms onshore.

"The wide-angle beam gives subsea vehicles connecting via the LUMA X a lot of freedom of movement," said Felix Schill, co-founder and CTO of Hydromea. "The small size of the modem and its standard transparent link allow for easy retrofitting into legacy systems."

"Radio waves do not penetrate water well, so resolving high-bandwidth communication underwater, for streaming high volumes of data, is a huge challenge," said Igor Martin, co-founder and CEO of Hydromea. "With our focus on miniaturization and scalability, LUMA X is the first optical device of its kind in such form factor with these impressive characteristics. It is also extremely power-efficient."

LUMA X comes in a titanium housing with serial and ethernet connectors and will be pressure-rated to 6,000 meter depth.

hydromea.com

New Products

Innovative new products, technologies and concepts

ROMOR Unveils two NEW Wave Gliders for Dalhousie University

ROMOR Ocean Solutions announced the arrival of two new Liquid Robotics Wave Gliders for Dalhousie University in Nova Scotia, Canada. The two gliders are an addition to the suite of ocean monitoring tools used by Dalhousie-based Ocean Tracking Network (OTN), the Ocean Frontier Institute (OFI) and the Marine Environmental Observation Prediction and Response (MEOPAR) network. These two new vehicles will be used to support critical marine research in the Northwest Atlantic and will be housed at the Centrer for Ocean Ventures and Entrepreneurship (COVE) in Dartmouth, NS. Dalhousie, under the auspices of the Coastal Environmental Observation Technology and Research (CEOTR) group, operates the largest glider monitoring program in Canada. "Liquid Robotics has worked with ROMOR to deliver Wave Gliders to Canadian research institutes like the team at Dalhousie University for a number of years, but this year presented some unexpected challenges, as we all know," said Jimmy Board, Senior Manager of Business Development at Liquid Robotics. "Darrin's understanding of the Canadian market has always been impressive and extremely

Imagee: ROMOR

valuable. This year he went above and beyond, navigating the challenges of 2020 to make sure we could deliver for the customer, and culminating in the delivery of new SV3 v300 Wave Gliders to expand our footprint in Canada." The gliders—also known as marine autonomous vehicles— exploit the difference between wave energy at the surface and the energy at depth to generate forward propulsion. Equipped with solar panels and satellite communications, these gliders can recharge, reposition and relay critical information for months at time. "ROMOR is delighted to see the latest in Wave Glider technology joining OTN's fleet at the Cove. Two years of project work with the team at Dalhousie's CEOTR glider team with Liquid Robotics has led to some innovative developments, including customized integration for the Wave Glider by Liquid Robotics and the development of a CTD profiling winch. We look forward to continued involvement on this exciting project," says Darrin Verge, CEO of ROMOR Ocean Solutions. **romor.ca**

Ping DSP iDX-PRO

Ping DSP introduced a new model of its 3DSS sonar, the iDX-PRO, featuring a fully integrated SBG Navsight Ekinox INS and Septentrio GNSS within the compact 3DSS form factor. The Ekinox is a 0.02° class instrument that together with the integrated GNSS provides a tightly coupled INS solution specifically tuned to operation difficult marine environments.

The new combination of the 3DSS and Ekinox excels in shallow water survey applications with high motion

Photo: Ping DSP

dynamics, such as exposed coastal areas, and in GNSS denied environments, such as under bridges. The iDX-PRO collects both high accuracy, wide-swath bathymetry (e.g.IHO Special Order, CHS/Exclusive Order, NL Norm 1A) and high resolution 3D imagery. As with all 3DSS solutions, the new iDX-PRO is competitively priced in comparison with MBES systems while meeting or exceeding the same hydrographic standards with a markedly higher area coverage rate, particularly in shallow water.

The new 3DSS-iDX-PRO is available to order and an upgrade path is also offered for existing 3DSS customers.

pingdsp.com

Oceanology International 2020 Goes DIGITAL

As travel restrictions from the COVID-19 pandemic linger, Reed Exhibitions announced last month that the decision has been taken to make Oceanology International 2020 a completely digital event. Oi2020 was originally scheduled for March 2020, and subsequently rescheduled for December 1-4, 2020. When it became apparent that the event could not take place, per usual, in person, the organizers moved swiftly to build and deliver the event virtually in the December 1-4 time frame.

What to Expect

The virtual event and networking platform allows you to search contacts in the database and arrange online meetings throughout the event and take part in video conferences, sessions and seminars run by industry experts (including the Navigation & Positioning Track, with *MTR* serving as the moderator).

Registration: How Does it Work?

The Oi 2020 Online platform allows you to search visitors and exhibitors, arrange high quality meetings and attend presentations by industry-leading experts. This online platform allows users to create personal profiles, identify key contacts based on area of interest and job type, build relationships and create business opportunities and create a pre-planned roster of private virtual meetings throughout the live event. A team of matchmaking professionals support the service, assisting with meeting arrangements pre-show and during; aiding with any technical questions throughout; managing the event's online meetings lounge.

- Register for your badge to gain access to your personal profile;
- Log in and update your profile using your registered email address;
- Search the database and find contacts specific to your requirements – filter by products / Interests;
- A personal, easy to use tool that helps you to connect virtually with people at the show;
- Receive meeting invitations from potential new leads;
- Run by a dedicated team of networking experts;
- All meetings take place online within the portal - with no third-party software required;
- Join industry experts through online video conference sessions and seminars;
- Host/attend ad-hoc, drop-in one-to-one meetings with potential new leads;
- Receive a meeting schedule with names, details and photos of your meeting partners;
- Event-live SMS and email reminders, along with tech support from the event-live concierge;
- Only those who have already registered for the show will be eligible to access the platform – please register to log in.

Register to attend for Free @:
oceanologyinternational.com

Oi 2020 Virtual Event

What:
Oceanology International 2020's virtual event - Oi Connect!

When:
December 1-4, 2020

Where:
OceanologyInternational.com

Why:
Oceanology International is the leading name in global subsea exhibitions. While COVID-19 has disabled the ability to meet in person, the organizers are working to facilitate world-class networking events online.

Watch the introductory video here:
https://youtu.be/hB87y59oC1Q

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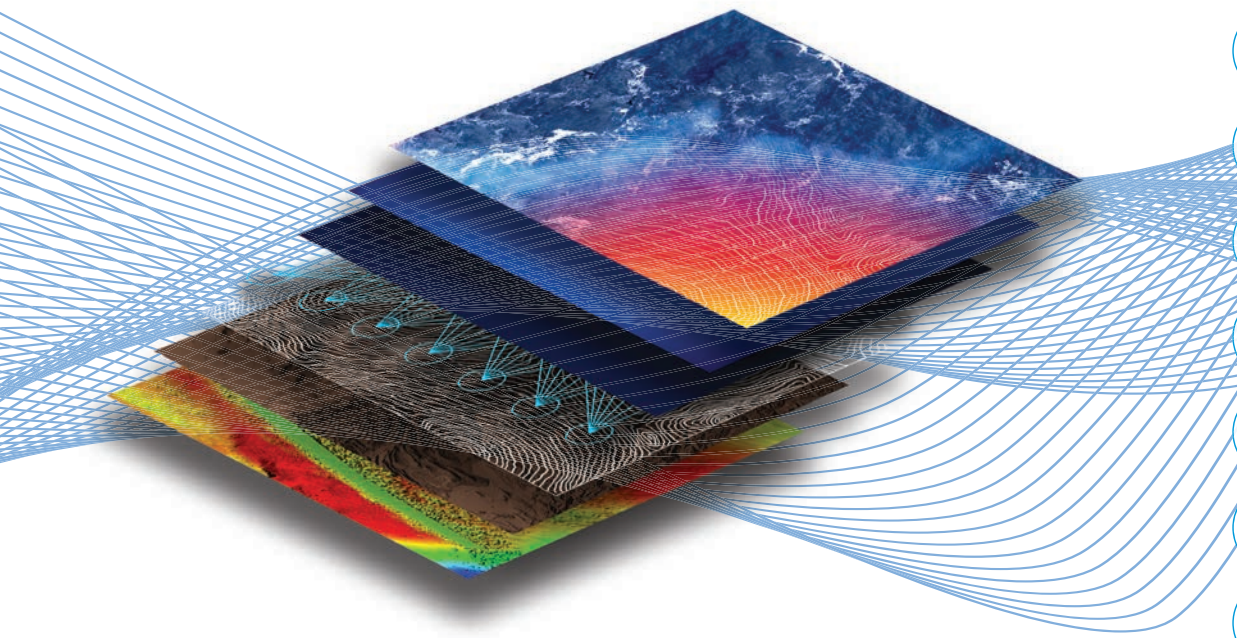

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1. Publication Title	2. Publication Number	3. Filing Date
Marine Technology Reporter	0 2 3 - 2 7 6	September 30, 2020
4. Issue Frequency	**5. Number of Issues Published Annually**	**6. Annual Subscription Price (if any)**
Nine issues per year	9	None

7. Complete Mailing Address of Known Office of Publication *(Not printer) (Street, city, county, state, and ZIP+4®)* — Contact Person: Kathleen Hickey; Telephone *(Include area code)*: 212-477-6700

New Wave Media, International, 118 East 25th Street, 2nd Fl, New York, NY 10010

8. Complete Mailing Address of Headquarters or General Business Office of Publisher *(Not printer)*

New Wave Media, International 118 East 25th Street, 2nd Fl, New York, NY 10010

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor *(Do not leave blank)*

Publisher *(Name and complete mailing address)*

John C. O'Malley, New Wave Media, International, 118 East 25th Street, 2nd Fl, New York, NY 10010

Editor *(Name and complete mailing address)*

Gregory Trauthwein, New Wave Media, International, 118 East 25th Street, 2nd Fl, New York, NY 10010

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Marine Technology Reporter	September 2020

15. Extent and Nature of Circulation — Requester			Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
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c. Total Requested Copy Distribution (Line 15f) + Requested/Paid Electronic Copies (Line 16a) ▶	20082	17173
d. Percent Paid and/or Requested Circulation (Both Print & Electronic Copies) (16b divided by 16c × 100) ▶	98%	99%

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17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the November/December 2020 issue of this publication.

18. **Signature and Title of Editor, Publisher, Business Manager, or Owner** — Kathleen Hickey — Date: 9/30/2020

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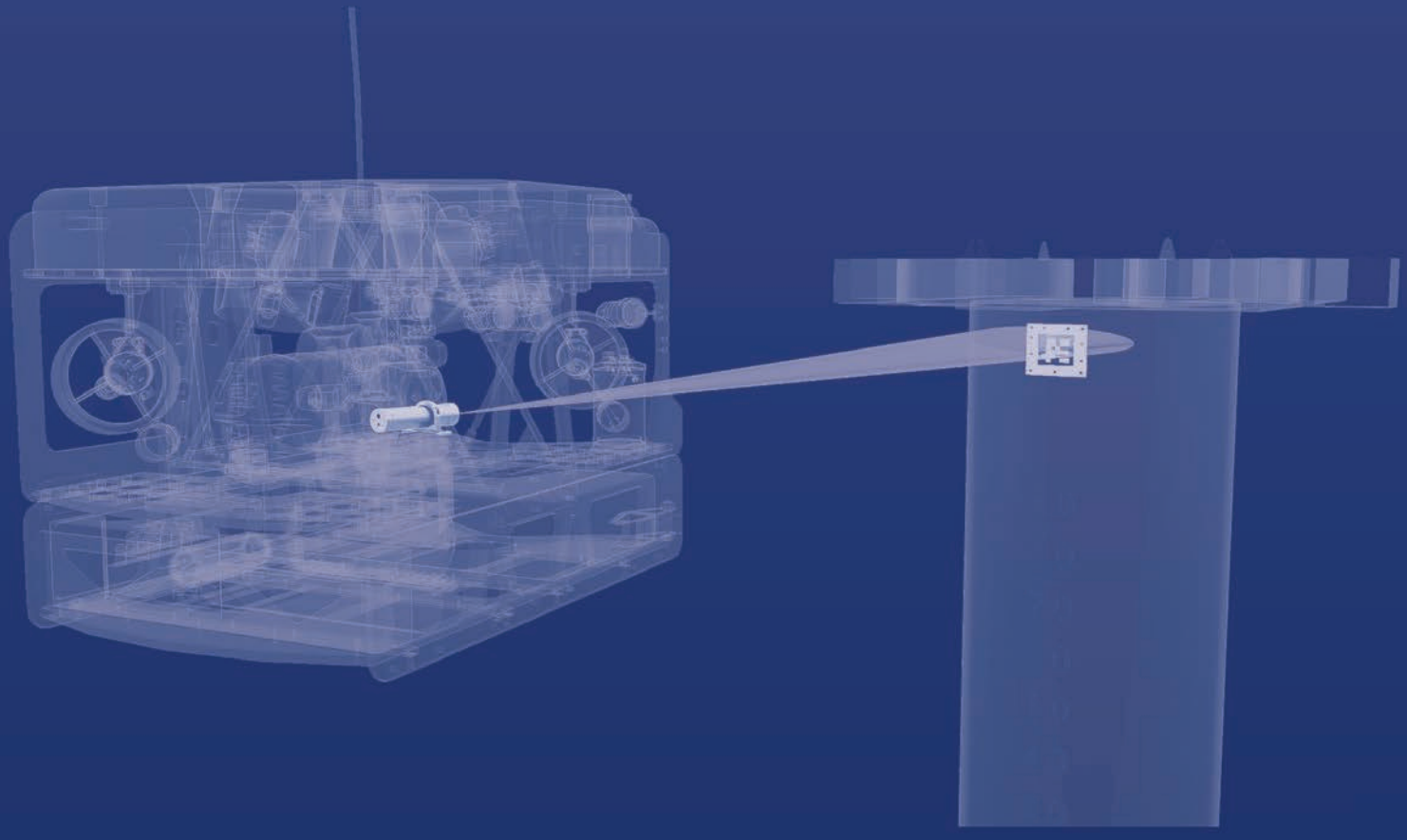

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