MARINE TECHNOLOGY REPORTER

July/August 2021

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Getting to Work

Expanded automation, new drivers for the renewal of the Work Class ROV fleet

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For Unmanned Vehicles

Prof. Raquel Peixoto
The Coral Warrior

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LIDAR Illuminates the Future of Oceans

Volume 64 Number 5

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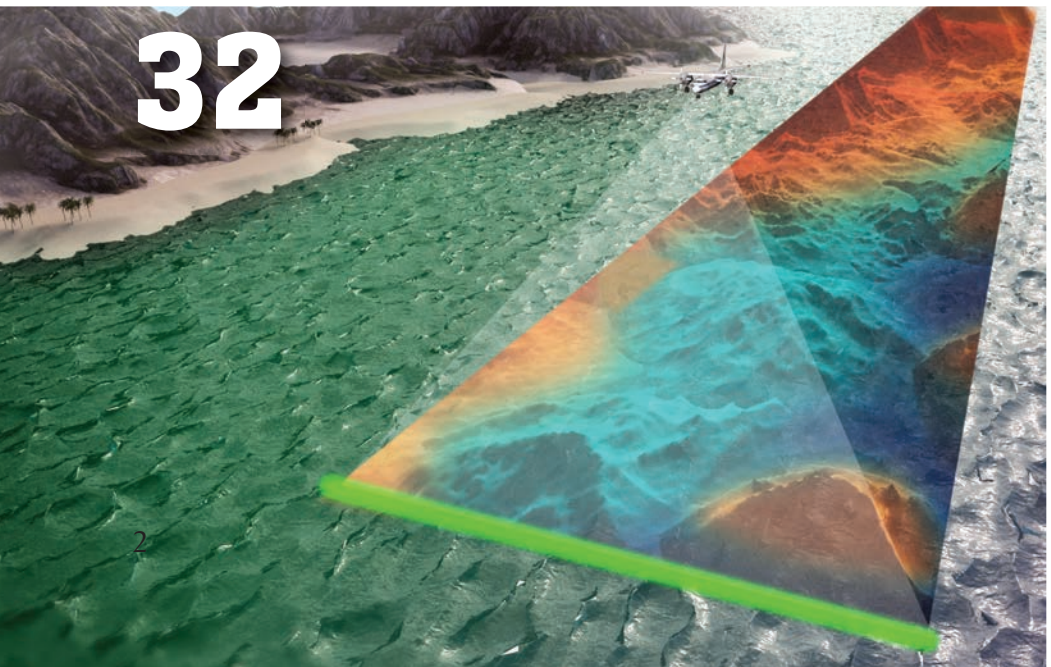

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On the Cover

TechnipFMC's Gemini ROV. Photo from TechnipFMC.

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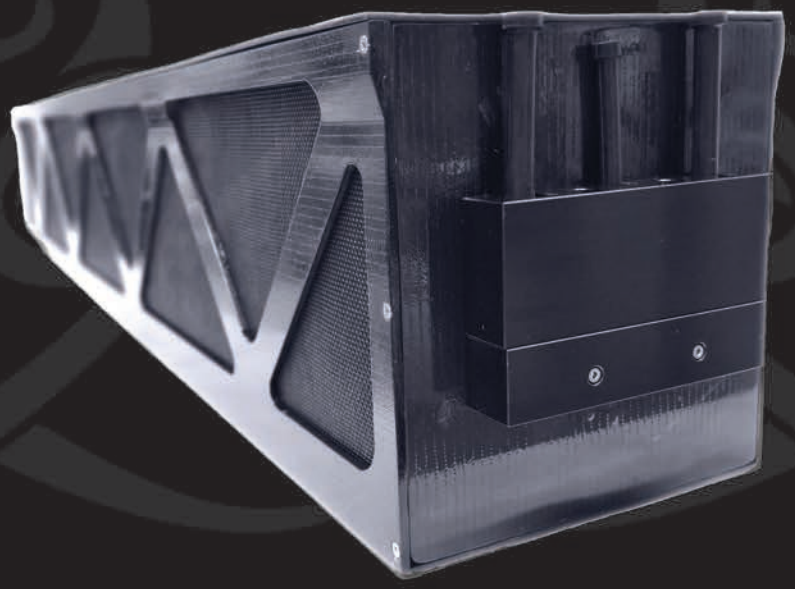

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Editorial

Time for Renewal

As we enter the 'dog days' of summer, I'm pleased to present the July/August edition of MTR with its focus on the world of automation and subsea vehicles.

Starting on page 26 Elaine Maslin takes a look inside the Work Class ROV market, at sector that has been stung by the prolonged downturn in offshore oil and gas over the last six years. While the sector is down, it certainly is far from out, and with the recent resurgence in oil pricing plus the massive investment coming in offshore wind, this vibrant and technologically rich segment will undoubtedly ride high again with signs that there is a pending renewal in this ROV sector, a renewal that will lean heavily on new and emerging automation advances.

Elaine has additional coverage on the marine minerals mining market in Norway, starting on page 36. As most of you reading this know well, marine minerals mining has been a very long time coming, and even today faces a number of business and environmental hurdles. But technology advances geared to ensure that mining operations are efficient while minimally impacting the environment point to a massive overall market growth in the coming three decades.

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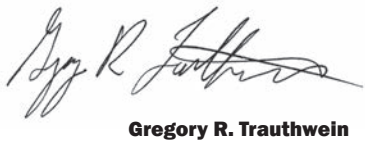
The application for the 16th Annual **MTR100** – *Marine Technology Reporter's* annual ranking of top 100 people, companies, technologies and concepts – is open. To ensure that you, your company and/or your subsea technologies are considered for inclusion in this prestigious ranking and reporting of the Top 100 influencer in the subsea sector, log-on and complete the application @ **https://mtr100.marinetechnologynews.com/Company**.



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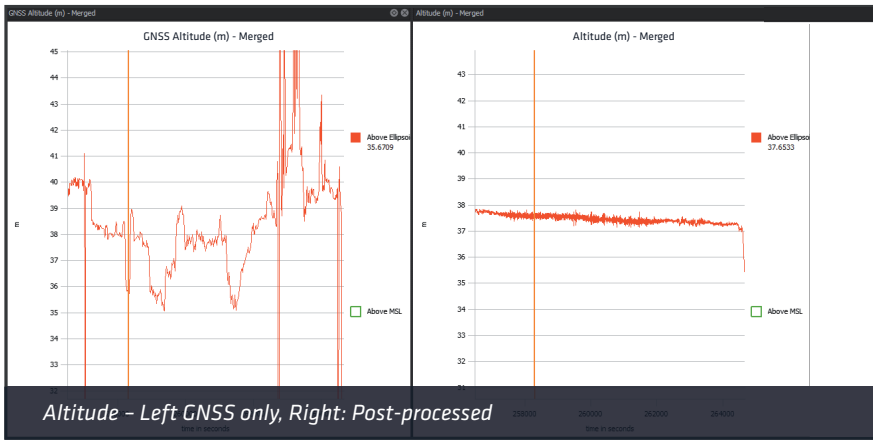

Altitude – Left GNSS only, Right: Post-processed

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Lundquist

Edward Lundquist is a retired naval officer who writes on naval, maritime, defense and security issues. He is a regular contributor to Maritime Reporter and MTR.

MacPherson

Donald MacPherson is Technical Director of HydroComp, a consultancy specializing in applied hydrodynamics and propulsion system simulation. A graduate of Webb Institute, Don is a Fellow of SNAME and member of its Propeller Hydrodynamics and Underwater Noise panels.

Maslin

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

Munoz

Bob Munoz is an undersea cable consultant who has over 30 years of experience in submarine cable route surveys and marine installation.

Thompson

Oliver Thompson is Market Intelligence Manager at Archer Knight. He has worked in research and data analysis across the energy industry, including business intelligence at ROVOP (an independent remote operated vehicles provider), where he was responsible for providing insight to support the company's business development, strategic growth and commercial activities.

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Capturing performance data for **Design of UVs**

By Donald MacPherson, Technical Director, HydroComp, Inc.

Conducting a sea trial is a necessary step upon delivery of a ship. This activity not only documents and validates anticipated ship speed and power, but if done correctly also provides performance data that can be useful for design purposes. The same holds true for underwater vehicles in general and thrusters in particular. However, while gathering data may seem easy, extracting useful trial data for typical UVs can often be pretty challenging.

We should start with an understanding of the system – the Vehicle-Propulsor-Drive system. For "transit" UVs whose mission is to move itself (doing survey work, for example), it is the drag of the Vehicle body and appendages that establishes the load on the system. The Propulsor – an all encompassing term for the thruster propeller and nozzle (when used) – provides the thrust needed to overcome the drag at a particular speed. The Drive spins the Propulsor at the necessary RPM to generate the right amount of thrust. The power generated by the Drive is simply that which the Propulsor requires at the RPM under the particular test condition.

As most transit UVs currently use electric motors as their Drive, it is easy for the controller to document RPM and current draw. In most tests Vehicle speed can be captured, which we will see is needed to determine system performance metrics. This set of data is pretty thin if you want to make any real conclusions about performance. But all is not lost...

System simulation

Let's consider what performance metrics are needed to fully describe a functioning system. As mentioned, the Vehicle characteristics and speed are responsible for the drag load on the system. The Propulsor produces a suitable thrust at a particular RPM, and presents a torque (i.e., the blade's rotational drag) to the Drive. Electrical input power (from voltage and current) produces a matching output shaft torque in the Drive. In an ideal setting, each piece of the system would be directly measured and documented:

Mechanical: Vehicle drag → Propulsor thrust → Propulsor torque →Drive torque → **Drive electrical input**

Operational: **RPM, Speed**

The regularly measured items are in bold, so as you can see, we have a lot of critical knowledge about the UV's performance that is undefined. For example, improvements in battery budget can come from reduced Vehicle drag, or greater Propulsor or Drive efficiencies. But we need to determine the missing pieces before we have any chance to improve the system components.

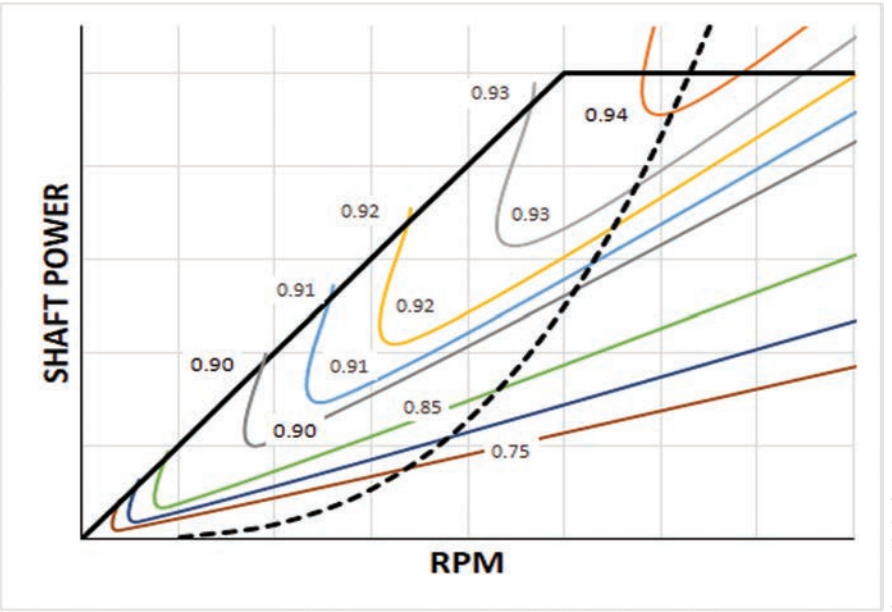
If we cannot directly measure these missing parameters, can we predict or estimate them with sufficient fidelity to be useful? Fortunately, in most cases the answer is yes.

Drive motor efficiency

While electrical input power is interesting from the standpoint of battery usage, the system performance needs the output mechanical shaft power. The ratio between the two is the motor efficiency, and we want the highest efficiency at the operating condition for the least demand on the batteries.

(Quick sidebar: Be careful about how torque and power are used to describe Drive performance. Torque is a specific metric at a particular RPM. Power is a much better way to communicate energy transmission. This is particularly true when talking about electrical input power versus output mechanical shaft power.)

Two key points regarding motor effi-



Source: HydroComp

ciency are that a) motor suppliers generally indicate motor efficiency only at full load and a particular RPM, and b) Propulsors almost never draw full shaft power from a Drive. Electric motor suppliers typically do not provide a full efficiency map (such as the one shown below) that quantifies the effect of partial load and RPM. That said, we do have means to estimate partial load motor efficiency so that we can predict the torque being developed by the Drive – and this should match the torque required by the Propulsor.So, the operational partial load motor efficiency is an important piece of information for design. For additional information about electric motors for UV applications, let me refer you to our earlier article in the March 2020 issue of Marine Technology Reporter.

Propulsor thrust and torque

How can we derive or estimate Propulsor thrust and torque given the little test data available? For this we will use the known performance characteristics of the Propulsor as a "numerical dynamometer" to predict thrust and torque. However, for an accurate prediction we need accurate test data for RPM, Speed, the Vehicle-Propulsor interaction coefficients (particularly wake fraction), and the thrust-torque performance coefficients for the Propulsor.

In the absence of a direct empirical determination (such as model testing), the interaction coefficients and Propulsor performance coefficients must be analytically derived. CFD computations from an experienced source could be used for this purpose, as are predictions from "simplified-physics" computations such as those found in the NavCad software (for system simulation) and PropElements® software (for open and ducted propeller analysis).

Let me caution, however, about the use of popular propeller series (such as the B Series or Kaplan ducted propeller series) for prediction of Propulsor performance. In short, there is such a divergence between traditional series and contemporary UV propeller, nozzle, and stern shape geometry that their use cannot be justified without some calibration or alignment. For example, blade area ratios are typically below the data set of these series, and their small diameter is subject to scale effect differences. Contemporary nozzle styles are not like the traditional geometries, and in many cases, nozzles are just protective shrouds that do not contribute any thrust-making benefits. (Two examples of contemporary nozzle/shroud geometries are shown below.) Stern shapes are often subject to a steep inflow angle into the Propulsor that is not picked up by the uncalibrated use of traditional series.

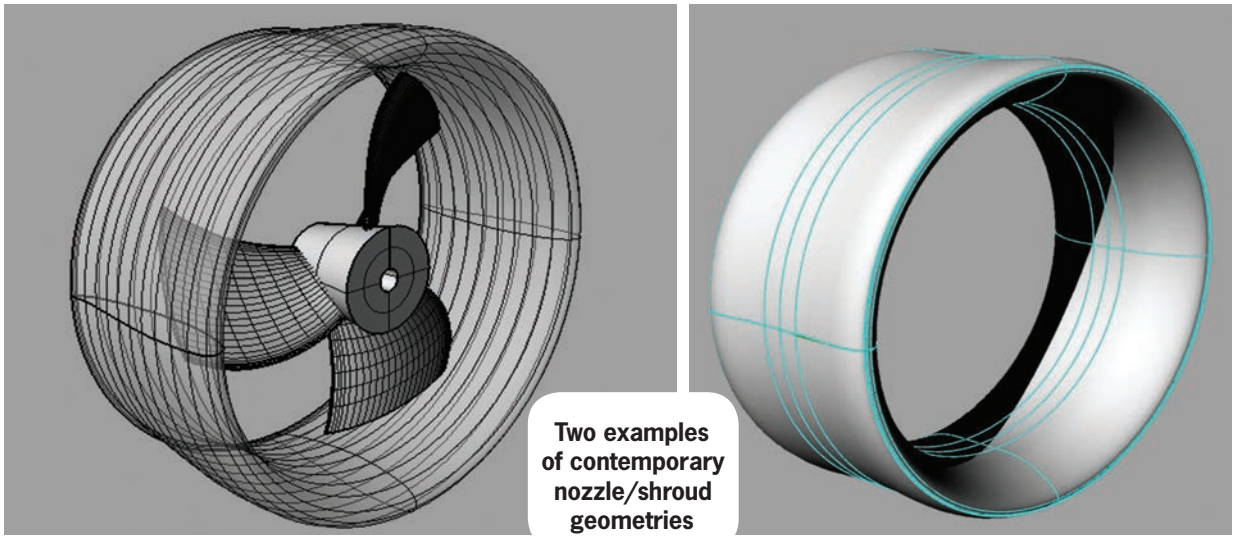
Predicting the Propulsor component performance with CFD or a tool like PropElements avoids these shortcomings, and in fact can develop the calibration corrections for improved prediction using a traditional series. With some care the Vehicle-Propulsor interaction can be predicted and a suitable Propulsor performance model can be developed. These will then allow for prediction of the Propulsor thrust and torque at each test condition.

Vehicle drag

The Propulsor thrust (as determined above) then can be used with the Vehicle-Propulsor thrust deduction interaction coefficient to determine the Vehicle drag at that condition. By conducting the tests and running the simulation for a variety of speed and RPMs, you can develop a drag curve for the particular body and appendage design.

A system simulation for design

Even under the best of circumstances the test simulation may still contain some uncertainty in the system's various performance metrics. But this is OK because improvement in design is principally a qualitative (or comparative) exercise where we want to see if one variation is better than the other. A robust system simulation with suitable models for prediction of the individual components should be both accurate and faithful to the potential improvements or changes being considered. Capturing test data and deriving performance metrics offers significant knowledge for any UV developer interested in improving their Vehicle, Propulsor, or Drive design.



Two examples of contemporary nozzle/shroud geometries

Source: HydroComp

“

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Senior Vice President and Director, David Evans and Associates, Inc. (DEA) Marine Services

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AN OVERVIEW OF THE WORK CLASS ROV MARKET

By Oliver Thompson, Market Intelligence Manager at Archer Knight

Source: Oceaneering 2021

Demand for work-class ROVs (WROV) has traditionally been determined by the state of the global offshore oil & gas industry. This is likely to remain the case in the short to medium-term. However, there's a new kid on the block – offshore wind. Growth in this sector is seen as a key enabler for northern hemisphere countries (with access to a coastline and suitable wind conditions) to hit net zero.

What does this mean for WROV demand? Following the 2014 oil price crash, many major ROV operators reduced their fleet size considerably. Oceaneering, which has the world's largest fleet of WROVs, cut its fleet from 337 units in the third quarter of 2015, to 279 units by the end of the Q3 2016.

Struggling to boost utilization, many ROV operators turned towards the burgeoning offshore wind sector, particularly in Western Europe. Independent ROV operator ROVOP, for example, claims to have been 'born' out of the offshore wind industry, with early asset utilization coming purely from work scopes connected to offshore-wind projects. While offshore wind could not completely fill the vast void in demand left by the oil price crash, it did begin to dampen the effect and even provide opportunities, particularly to some of the smaller, independent companies in the ROV market, like ROVOP, C-Ventus, Bluestream, and more recently ROVCO.

Fast-forward a few years and just as WROV demand in the traditional oil & gas sector had stabilized and started to show signs of growth, the industry was hit with the shock of the global pandemic.

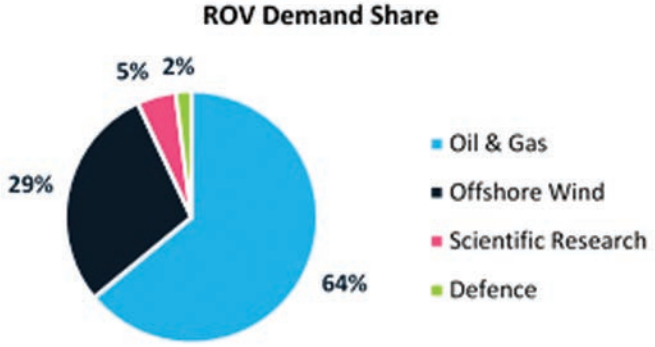
We have yet to see how the sector will recover as economies begin to open and demand for energy increases. But offshore wind is again likely to dampen the effect and, as we look to the future, is set to play an increasingly significant role in the overall demand for WROVs.

At Archer Knight, our analysis, suggests that offshore wind now accounts for around 29% of global ROV demand. However, this still leaves the oil & gas sector with around a 64% demand share, with the rest made up of demand from the defense and scientific research sectors.

As of 2021, we estimate the global fleet of WROVs to sit at around 900 units, many of these units are relatively old and operators have a decision to make: should they invest in new, more-efficient electric WROVs, or continue to operate with older fleets and attempt to extend their life.

Although, growth in offshore wind will increase demand, to date many WROV requirements have predominantly been serviced through utilization of the excess supply previously targeting the oil & gas sector.

Our view is that demand will continue for new WROV units, but we expect to see a recalibration. This will lead to the oil & gas sector WROV operators running their existing fleets for as long as possible, until they see growth both in traditional and new markets. After the struggles of the last three to five years, and the global focus on reduced emissions, more efficient, electrically powered units will also become more prevalent.



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ROV SERVICES MARKET UPDATE

By David Bat, President, Kimberlite International Oilfield Research

The ROV Services market continues to be a key component for helping subsea operators achieve greater levels of operational efficiency and to reduce costs and will play a growing role in supporting the expansion of future offshore wind projects with tasks like laying cables, pre- and post-lay cable survey and other seabed activities.

The size of the ROV Services market has declined to approximately $1 billion, from about $2 billion in 2014, reflecting a wider industry decline in activity from approximately 800 ROVs in operation to only approximately 400 ROVs operating today on average. While utilization continues to improve from the 2020 trough, most industry experts do not expect the market to return to 2014 levels Oceaneering commands approximately 50% of the ROV services market share, followed by Subsea 7 at 11%, Fugro at 7%, DOF Subsea at 6% and TechnipFMC with approximately 6%.

Oceaneering continues to invest in technology and capabilities with the Isurus workclass ROV to support work in the offshore renewables segment, the Liberty which is a battery-powered electric ROV to support IMR, commissioning and underwater intervention activities with up to 90% reduction in carbon footprint and the soon to be released Freedom, an autonomous vehicle to support pipeline survey, seabed survey, close visual inspection and light intervention activities.

TechnipFMC, a relatively newer entrant into the ROV Services business, albeit with a long heritage in ROV design and manufacture, has deployed its Gemini workclass ROV in the Gulf of the Mexico which offers the capability tool changing and advanced operations to conduct longer duration missions translating into time and cost savings for drilling operations.

More broadly, 2020 represented an unprecedented year in which the benefits of leveraging remote operations, automation and digital solutions became more visible among both operators and suppliers alike and is being prioritized as key investment initiatives for the future of subsea operations.

Looking specifically at ROV services, a recent industry survey conducted by Kimberlite International Oilfield Research found that subsea operators are looking for improved ROV reliability/uptime and visualization systems and for further improvements to ROV tooling and automation capabilities.

These desired improvements and advancements in ROV capabilities will enable subsea operators to conduct longer missions while supporting advancements in digitalization initiatives designed to improve real time reporting and analysis along with improved remote operational support.

Whatever the future holds in the years ahead, the oil and gas industry has proven time and again the ability to innovate and adjust to challenging market conditions.

One difference coming out of the COVID pandemic is the realization that the use of remote operations and digital solutions will continue to grow and develop as operators seek to improve efficiencies and financial returns.

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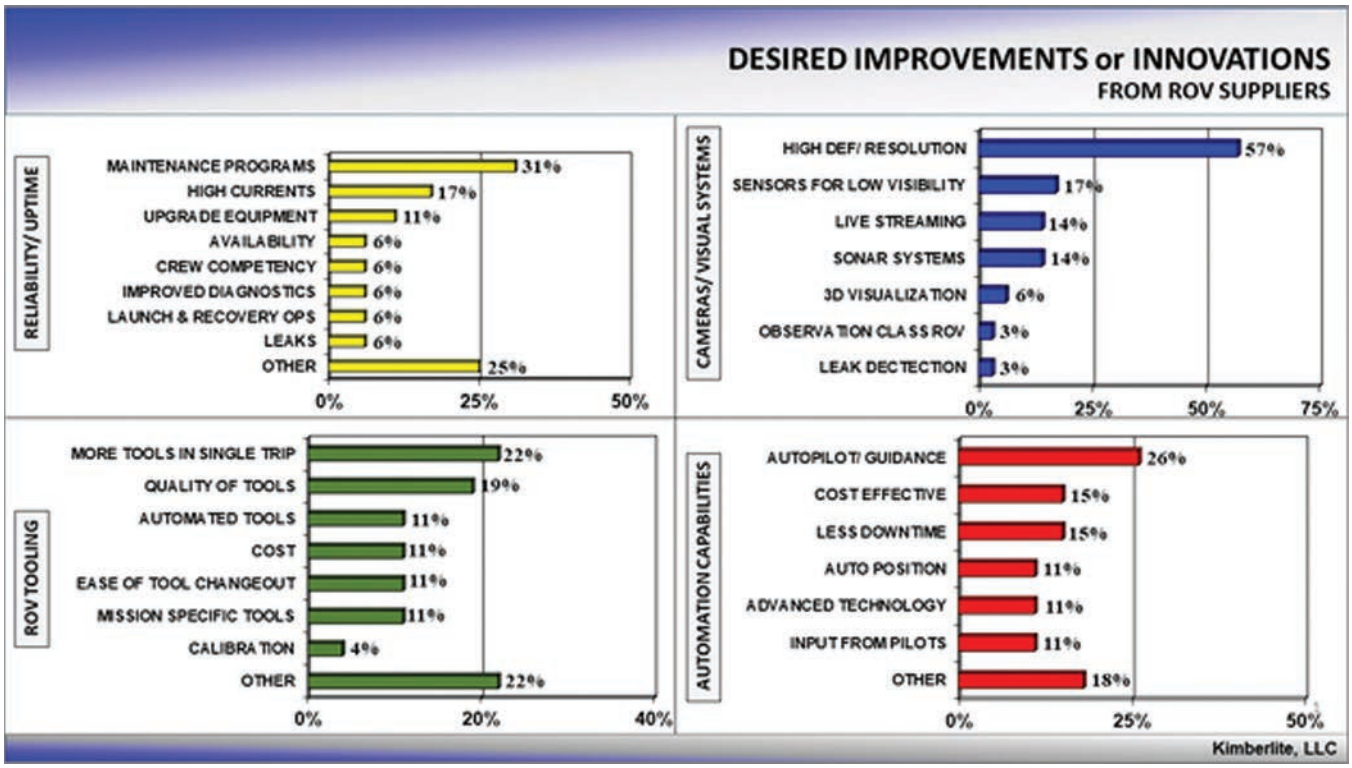
DESIRED IMPROVEMENTS or INNOVATIONS
FROM ROV SUPPLIERS
RELIABILITY/ UPTIME
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HIGH CURRENTS 17%
UPGRADE EQUIPMENT 11%
AVAILABILITY 6%
CREW COMPETENCY 6%
IMPROVED DIAGNOSTICS 6%
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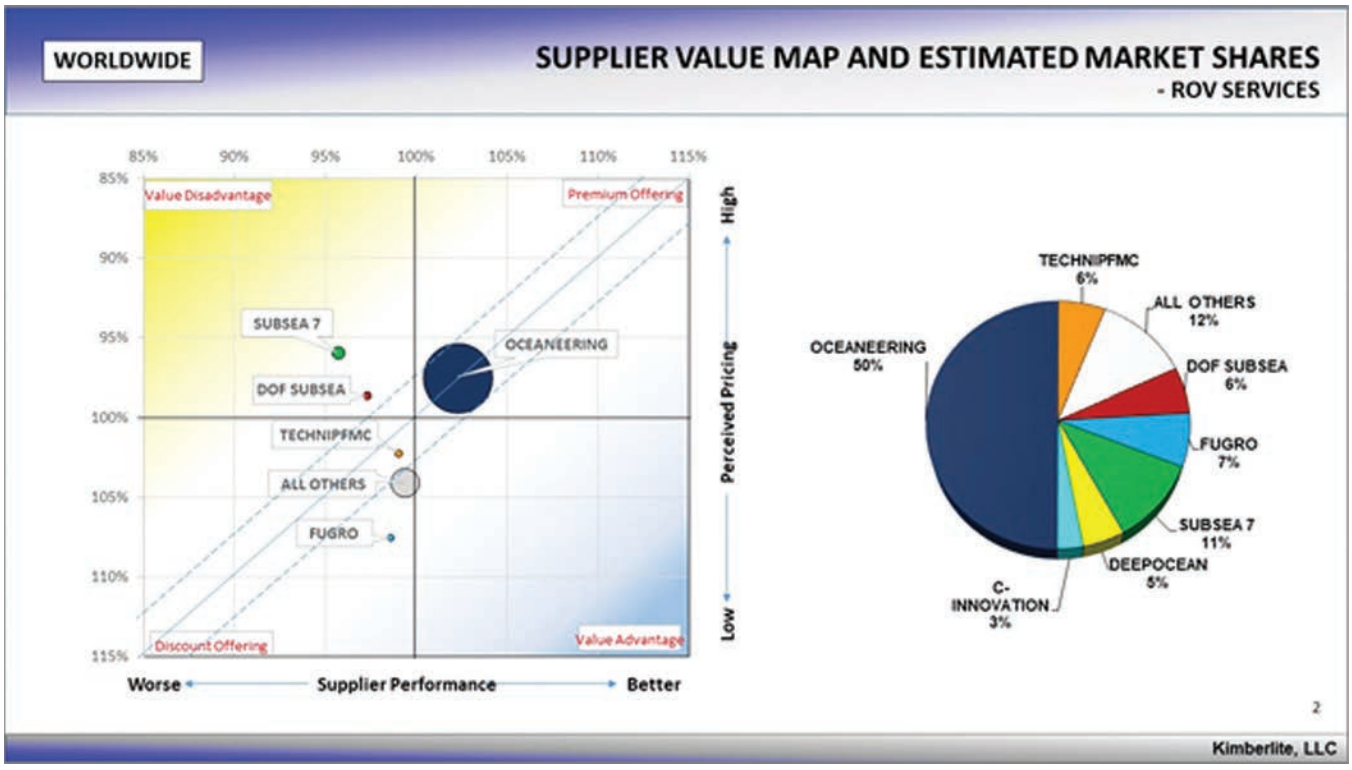
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SUPPLIER VALUE MAP AND ESTIMATED MARKET SHARES
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85% 90% 95% 100% 105% 110% 115%
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OCEANEERING
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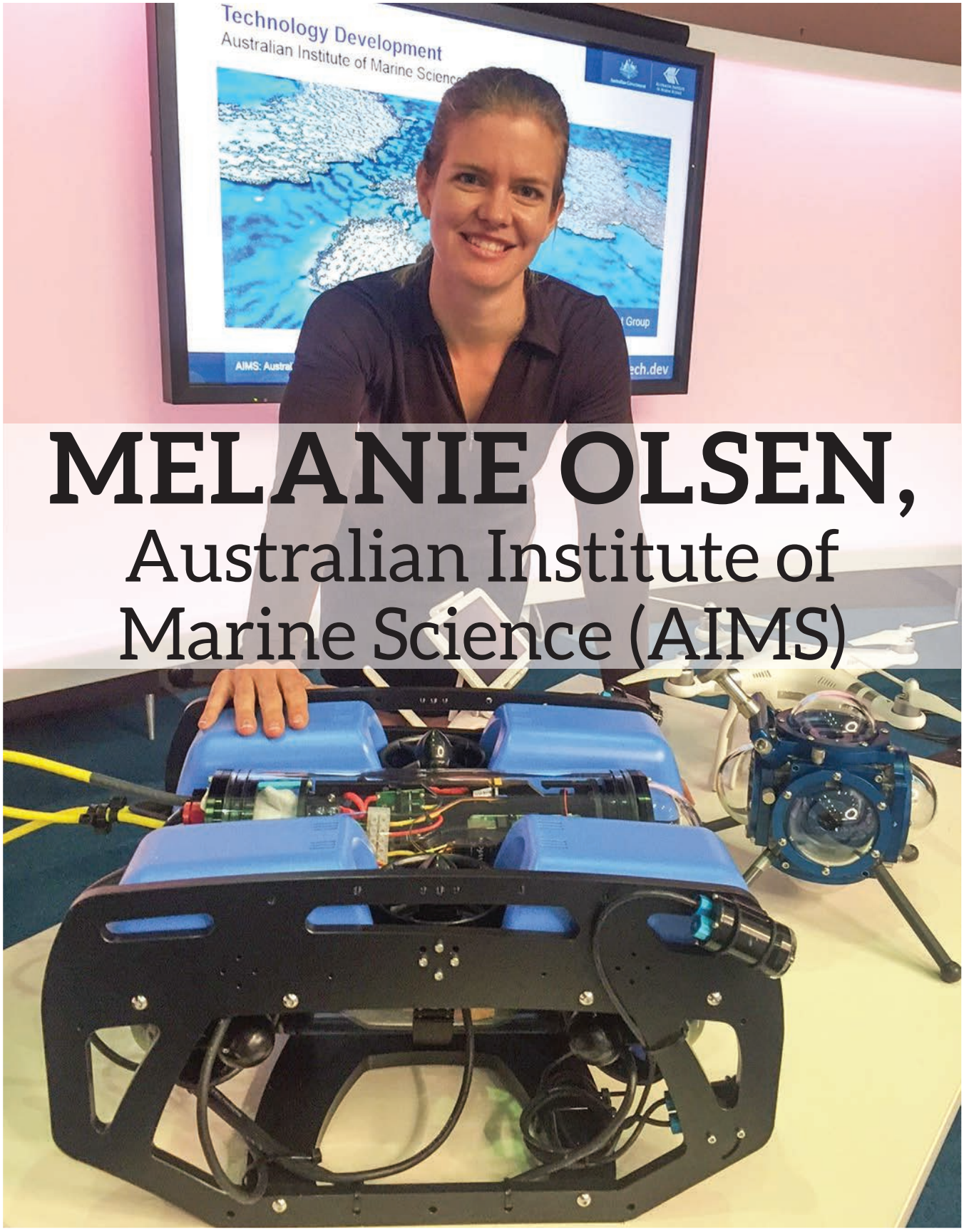


MELANIE OLSEN, Australian Institute of Marine Science (AIMS)

AIMS

"Civilization was built on people giving it a crack. Don't go in worrying you are not capable or good enough. You'll learn as you go, and soon you'll realize that no one has all the answers."

Melanie Olsen is harnessing 10 years of missile defense and electronic warfare systems expertise to drive rapid technological innovation in marine research and monitoring. The AIMS Team Leader for Technology Development Engineering shares her unique journey.

Growing up in a third-generation farming family near the small settlement of El Arish in north Queensland, Melanie Olsen thought engineers were train drivers. When a James Cook University engineering lecturer visited her small rural high school with a quad helicopter, Olsen knew she'd found her career path and studied computer systems engineering at James Cook University.

She was accepted into the Defense Material Organization (now Capability Acquisition and Sustainment Group) graduate program that gave her the opportunity to conduct three six-month rotations across Defense, helping to build and sustain Defense capabilities. When she got to maritime electronic warfare systems and missiles, she found her niche.

For 10 years, Olsen worked closely with project teams in Canberra, Adelaide and the U.S. in the design, acquisition and sustainment of future maritime electronic warfare technology, such as the Nulka hovering rocket active missile decoy system. After hours, Olsen also studied part-time and obtained a Masters in Electronic Warfare Systems Engineering from UNSW.

She discovered she had a talent for translating science-speak to the engineers and stakeholders and engineering-speak to the scientists and project managers. "I hardly ever noticed I was the only female in the room until people pointed it out," she said. Once, when meeting her

Australian Institute of Marine Science (AIMS) Technology Development Engineering Team Leader Melanie Olsen with a prototype autonomous underwater vehicle.

AIMS

U.S. collaborators face-to-face for the first time, they were surprised to discover she wasn't a bloke called 'Mel' (short for Melvin they had thought).

It wasn't unusual for stakeholders meeting her to assume she was the executive assistant rather than the managing engineer.

Throughout her career in a male-dominated industry, Olsen pushed through those awkward moments of being singled out, focusing on delivering solutions to the challenge at hand. While she loved her job, the long hours, overnight international teleconferences and short-notice travel was difficult to manage as a single mother with no family support nearby.

Olsen saw the opportunity to apply for a job closer to home with the Australian Institute of Marine Science (AIMS) position of engineering team lead, technology development. She started in 2016 and discovered there were many similarities to her role in Defense.

These days she leads an innovative team developing systems helping to protect coral reefs rather than national sovereignty. They are driving rapid technological innovation to open new capabilities for Australia's tropical marine research agency.

The aim is to design technological solutions to enable AIMS to meet its 2025 Strategy target to deliver twice the information in half the time and at half the unit cost.

This includes introducing autonomous vehicles and artificial intelligence (AI) to make data collection and analysis more robust, efficient and safe. These solutions are being sustainably integrated into AIMS' tropical marine observation network.

She is also Project Director of ReefWorks, AIMS' newly established tropical marine technology test range, the first such facility in Australia. ReefWorks offers a national capability to test marine technologies, remotely-piloted and autonomous systems, and new sensors in a secure, tropical marine environment.

It opens opportunities for the marine autonomous systems industry and Government organizations such as Defense to harness AIMS' capability, tropical marine expertise and nimbleness in conducting test and evaluation, as well as enabling AIMS scientists and engineers to learn from colleagues in related industries.

Olsen has been the IEEE (Institute of Electrical and Electronic Engineers) Northern Australia Section Chair since 2020, joined the Australian Army Reserves in 2019 and is a competitive powerlifter. She's a member of the AIMS Equity, Diversity and Gender (EDGE) Working Group which was awarded Athena Swan Bronze status in 2020 for its commitment to improving gender equity, diversity and inclusion.

Her advice to girls and women seeking a career in engineering is simple: "Civilization was built on people giving it a crack. Don't go in worrying you are not capable or good enough. You'll learn as you go, and soon you'll realize that no one has all the answers."

All images: KAUST

Raquel S. Peixoto is t

The world's coral reefs are in crisis, with climate change emerging as the biggest threat of mass coral reef bleaching. Coral reef health walks hand-in-hand with overall ocean health, in addition to supplying effective shoreline protection and supporting businesses globally, from fishing to tourism. In the search for solutions, Professor ***Raquel S. Peixoto*** *and her team at the King Abdullah University of Science and Technology (KAUST) have reportedly found a new method to aid the stress tolerance and resilience of coral.*

By Greg Trauthwein

MARINE TECHNOLOGY TV
Watch the video @ bit.ly/2TGw9md

Coral Warrior

...the ...

Professor Raquel S. Peixoto is a marine microbiologist from Brazil, the co-chair of the Coral Conservation Committee with the International Coral Reef Society and an associate professor at KAUST, leading a team of researchers and the students trying to better understand the microbiome associated with coral, essentially developing a microbial therapy to protect coral reefs.

"Coral reefs are a unique and biodiverse ecosystems," said Professor Peixoto during her recent interview with MTR TV. "About 32% of the named marine species depend on coral reefs, although they only cover a 0.1% of the ocean surface. On top of the immense importance of these ecosystems, biologically and ecologically speaking, they also protect our coast against waves and storms. About 90% of the height and energy of waves are actually minimized or dissipated by coral reefs."

The rise in greenhouse gas emissions and resultant marine heatwaves and ocean acidification has led to coral bleaching and the decrease of calcification rates of not only corals, but other marine calcifying organisms, according to Professor Peixoto. "On top of this global threat, we also have local impacts that can increase the damage: pollution, land use, agriculture runoff and over fishing," to name a few. According to Professor Peixoto, there is an urgency to the situation. "We've lost about 50% of the coral reefs in the last 50 years. And about 90% of the coral reefs have bleached at least once in the last years. We have a closing window of opportunities to protect coral reefs."

While the research continues at a local level, early results are promising as Professor Peixoto and her team have reportedly found a way to reverse the damaging effects global warming has on coral, increasing bleached coral reefs' survival rate

by 40%.

Professor Peixoto and KAUST are well-positioned for this R&D with its proximity to the Red Sea, an ecosystem with coral that withstands the rigors of high summer averages nearly 90° F, a temperature that kills coral in other oceans. The KAUST studies are aimed to understand how Red Sea corals survive these temps, in order to potentially help corals elsewhere.

BMC: Rebuilding the 'Breakdown in Harmony'

"Coral bleaching is the event when the photosynthetic algae living within corals leave the coral, and with them take about 80% of the energy and carbon sources that are important for coral feeding," said Professor Peixoto. The increased water temperature stress the algae (to the point that it starts) to produce toxic compounds that are toxic for both corals and algae. Because of that, the symbiotic relationship that is so important for corals to survive is affected and the algae leaves, or is expelled by the corals. With the energy, they also take part of the color as these algae have this brownish pigment. And this is why we call it bleaching."

But the problem isn't simply a matter of discoloration, as Professor Peixoto explains "the most important problem is not the color, but the energy, and then the nutrients that are being lost by these corals. Not only is the algae important, but all the microorganisms living within corals."

With the biosystem out of whack, the beneficial bacteria living within corals are also impacted by dysbiosis process. "That means that we have these organisms living in harmony with their microbiome. There is the breakdown of these harmonic relationships. We have a cascade of problems. What we are trying to do is that we are trying to reboot it. We are trying to make sure it is beneficial microbes are not going to be lost," said Professor Peixoto. "And more than that, we are trying to make sure that they can actively protect the algae, protect the corals and make sure that the algae will last, it will stay longer within the corals, for example, or at least that the corals will survive until the algae is back. So what we are trying to do is to reboot this process, and make sure that we keep the beneficial microbes. It's a very similar approach when we humans take yogurt before taking antibiotics."

BMC is a method developed by Professor Peixoto and her team at KAUST to manipulate specific microbes to aid the stress tolerance and resilience of coral. To date, the results have been impressive:

- **Increase bleached coral's survival rate by 40%** and stabilize photosynthetic performance by the endosymbiotic algae.
- **Trigger a dynamic microbiome restructuring process** that instigates genetic and metabolic alterations in the coral host that eventually mitigate coral bleaching and mortality.
- **Exert an overall "healing effect"** as evidenced by increased recovery and stress attenuation processes in coral gene expression.

Early Findings

Professor Peixoto and her team at KAUST are collecting corals and isolating bacteria. "It's very important that we use common marine bacteria, abundant bacteria known for being beneficial. They are not known for causing any disease to any living organisms. We select this part of the microbiome and then we run a screening for potentially beneficial mechanisms. Some bacteria that can increase the input of nutrients, some bacteria that can actually degrade the toxic compounds that cause the bleaching. Some bacteria are antagonistic bac-

teria against pathogens. The result is a consortium of bacteria that can provide beneficial mechanisms for the host, the coral. "We then inoculate the corals with this cocktail, or this consortium of different bacteria, hoping that together, they can mitigate the potential problems," said Professor Peixoto. She said to date "the results indicate that we can prevent bleaching in some cases and we can also increase the recovery of some of the coral species. It looks like different coral species will respond differently to this type of approach. So far, all the attempts that we've done in the lab have been successful."

She added that it looks like, even in normal conditions, these BMCs can be helpful for corals to become healthier, enabling them to grow even better.

Taking results from the lab to real world applications can oftentimes hit a stumbling block: funding, particularly in deploying the solution globally.

"As to the cost, it's really a rough estimate, as so far we haven't even started to try to optimize it," said Professor Peixoto. "Right now we are still trying to prove the concept."

Pressed for an estimate, she said the system could be established in three to five year, and a 'guesstimate' would be a treatment cost of around $600 to $700 per square kilometer.

What is Mass Bleaching?

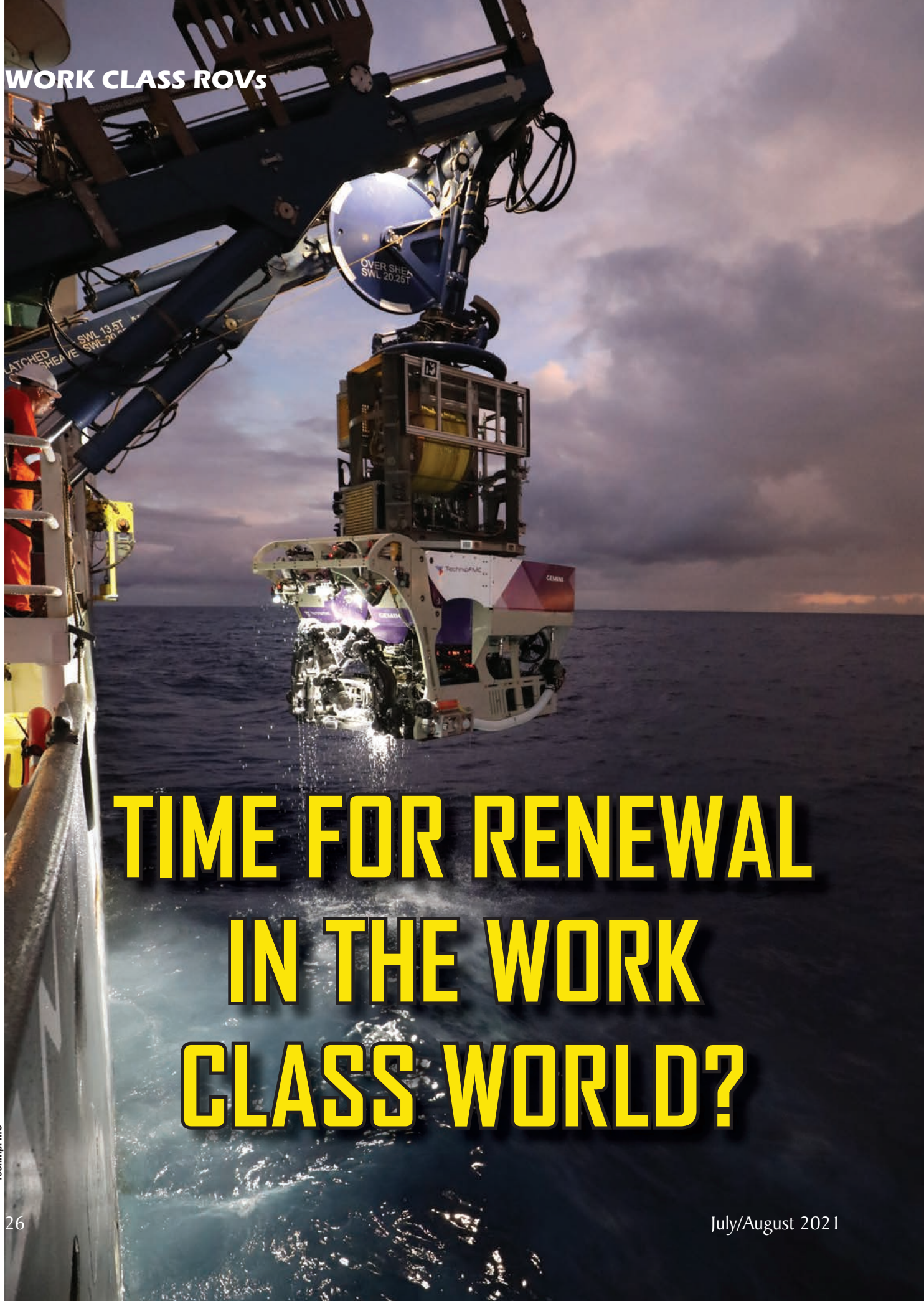
According to the National Oceanic and Atmospheric Administration (NOAA), in 2016 heat stress encompassed 51 percent of coral reefs globally and was extremely severe—the first mass bleaching (85 percent bleached) of the northern and far-northern Great Barrier Reef killed 29 percent of the reef's shallow water corals. Bleaching also occurred in much of the western Indian Ocean, including 69 percent to 99 percent of corals bleached and 50 percent dead in the Seychelles.

The third global bleaching event, from 2014 to 2017, brought mass bleaching-level heat stress to more than 75 percent of global reefs; nearly 30 percent also suffered mortality level stress. This bleaching event was the longest, most widespread, and most destructive on record.

Source: NOAA

Meet Professor Raquel S. Peixoto

Professor Raquel S. Peixoto is an associate professor of marine science at KAUST. Her research is currently focused on outlining how the manipulation of coral-associated microorganisms, using Beneficial Microorganisms for Corals (BMCs) is possible and can increase the host's resilience and resistance against environmental threats. She conducts research at the KAUST Red Sea Research Center, where she is developing a Red Sea Microbial Vault (inspired by the Microbiota Vault) to learn more, collect, store, and analyze microbes from the Red Sea. Professor Peixoto believes that the Red Sea could hold answers for the aid and recovery of corals around the world. She received her Ph.D. in microbiology, M.S. in biotechnology and B.S. in biological sciences from the Federal University of Rio de Janeiro, Brazil.



TIME FOR RENEWAL IN THE WORK CLASS WORLD?

TechnipFMC

Isurus is based on Oceaneering's Magnum Work Class ROV system with a hydrodynamic design.

There are tentative signs of the start of a renewal in the work class ROV fleet. ***But what form will it take?***

By Elaine Maslin

The work class ROV (WCROV) market has taken something of a battering over the past few years. The 2014 downturn and then a pandemic has meant the ROV services market and the fleet have suffered, alongside the rest of the offshore industry.

Oversupply, thanks to a spate of investment in new vehicles through 2010-2014, and a drop in demand has meant there's been little appetite for new WCROV investment, says George Shirreffs, VP sales and marketing, Schilling Robotics, TechnipFMC.

In addition, there have been new types of vehicles coming into the market, like the Reach Surveyor and soon also Oceaneering's Freedom, taking on some of the work WCROVs previously did, such as pipeline survey.

There are now, however, signs of light. For one, activity did recover in the latter half of 2020, says Peter Buchanan, Director Products and Services Subsea Robotics and Tooling (SSR), Oceaneering. In addition, the offshore wind market has been making more use of WCROVs, enabling them to do cable lay survey and cable pull in, for example, with one vehicle, as well as handle the high currents often found in shallow water offshore wind areas, he says.

Oceaneering's Isurus, launched in 2019, has been making ground in this market, where the likes of heavy lift/cable lay operators have swapped out their vehicles, such as a Millennium for an Isurus, which is specifically configured for high current operations, says Buchanan. For a cable lay operation, the ROV is a pacing item; if it's slow, it's holding up the cable lay operations, which can be a $350,000k/day cost, he says.

Shirreffs also sees positivity. "We are starting to see the shoots of the next growth cycle," he says, which includes interest from renewables. It's also about time for a new investment cycle, adds Peter MacInnes, TechnipFMC's marketing director, ROV Services. These occur usually every 10-12 years and are often also linked to technology progression, he says. In the past, that's been about increasing reliability, depth rating and power, with uptime as a key metric. Now, TechnipFMC is looking instead at productivity, he says, the result of which is their Gemini WCROV, of which it's operating two in the US Gulf of Mexico. Part of this is about automation. On Gemini, tool acquisition is no longer a manual piloting task, it's an automated manipulator task, using machine vision and force accommodation, Steve Cohen, Vice President of Product Development at

Fugro's FCV ROV

Fugro

Schilling Robotics in TechnipFMC, told the Underwater Technology Conference, held online in June. Staying subsea longer is also part of it; Gemini has achieved a 28-day dive duration and 120-day capability is on the horizon, he says.

AUTOMATION AND REMOTE OPERATIONS

Oceaneering has Video Tracking and Positioning (VTAP), a form of machine vision technology, to enhance dynamic positioning of its vehicles relative to objects in the field, such as a valve panel, allowing pilot supervised hands hot stab operations, for example. Automation supports another growing area; remote piloting. With more automated tasks, using VTAP, any latency is easier to overcome, says Buchanan, although the 4G networks now available limit latency. Oceaneering has, across all its systems, done 50,000 hours of remote piloting on 3300 operations (including remote survey) using 22 WCROVs, says Buchanan, from remote pilot centres in Morgan City, Stavanger and soon another in Aberdeen. While Oceaneering's Liberty system (the E-ROV with a cage and battery pack) is 100% remote operated, remote piloting of the rest of the WCROV fleet is a hybrid set-up – onshore pilots supplement offshore ones.

ROV crew will still be needed offshore for some time, to support launch and recovery operations and vehicle configuration and maintenance, he says. But also having onshore pilots lowers how many crew have to be sent offshore, reducing bed space constraints, HSE risk and logistics, and means crew spend less time offshore not doing anything. Also, says Buchanan, specialists can more easily be brought in for specific tasks when they only have to visit an offshore pilot station. "Until the system itself changes fundamentally, it's still designed to be maintained regularly," he says.

"For Fugro, the entire strategy is about doing as much as possible remotely and with uncrewed systems," says Ivar de Josselin de Jong, Director Remote Inspection at Fugro. "Our strategy is that everyone who is only looking at a screen will work from a remote operations centre in the future." In addition, operating remotely operated vehicle (ROVs) from an uncrewed surface vessel (USV) in an uncrewed environment, makes going all electric "a no brainer". Fugro has a fleet of ROVs, from smaller systems to its own range of FCV WCROVs, and a network of eight remote operations centres, although WCROVs are not operated from these yet. It's now adding new electric vehicles to the fleet that will be operated remotely via its new uncrewed surface vessels (USVs), including the Blue Volta and Blue Amp, a new light work class vehicle.

ROV ELECTRIFICATION

Electrification of heavy duty WCROVs will come, in time, but will be a challenge, he says, "because of the power requirements and that also has an impact on how far you can go with autonomy and potentially even tetherless operations, because there's a limited amount of energy." There will also still be a place for crewed ROV vessels and more traditional systems, when they're needed. Moving to all electric also has another challenge; the availability of electric tooling, as the market is dominated with hydraulic systems currently.

Others are also developing electric systems – including tooling. SMD unveiled its electric vehicle (EV) WCROV early last year. Saipem is working on the Hydrone W fully electric work class ROV. Saab Seaeye is developing an all-electric full work class ROV (bigger than its Leopard work class ROV, which in large part took over the work of Saab's Jaguar, because it was smaller and more powerful). Part of this move has been Saab's development of a T4 equivalent electric manipulator, or e-manip, which is currently being beta-tested by a client in the U.S. (it's also been trailed on a Sabertooth, although it wasn't designed for this vehicle).

Going electric does have many benefits, says Buchanan, including lower power consumption and greater reliability. It would also support more hybrid states of operation, where an ROV is left on the seabed, for example, like the Liberty eROV system. Could that even mean being able to release the tether?

For TechnipFMC, the focus is on lowering the cost of ownership and environmental impact, but hydraulic will always still be needed, says MacInnes. While electric can work for survey or mapping, enabling greater propulsion efficiency, maintenance and repair operations still need hydraulic, "because there's a sea full of subsea production system equipment that requires hydraulic intervention," he says.

So, the future is more automated and maybe electric, with a greater mix of vehicles out there. Andy Rose, technical advisor at IMCA and a former ROV pilot, says, "I think we're going to end up with a split, with big WCROVs doing construction and installation jobs and what's traditionally been the inspection market will go over to AUVs, certainly for all survey." We'll be moving away from tethers, using better batteries and get better at sending information and controlling things under water, he says, as a drive to reduce reliance on crewed vessels continues.

Oceaneering's Isurus ROV, designed for harsh current operations in offshore wind work.

Fugro

LIDAR Helps to Illuminate the Future of Oceans

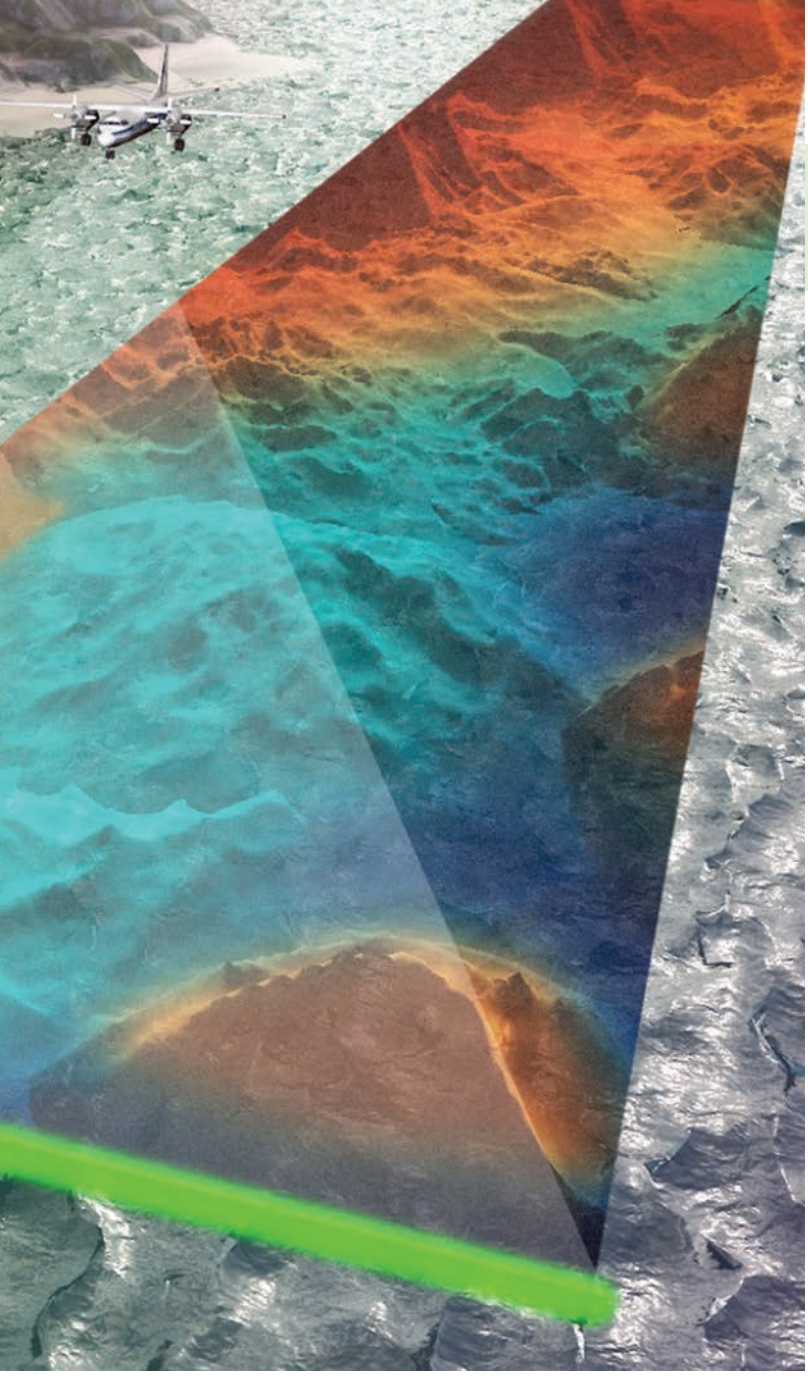
By Celia Konowe

The statement that 80% of our world's oceans remain unexplored is well known—and possibly, overstated. Observance of United Nations World Oceans Day on June 8 underscored the determination to better understand and protect our waters. While limitations in the ocean still inhibit the same level of progress that we've achieved on Earth's terrestrial surface, some of the same technology is playing a role in the game of marine catch-up.

Lidar, which stands for "light detection and ranging," utilizes laser light to measure distances on Earth and produce 3D models of the surveyed area. The technology is either topographic or bathymetric, employing a near-infrared laser for the former and a water-penetrating green laser for the latter. Lidar data enables countless applications, including examining natural and manmade environments, transportation routes, and maintenance inspection. In the marine world, lidar has gained a reputation for increasing our exploratory efforts and, more recently, for examining the coastal ecosystems, communities, and structures that grow increasingly sensitive to climate change and intensifying weather patterns.

Lasers: A Shore way to Protect the Coast

Velodyne Lidar, a lidar solutions company based in California, has recently partnered with Seabed B.V., a technical solutions group from the Netherlands, to help complete a lidar



35kg RAMMS ALB sensor offers a unique combination of scanning capability (2ppm density & 3x Secchi penetration), and small form-factor.

mobile mapping system. With the goal of protecting sensitive shorelines through sustainable planning, Velodyne's contribution is the Puck lidar sensor, which will complement Seabed's existing mapping technology.

"Velodyne produces technology to help machines 'see'—the Puck can be considered the eyes of the application. It collects real-time, surround view, 3D-distance and calibrated reflectivity measurements to detect potential hazards, even in a wide variety of lighting and environmental conditions, including in the dark, where cameras struggle," Executive Director Europe Erich Smidt explained. Velodyne's Puck sensor will help provide holistic, above-water point cloud data, including specific measurements of inshore, nearshore and inland waterways from up to 100 meters away, and is designed to be mobile and easy to use without specific training, saving both time and money in data collection.

The implications of this work are seemingly limitless. Aside from conserving sensitive historic and marine environments, Velodyne's lidar technology can be paired with a bathymetric echo-sounder to provide complete, above- and below-water 3D imaging. This data can be used to assess bridges, piers, dams and other infrastructure, further helping sustainability planning, as well as navigation safety. Sustainability, though, may be a growing cause.

Fugro is also tackling the coastline protection head on. For the first time in the UK (previous applications have occurred in North American and the Caribbean), its Rapid Airborne Multibeam Mapping System (RAMMS) will be used to collect bathymetric lidar data. Coastal flooding has become a concern due to rising sea levels and intensifying weather patterns and the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland has called for a study of the 763 km coastline. "A recent report by The Lightsmith Group has highlighted costs of $167 to $357 billion a year by 2030 to tackle climate change in developed countries with an expected $119 billion of global costs annually linked to extreme weather events by 2040," said Chris Boreland, Fugro's business development manager for remote sensing and mapping solutions. Unfortunately, this means that human-made and natural environments along coastlines will be at the forefront of climatic impact in the coming decades.

DAERA's hope is to create a baseline survey across Northern Ireland that will identify areas at highest risk of coastal erosion and flooding now and into the future. The consequent 3D model will be a tool for policymakers and coastal managers alike. "The issue is that the coastal environment, particularly the nearshore or 'white ribbon' region, is extremely challenging to survey," Boreland explained. "Survey vessels can't get close enough due to the shallow water and wave action, and it's too dangerous for onsite surveyors to wade out."

Fugro's RAMMS sensor can be operated from a small aircraft or unmanned aerial vehicle to capture high-resolution data three times the depth of visual water clarity. The system pulses rapid beams of light from the sensor, which travel to the ground or seafloor and are then reflected back. The returns are collected by the system and converted into a surface map of the ground or seafloor. What makes RAMMS unique, Boreland explained, is that it uses a green laser. "The light penetrates the water column and can return seafloor data to 3× Secchi depth, which means three times the penetration depth of natural sunlight in a given water column."

RAMMS can also be combined with other remote sensing technologies for variety of imaging needs, bathymetric or topographic. Additional applications include nautical charting,

coastal and marine engineering, coastal zone management, and storm modelling. Fugro hopes their work with DAERA is only the start: "The implications of this could be the roll-out of this technology across most of Europe's coastline to help countries understand how erosion there will affect them in the medium-to-long term," Boreland said.

Some scientists, however, are taking the capabilities of lidar a little farther.

Seeing Beyond the Laser

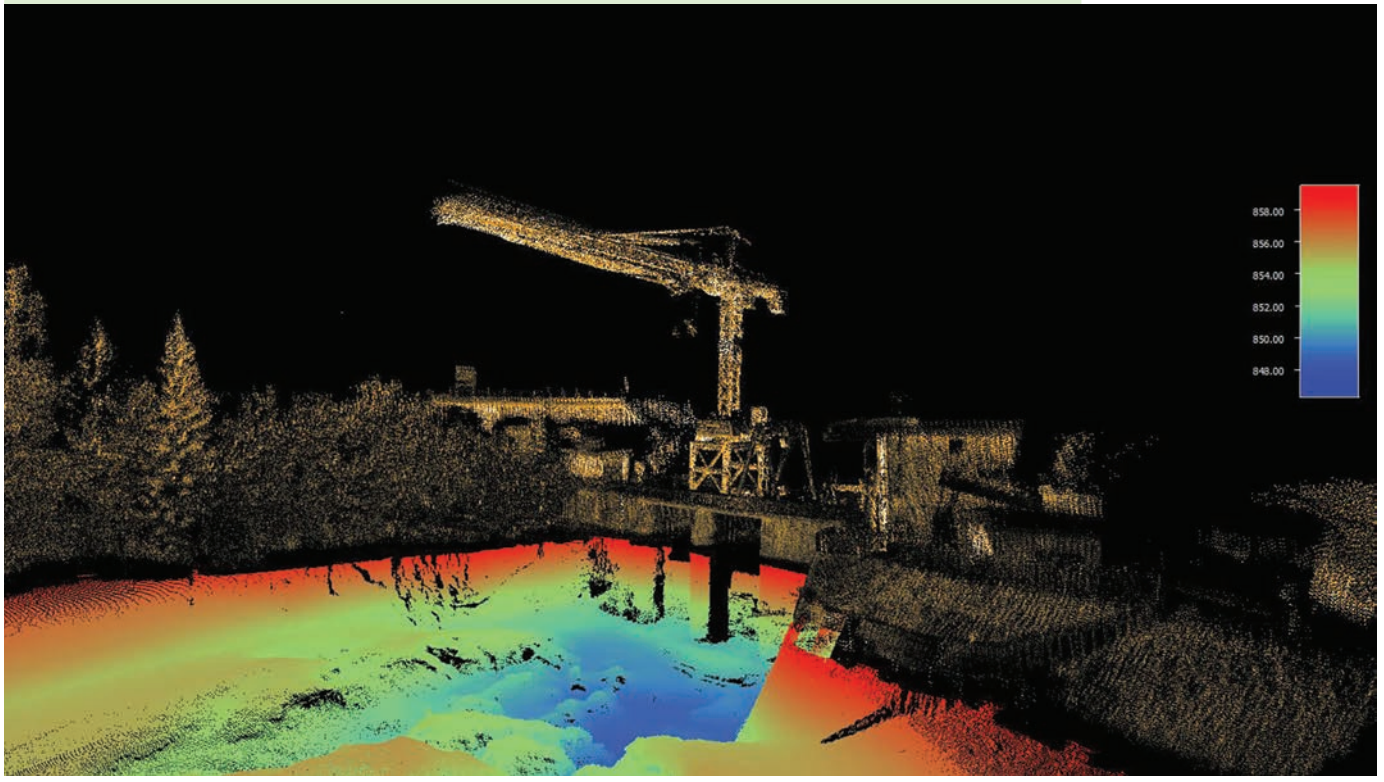
The abilities and scope of lidar applications have advanced significantly in recent years, providing more technological solutions to climatic and other challenges faced by the marine industry. Subsea exploration has remained a fascinating mission for humankind with most of our oceans remaining unexplored, despite technological advancements, due to crushing pressures, freezing temperatures, and pitch-black darkness. One tactic to overcoming these limitations, however, may use more than just lidar.

Engineers at Stanford University have developed an aerial solution for underwater imaging by combining light and sound, each filling in the gaps created by the other. Electromagnetic radiation (such as visual light, microwave, and radar signals) loses energy when passing from the air to the water and vice versa; soundwaves struggle in a similar sense. The hybrid Photoacoustic Airborne Sonar System (PASS) leverages the best of both, with the hope of eventually conducting largescale aerial marine surveys that are comparable to those of Earth's terrestrial landscapes in terms of feasibility and detail.

PASS works to circumvent the air-water interface, first firing a laser from the air that is absorbed at the water's surface. As the laser is absorbed, it generates ultrasound waves that reflect off underwater structures, whether natural or manmade, and then travel back to the surface. The returning soundwaves, recorded by transducers, are still sapped of some of their energy upon breaching the surface, but less than in sonar-only applications since energy is preserved by generating the soundwaves with a laser. Software is then used to piece the acoustic signals together into a 3D model. "Similar to how light refracts or 'bends' when it passes through water or any medium dense than air, ultrasound also refracts. Our image reconstruction algorithms correct for this bending that occurs when the ultrasound waves pass from the water into the air," said Amin Arbabian, study leader and Stanford associate professor.

While current experiments are being performed in static water, work is being done to transition PASS for use in water with waves, a more challenging task. In the future, tests will be conducted in a larger setting, eventually moving into open-water

The iLiDAR system conducts 3D data capture of intricate measurements of inshore, nearshore and inland waterways from up to 100 meters away.



Seabed

environments, making PASS and the future of lidar technologies truly boundless.

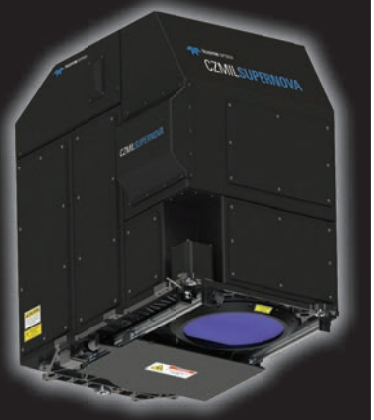
A Mappable Future

In an ever-changing world, surrounded by oceans that remain largely a mystery in their complexity yet increasingly sensitive to climate change, lidar technology has paved a path towards further exploration and understanding. Its applications have proliferated beyond protecting sensitive marine and coastal environments. "Lidar can also be deployed for the updating of nautical charts and most recently, we have deployed it on cable landing sites connected to offshore wind farms and undersea fiber communication projects. Moving into the future, this technology will become the standard solution for mapping and ongoing monitoring of the white ribbon around our coastlines," said Boreland.

Additionally, lidar has found a home in the realms of maritime vessels, security, shipping and container handling, and automated guided vehicles by providing real-time position data on people, objects and port infrastructure. "Lidar-powered automation can improve efficiency and safety, while also reducing costs and risks in seaport, marine and intermodal terminal operations," explained Smidt. "Lidar sensors are becoming a valuable component to port equipment and vehicles, helping to enhance reliability and predictability."

As lidar becomes more autonomous, affordable, and effective, our opportunities to explore and protect expand as well. The ticking clock of climate change and human's unsatiable curiosity are our motivators, pushing the boundaries of what is known in the name of need and knowledge. This year's World Oceans Day webinars and social media reinforced the centrality of oceans for maintaining all life on Earth. Rapidly improving lidar technology and creative, new applications for it represent vectors to achieve that mission. The resulting solutions and discoveries will be as boundless as the seas below.

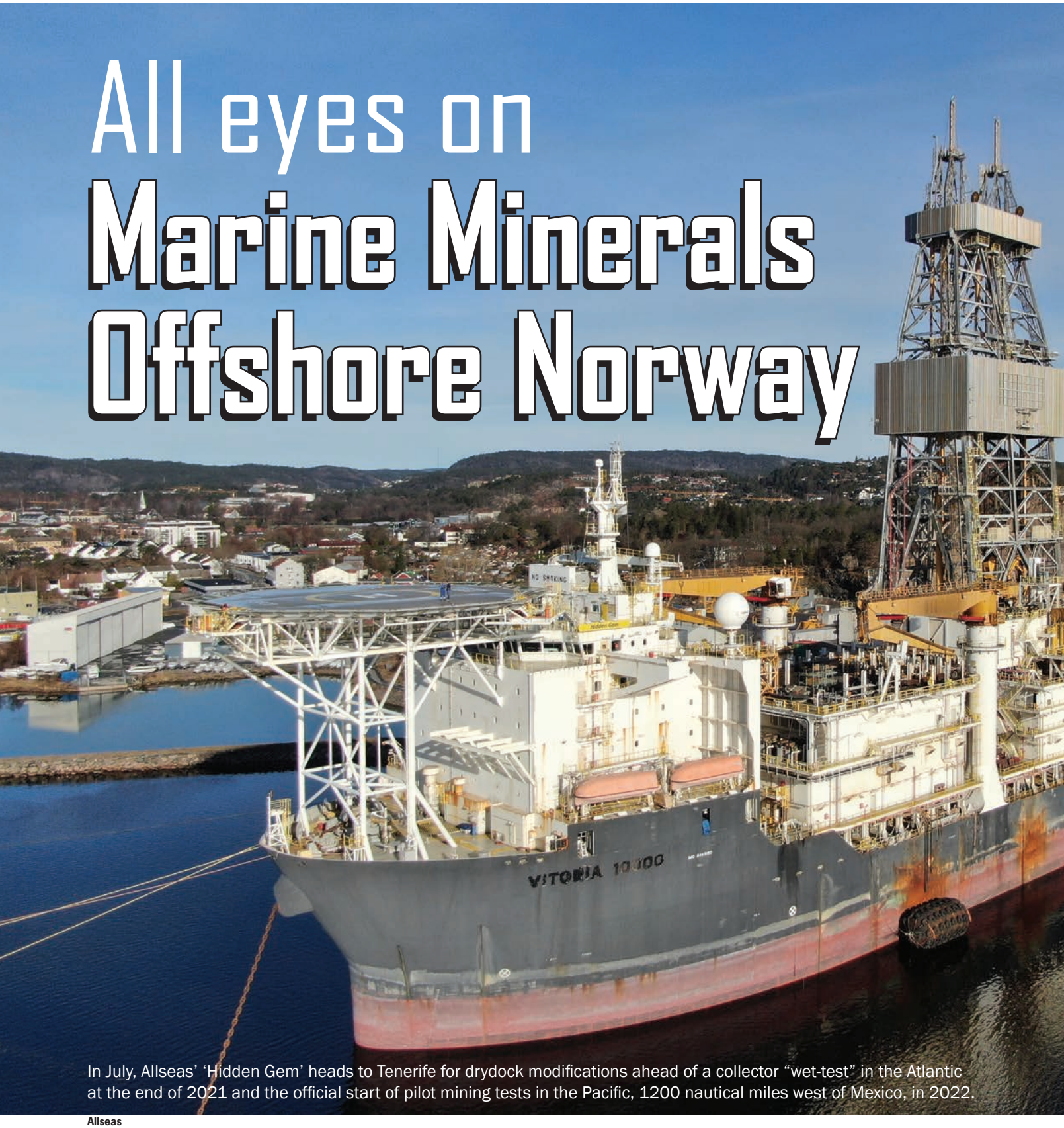
Teledyne Optech launches CZMIL SuperNova



Teledyne Optech and Teledyne CARIS announced its next-generation bathymetric lidar, the CZMIL SuperNova, which is touted by the companies as having the best depth performance and the highest green laser point density in its class. Introducing SmartSpacing technology for even and efficient point spacing, real-time processing capability for reduced post-processing time and configurable modes for maximizing performance in different water environments, the SuperNova provides a wide range of inputs for climate change modelling and is Ideal for inland water environments, base mapping for coastal zones and shoreline.

To complete the solution, Teledyne CARIS has integrated its BASE Editor software for seamless data processing capacity. Leveraging AI techniques for land/water discrimination and noise classification the CZMIL SuperNova bathymetric solution effectively delivers on marketplace demands for efficiencies in the processing workflow.

All eyes on Marine Minerals Offshore Norway



In July, Allseas' 'Hidden Gem' heads to Tenerife for drydock modifications ahead of a collector "wet-test" in the Atlantic at the end of 2021 and the official start of pilot mining tests in the Pacific, 1200 nautical miles west of Mexico, in 2022.

Allseas

Marine minerals are coming under sharp focus offshore Norway. Analysts suggest it could be a $20 billion annual revenue industry by 2050, which is why many are taking an interest and developing the technology to make it happen. ***Elaine Maslin reports.***

Marine mineral mining has been something of a slow burner in the wider marine world. It has some clear challenges, not least location and depth of these potential resources, but also concerns around its environmental impact.

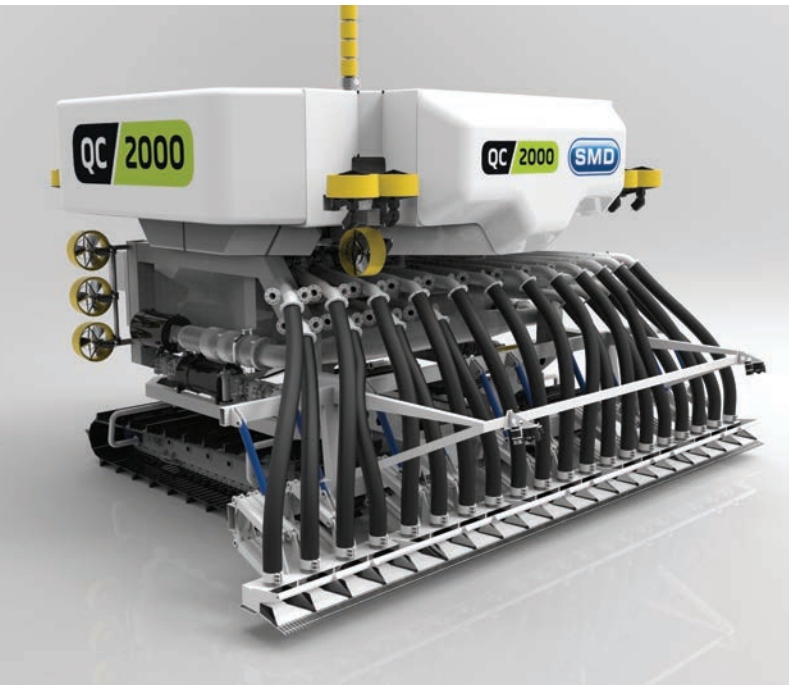
Yet it now appears to be coming into a distinctly sharp focus, not least in Norway where, early June, Norwegian Minister of Petroleum and Energy Tina Bru told a conference that "seabed minerals has the potential to become a new and important industry for Norway, the resources are present and accessible."

Norway is starting a process to open areas of its continental shelf for mineral activity, led by the Ministry of Petroleum and Energy. Impact and resource assessments are underway, including a research study of the Knipovich Ridge this year, before a decision on opening areas for mineral exploitation is made, Cecilie Myklatun, Chief Specialist at Norway's Ministry of Petroleum and Energy, told the one-day, online marine minerals seminar, organised by GCE Ocean Technology and Norwegian forum for Marine Minerals (NMM).

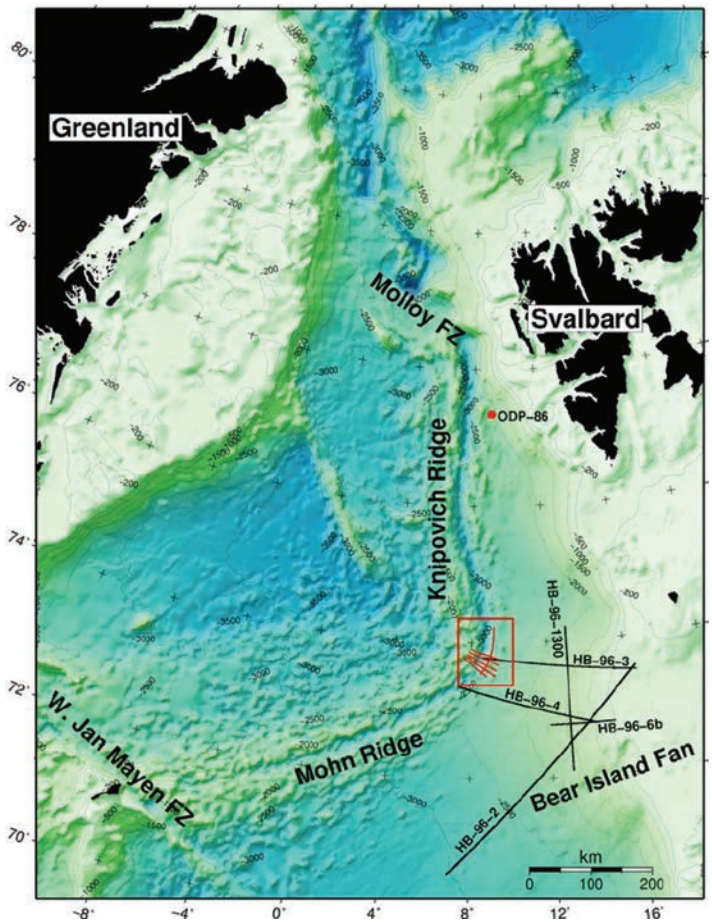
There are a number of drivers for this enthusiasm for seabed minerals exploration and harvesting. Myklatun says that according to the International Energy Agency, current investment plans for mineral supply falls short of needs for making the likes of solar panels, wind turbines and electric vehicles. Others says there's enough copper on land, but the grades are dropping so cost and environmental impact are increasing.

A report from November 2020 by Norwegian analysts Rystad last year pointed to the potential for a $2 billion service industry in Norway, to support a (again) potential $20 billion annual revenue marine mineral extraction by 2050. It pointed to massive sulfides (which originate from hot vents in the ocean where sulfide-enriched water flows out of the seabed, typically in 2000-3000m water depth) as having the most potential in the country.

Not everyone is so keen. Karoline Andaur, CEO WWF Norway, points out that Volvo, Samsung, BMW and Google have called for a moratorium on deepsea mining until we know what impact it would have. "We are just beginning to discover



• SMD's QC2000



Rolf Mjelde, University of Bergen

the mysteries of the species of the deep," she says. "We can't risk long term and irreversible damage to these eco-systems. We need to understand the deep sea before any deep sea mining can take place."

Others, like Prof. Miguel Miranda, President of IPMA, Portugal's national ocean laboratory, told the event that we will need marine minerals, but they're also a finite resource we should look longer term on how we can manage them so that we don't have to keep mining. Prof Miranda also says we should be careful about what we mine first, targeting nodules first, as harvesting them is potentially less harmful to the environment.

Nevertheless, exploration for marine minerals has been going on since the 1990s, says Harald Brekke, Senior Geologist Norwegian Petroleum Directorate and Chair of the Legal and Technical Commission International Seabed Authority (ISA). Regulations for exploration of polymetallic nodules (potato-like rocks on the seabed formed of layers of iron and manganese hydroxides around a core) were adopted in 2000. However, the same for exploitation, under expected 30-year licenses, isn't expected until 2022, at the earliest.

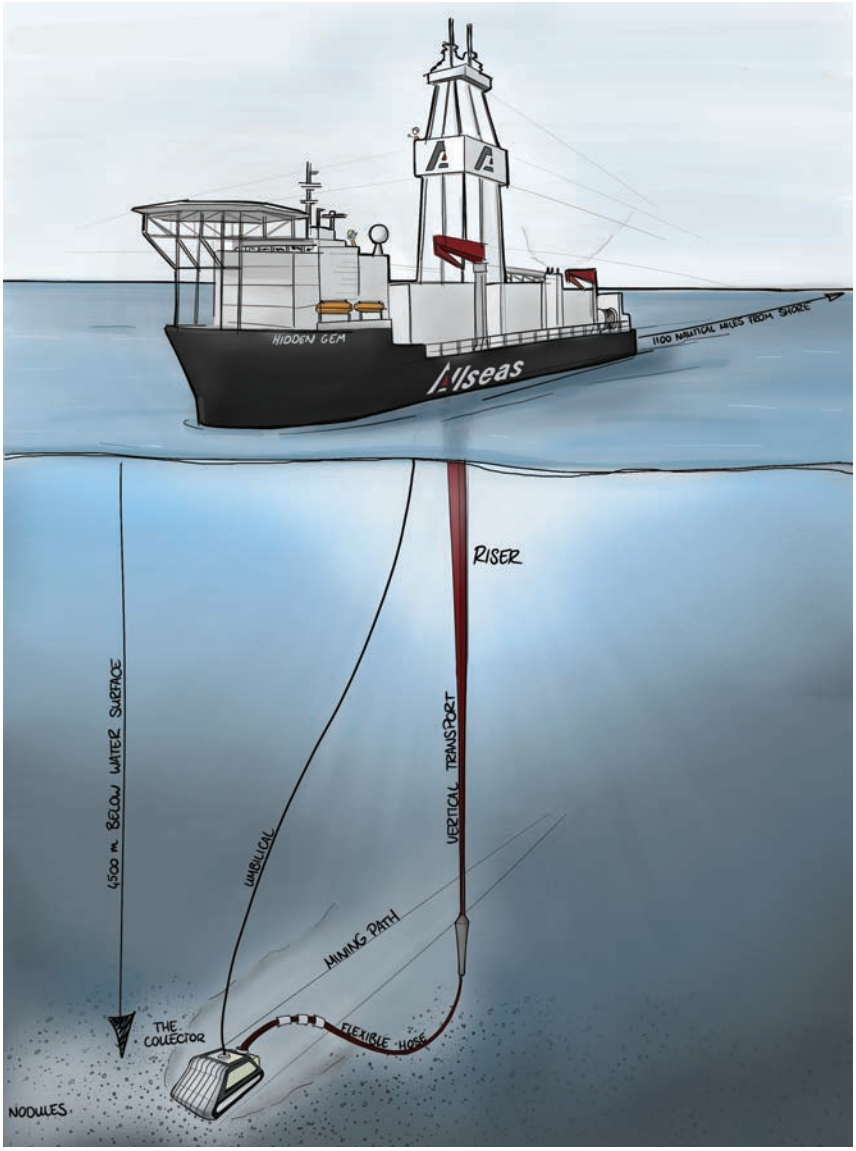
Still, companies are gearing up for this activity, creating technologies to support mineral mining. In what's been billed as a world first, Belgium-based DEME Group's Patania 2 nodule collector has been undergoing trials in 4,500 m water depth in the Clarion Clipperton Zone of the Pacific Ocean (where it had a minor disconnection mishap in April). Soil Machine Dynamics in Newcastle, UK, recently unveiled a new nodule collection solution, the QC2000 Nodule Collector. As well as acquiring a drillship for conversion to a nodule collection vessel (to be named Hidden Gem), Allseas is also working on a deep-sea mining harvester and riser system to gather mineral-rich nodules from the seafloor, in partnership with DeepGreen, now known as The Metals Company. New York-based Pliant Energy Systems has a more sci-fi looking robotic concept to collect nodules from the seafloor. There are many more developments out there.

But back to Norway. The Norwegian government's interest in opening areas for mineral exploration has sparked a raft of new home-grown companies, many founded by former oil and gas or subsea industry executives. Loke Marine Minerals, for example, was founded late 2019 and is focusing on technology needs for exploration and production of seafloor massive sulfides and manganese crusts (rockhard layers on the flanks of submarine volcanoes called seamounts), both found on the Norwegian Continental Shelf, between Jan Mayan and Svalbad.

Tore Halvorsen, formerly of TechnipFMC and who now heads Technology and Operations at the firm, sees opportunity

Fig.1. Bathymetric map of the northern part of the Norwegian-Greenland seas and the continental margins, showing the mineral Knipovich and Mohn Ridges.

for technology and business development and says that the oil and gas and subsea heritage of Norway puts it in good stead. “There’s no off the shelf mining system for seafloor massive sulfides or manganese crusts,” he says. “The good thing is we have 50 years’ experience in oil and gas and it has a lot to offer mining.” The technology for rock cutting also exists, he says. What’s different in marine mineral mining is a new combination of environmental considerations, such as distance from shore (about 700km in fact, from the mainland), water depth at up to 3500m and winter temperatures reaching down to -27 degrees C, he says, in addition to limiting impact on the environment. “The key message is we need to spend enough time understanding the challenges, plan for it and solve it before we kick off,” he says.



Schematic: Allseas is also working on a deep-sea mining harvester and riser system to gather mineral-rich nodules from the seafloor, in partnership with DeepGreen, now known as The Metals Company.

"The challenge for offshore mining (massive sulfides) is continuous mining in 3.5km water depth," he says, and getting the ore (up to 6,000 tonne of it per day) to the surface and then transferring it to shuttle tankers every seven days (amounting to some 50,000 tonnes) or perhaps wet-storing it subsea. Pumping systems, hot swappable units to maintain uptime and large-scale water treatment will be needed, in the region of 120,000 b/d, so that only clean water is discharged back to sea, he says. That all amounts to about a 30MW power requirement, which, today, would need to aim to be zero emissions, which means hydrogen or ammonia.

"None of these are show stoppers, but they have to be accommodated to have a robust system," he says. "These sulfides are in clusters and each could be up to 300m wide and up to 250m deep. So the tool has to do horizontal and vertical cutting." Loke has been looking at a system with dual drill cutters with an integrated suction box behind the cutter heads to allow suction of ore direct from the cutter heads to prevent plumes."

"Manganese crust requires a different approach," he says. They have higher porosity and low compressive strength and occur in layers on sea mounds <25cm and with relatively harder substrate. They're often on steep and uneven surfaces, making harvesting harder for larger cutting tools, he says. "There's been limited interest (in crusts), primarily due to lack of mining technology," says Halvorsen. "Our approach is inspired by ROV technology, using small buoyant vehicles for cutting and collection. Several could be employed in an autonomous formation for scalability." The company is and developing cutter heads and collection technology, as well as traction systems. "It's very promising and we believe this technology can be a real answer."

Some technology that has been trailed is riserless coiled tubing, for gathering cores as part of the NPD's resource assessments. AUVs and ROVs have already been used for mapping and gathering samples, but cores provide much more information about resource potential. During the NPD's cruise on the Mohn Ridge last year, it drilled for cores using riserless coiled tubing operated by Haliburton, in 3,000m water depth, from the Island Valiant. Bjarne Neumann, Managing Director at service provider TIOS, says the target was to get as many cores

• During its cruise on the Mohn Ridge last year, the Norwegian Petroleum Directorate drilled for cores using riserless coiled tubing in 3,000m water depth, from the Island Valiant.

Images from service provider TIOS.

as possible in 2799-3085 m water depth.

"It was the first time coiled tubing used in this depths and on drilling sulfides," said Sissel H. Eriksen, Senior Advisor Exploration, Norwegian Petroleum Directorate. About 40 cores were recovered during 14 runs, with a total length of 10m. It was seen as a success, but wasn't easy. "It's like trying to pushed cooked spaghetti in to the soil," sys Eriksen. "It's a real challenge." But lessons were learned on how to do it better next time, says Neumann.

New ways to sample and core deposits is on the hit list for Bergen-based ADEPTH Minerals, which was founded last year. The firm's CEO, Anette Tvedt, says the primary tools for resource assessment are high resolution maps and cores, but more flexible and dynamic systems are needed to get deeper cores more easily than can be done today.

It's developing a system called Flexicore together with Seabed Solutions (co-founded the Hans Petter Klohs, who founded ADEPTH). It's a subsea core drill unit, based on land-based drilling technology modified for deep sea operations. The first unit will be developed for operations down to 200m initially, but it will in future be able to go deeper, she says. The system is being designed to drill on challenging terrain, at 20-30 degrees, and to drill at an angle, in order to assess out crops. "Quite a bit of work has been done on the drill bits to ensure can get through these rocks," says Tvedt. "We're also looking at how to minimise its impact. This machine has extremely low ground pressure. Also equipment to minimise sediment plume while drilling."

While not developed in Norway, IHC Mining has developed a vertical transport system, which has been tested in a 135m deep mine shaft and would be supported by a seawater lubricated and cooled permanent magnet motor driven pump. The latter has been tested in a fjord near Bergen at 425m water depth, but it could work at 6-9km deep with no issue, says Wiebe Boomsma, Manager Product Development, IHC Mining. "The next step is large scale pilot mining test to test the technology in full scale," he says.

SIMPLE USV OFFERS MULTIPLE SOLUTIONS

Hydronalix/Released

Hydronalix keeps finding new uses for Unmanned Surface Vessel Technology

By Edward Lundquist

EMILY may be a small unmanned surface vessel (USV), but she's a big idea that keeps getting bigger.

EMILY is the Emergency Integrated Life-saving Lanyard, made Hydronalix of Sahuarita, Ariz. It is a rugged, lightweight flotation device for up to six people that can also bring them back to shore and safety. The remotely-controlled USV can be rapidly deployed from the shore, off a bridge, or from a boat or aircraft to help people in danger of drowning.

EMILY was launched by Hydronalix CEO Tony Mulligan and Executive VP Bob Lautrup with a series of Navy sponsored Small Business Innovation Research (SBIR) investments starting as far back as 2001. Mulligan has continued to develop and extend the company's technology and its EMILY product line to provide multiple solutions to a wider array of problems.

The concept of a compact, battery-powered, water-jet propelled robot that's designed to assist lifeguards in the event someone is drowning or in distress has become the basis for a number of other versions and capabilities, from gateway communications buoys, covert surveillance platforms, mine hunters and infrastructure inspection systems.

"About 18 years ago I worked on STTRs and SBIRs with a small company, Advanced Ceramic Research (ACR), which made unmanned aircraft that were used in Iraq and Afghanistan," said Tony Brescia, a systems engineer with the Naval Air Warfare Center Aircraft Division at Patuxent River, Md. "Some of the aircraft systems and technologies we developed together are still flying with the Air Force and NOAA."

That small business was sold to a prime, and founder Mulligan, had a non-compete agreement that kept him out of UAVs. But, Brescia said, the good ideas developed through the SBIR/STTR program have continued to evolve into more and better ideas.

Mulligan started another company that focused on unmanned surface vehicles. Through the SBIR process of "extend derive

Meet EMILY the robotic lifeguard, officially known as the Emergency Integrated Lifesaving Lanyard. Created with support from the Office of Naval Research (ONR), EMILY is a remote-controlled buoy that recently was used to rescue nearly 300 Syrian migrants from drowning in the waters off the Greek island of Lesbos.

and complete," a number of the technologies that started out when Mulligan ran ACR continued to evolve and transition into work he was performing with his new company, Hydronalix. That has helped the Navy and the military, but has led to commercial success for Hydronalix. "The SBIR investments help us generate new technologies that create more growth on the commercial side."

From those efforts came EMILY, just one of the products derived through this partnership with the Navy. EMILY has captured the attention of the world, with hundreds of the lifesaving devices in use around the world. The robotic system can reach people in distress faster than a swimmer or someone on a surfboard. The brightly colored buoys weigh just 25 pounds and can travel at up to 22 miles per hours and a two-way radio, camera and lights for night missions. It can be thrown in the water, tossed off a boat or bridge, or dropped out of an airplane. The device has a tether so a swimmer in distress can grab it and be pulled to safety.

"This is not just for lifeguards," said Paige Day, a retired fire chief who now works for Hydronalix. "It's for public safety agencies. Not all police officers, firemen, fish and game wardens or park rangers are trained rescue swimmers, but they can perform a water rescue with this tool."

The Rockaway Beach Volunteer Fire Department in Oregon, which now has two EMILYs, used EMILY to save an entire family caught in a rip current in 2019.

Complete, derive and extend

SBIR encourages small businesses to "complete; derive; and extend," and EMILY has done just that. Hydronalix keeps finding new uses. The EMILY USV is now being outfitted with different sensors that can conduct a variety of

missions. In addition to the remote-controlled rescue EMILY, there's an autonomous SONAR Search and Rescue EMILY, Police EMILY, and SPEEDoo Water Sampling EMILY that can test sewage or industrial waste for hazardous substances or to monitor natural events such as a red tide bloom.

A more powerful model called Swiftwater EMILY is being used by the U.S. Border Patrol to rescue people in the strong current of the Rio Grande River along the U.S,/Mexican border.

While underwater surveys often require a ship and sophisticated equipment, Sonar EMILY can be packed up and delivered quickly to a disaster area and put to work right away.

"Sonar EMILY can be used to create sonar maps of the sea floor or look for bodies or missing objects," said Mulligan. "After Hurricane Dorian struck the Bahamas in 2019, we used EMILY at Marsh Harbor to survey the channel to enable ships to navigate into ports to deliver relief supplies, then moved on to Baker's Bay on Great Guana Cay."

Sonar EMILY is being used to monitor the integrity of bridges in Michigan. The Michigan Department of Transportation (MDOT) has a fleet of them.

''Any time we have a major storm event, inspectors are required to go out and monitor these bridges to make sure they're safe and that nothing catastrophic is going to happen to them,'' said Chad Skrocki, assistant bridge engineer for MDOT's Bay Region. "'In the past, scour inspections were difficult, especially during periods where water was surging. We wanted to come up with a method that was safe and easy for inspectors to use. Using the USV is much safer and less labor-intensive than traditional inspection methods for detecting scour. Sonar EMILY provides a great deal of information, in real time, to the inspector about what is occurring to the channel bottom below the water surface around the bridge substructures. The preliminary inspections can become far more efficient and then, if needed, we can use manned inspections to verify the things we've found with the USVs."

Casey Collings, an engineer and diver with the Great Lakes Engineering Group (GLEG), a company that does bridge inspections for MDOT, and actually bought a Sonar EMILY for themselves, said Sonar EMILY provides valuable intelligence before the divers enter the water, especially when the water visibility is low. "We may still have to dive, but now we know what we're getting into. We save a lot of time. More importantly, it's really important for diver safety," says Collings.

With Brescia's help, the DoD Domestic Preparedness Support Initiative provided either EMILY, Swiftwater EMILY or Sonar EMILY to first responders in New York, New Orleans, Honolulu, Kauai, Houston, Denver, Washington, D.C., and Norfolk. "The Los Angeles County Fire Department Lifeguards have been our main testing group since around the 2011-2012 timeframe," said Brescia.

U.S. Marine Sgt. Hadden Sherman, an explosive ordnance disposal (EOD) technician, assigned to 4th Platoon Littoral Explosive Ordnance Neutralization (LEON), 1st EOD Company, 7th Engineer Support Battalion, 1st Marine Logistical Group, works with an AMY unmanned surface vehicle used for sea floor mapping and mine hunting, as part of Baltic Operations (BALTOPS) 2021.

U.S. Marine Corps photo by Cpl. Robin Lewis

Virtually indestructible

"EMILY is made of Kevlar and aircraft-grade composites. It can handle a 30-foot wave. It can be thrown out of a helicopter or off bridges, Mulligan said. "It's virtually indestructible."

EMILY has been used in Mongolia and Kazakhstan during floods, in Indonesia for tsunami response, and in Greece to rescue migrants.

With Office of Naval Research funding, EMILY has been upsized to a 65" and 75" Autonomous Mobile Bouy ISR platform called AMY with tracking cameras, radar, weather station, and sonar imaging.

Most recently, EMILY, AMY, and a pair of other Hydronalix solutions--NIX and ADAPT—were used in demonstrations as part of the BALTOPS 2021 multi-national military exercises conducted in June in and around the Baltic Sea.

AMY is a general purpose USV that can be customized with sensors above and below the surface, such as radar, cameras and sonar. It can also serve as a gateway buoy to relay information from underwater vehicles to networks above the surface. At 145 lbs., NIX is about the same size as AMY, but is faster (20 knots-plus), has longer endurance (24 hours) and can carry cargo as well as sensors.

The Hydronalix UAV—ADAPT—complements the company's boats. ADAPT is low-cost (so much so it's disposable), and can carry a small payload. It requires no training or skill," Mulligan said. "You fly it with your cell phone."

Trends in Marine Services for Subsea Telecoms

By Howard Kidorf, Managing Partner of Pioneer Consulting and Bob Munoz, Undersea Cable Consultant

The market for marine services in support of the installation and maintenance of undersea telecommunications cables has matured over a period of more than 100 years to reach its present state of development. The largest providers of marine services (companies such as the Global Marine Group, SubCom, Alcatel Submarine Networks and Orange Marine) take different approaches to operations, but provide a mature and assured set of services that play a critical role in the industry. Marine services support the suppliers of undersea cable systems (delivering 50,000 to 150,000 km per year) with various survey installation services. Also, essential services are provided to telecommunications cable owners and operators through maintenance and repair of about one million kilometers of currently installed cables.

The market can be further segmented by processes required in the telecommunications cable marketplace. This includes activities such as feasibility and desktop study, software and charting services, survey and route engineering, marine installation (shallow and deep water), cable jointing technology, provision of equipment to marine service providers and personnel services to resource these activities.

Let's dive into the latest trends we're seeing in the marine services sector.

Vessels

For submarine telecommunications cable marine services, a recent report prepared by Pioneer Consulting provided details of 21 survey vessels and 65 active cableships capable of operating with cables at full ocean depth. Over the last 10 years there has not been a significant retirement of cable ships, and only eight new cableships were added to the global fleet. However, the average age of the current active cableship fleet is a notably old 25 years.

As before, there continues to be a balance between the conversion of old vessels for cable operations and the desire to build new vessels that require lower maintenance.

The typical cost for building and outfitting a new purpose-built installation cableship is over $100m and takes about two years to construct. Without the certainty of continued growth in the industry, the long-term commitment to maintenance and operating costs has made this initial investment difficult.

Still, new vessels have been launched and future vessels planned. Orange Marine recently announced the construction of a new vessel, C/S Sophie Germain, specially designed to optimize the repair of submarine cables. Notably, the new vessel makes a nod to the increasing importance of environmental footprint in the ship operation's arena. The United States Navy has awarded contracts for the design of a replacement for their only dedicated cable ship, the USNS Zeus, and Kokusai Cable Ship (KCS) is building a vessel optimized for the installation of both power and optical telecommunications cables.

Over the last 10 years, the industry has seen a significant growth in the number of survey vessels available for performing marine cable surveys. Fugro and EGS continue to be the main providers for submarine cable surveys, but other installation companies, namely IT Telecom, Maritech, and Elettra, are providing services for marine cable surveys as well. With

the purchase of C&C Technologies in 2015, Oceaneering International has also entered into the cable survey industry. There are currently about 21 active vessels equipped to perform cable route surveys. Some smaller companies own survey equipment kits that can be transported to project sites and mobilized on vessels of opportunity.

Services

The market for marine services for telecommunications cables continues to mature. In addition to highly visible large vessels, the market includes services such as:

- Shallow water installation and maintenance
- Cable Depots
- Desktop studies and route engineering
- GIS software and charting
- Cable awareness and cable protection
- Personnel resourcing

From small companies to large, the marine telecommunications services marketplace is common in one respect: the requirement for highly specialized services. Although the market is segmented into a combination of niche and vertically integrated players, at its periphery are a large number of small companies that together fill the gaps, leading to integrated solutions across the globe that provide service that meet a shared international standard. For the purchasers of marine services, this means that expectations are very clear, and must be met every time.

Submarine cable services exist within the larger network of cable system manufacturers, maintenance providers, and carriers – who are the ultimate customers for marine services. The 30-year trend towards telecommunications privatization and transition to non-carrier providers of telecommunication services (i.e., "tech" content providers) has led to increased competition and sensitivity to costs. Although there are some aspects of the market that remain from a time when telecommunications were globally regarded as a government service, this perspective has largely been replaced by a market-based approach. While global macroeconomic factors do have an effect on marine services, the dominant effects are nearer to home, with the oil, gas, and power cable sectors all relying

Pioneer Consulting

Pioneer Consulting team member oversees the landing of subsea cable.

on overlapping skills. This means that the prospects for the telecommunications services marine sector is significantly influenced (and could be dominated) by the same factors impacting the oil, gas, power cable, and wind farm marketplace.

To adapt to these changes, marine service companies are diversifying their portfolios. GMSL, ASN, and SubCom have all leveraged on their subsea telecom experience to support communications to offshore oil and gas assets and offshore observatories used by scientific research organizations. Few have chosen to leave the telecom sector, as, although less profitable, it can act as a counterpoint to the energy sector to allow multi-use resources to be shared across markets.

The Future

As we look to the future, some notable trends we expect to continue include:

- **Greater shore end protection and deeper burial:** Twenty years ago, one-meter burial was common. As industrial fisheries continue to extend their activities into deeper water, the requirements for greater cable protection at deeper depths continue to evolve as well. These trends have led to two-and three-meter burial, resulting in higher sea plow tow tensions becoming more common, particularly on high-capacity transoceanic systems.
- **Deep-water armor for cable installations:** Risks to undersea cables at deeper water depths, such as drifting Fish-

ing Aggregating Devices and mass wasting due to deep water turbidity currents, have led to this necessary development.

- **Increase system capacity in undersea cable and component design:** Newer systems are starting to deploy cables with higher fiber counts and fiber switching repeaters and branching units. However, this is not expected to significantly impact marine services nor the quantity of deployed cable.
- **Regional infill for submarine cable systems:** While there will always be a need for transoceanic systems to be built or replace underserved routes, we see greater need for regional systems to meet the expansion of broadband intra-regionally. For marine services, this would indicate greater reliance on good route engineering, inshore cable protection, and the development of shallow water marine solutions to improve effectiveness of deployment and maintenance.
- **Continuing technological developments to improve system reliability:** Whether it's the increased reliance on survey and lay software aboard vessels, faster signal processing, broadband access while at sea, or improved mechanical and electrical equipment, increasingly sophisticated solutions are needed to meet the exacting requirements of the end client.
- **Stress in the marine maintenance marketplace:** We see the possibility of changes to marine maintenance services causing potential problems, not least to small carriers and owners of capacity, who may find their needs considered less if the current status quo on consortium maintenance breaks down.

The changes we are witnessing reveal a maturing market that is adapting to meet the increasing demand for global connectivity. To achieve and maintain the welfare of worldwide broadband capacity, greater focus on reliability and resilience must continue to be addressed. We'll be watching the development of these trends with great interest.

Navy extends service life for Global-class research ships, but bids farewell to FLIP

UW Oceanography - University of Washington

By Edward Lundquist

The U.S. Navy's three Global class oceanographic research ships (AGORs) have received a new lease on life. The ships – R/V Thomas G. Thompson (AGOR 23), R/V Roger Revelle (AGOR 24) and R/V Atlantis (AGOR 25) – which entered service between 1991 and 1998 – were built with 30-year expected service lives. Thanks to extensive overhauls on all three they have been returned to service with another 15 years of useful service.

AGOR 23 is operated by the University of Washington; AGOR 24 is operated by Scripps Institution of Oceanography; and AGOR 25 is operated by Woods Hole Oceanographic Institution.

According to Rob Sparrock, program manager for research ships with the Office of Naval Research (ONR), Atlantis completed its overhaul on July 10. Sparrock said the Navy invested about $50 million to modernize each ship. "We've extended their service lives by at least 15 years, so we got 45 years of service for less than the cost of one new ship with a 30-year service life," he said.

Atlantis is operated by Woods Hole Oceanographic Institution (WHOI), and is the mothership to the Navy's deep-diving ALVIN bathyscaph. While Atlantis can perform the same kinds of research as the other Globals, and will sometimes deploy without the deep submergence vessel, only Atlantis can support ALVIN.

"Atlantis will perform 280 to 300 days of underway science a year, with 100-plus days devoted to ALVIN work." Sparrock said.

The 274-ft., 3,000-ton ships received new, more reliable and environmentally-friendly – and quieter – diesel engines. The laboratory, work and habitability spaces have been improved.

"They're 25 to 30 years old, but we've made them 'newer' and greener than most research vessels," Sparrock said.

During the refit the propulsion system was largely replaced with new diesel generators, overhauled propulsion motors, and new switchboards, control systems, and alarms. Electrical cable and pipework were replaced as well as the air-conditioning, refrigeration, sewage, and freshwater systems. New research and navigation instruments were also added.

"The Revelle belongs to a class of research vessels that can do things few other research ships can do," said Stephen Kelety, marine superintendent at Scripps. "It can accommodate a large number of scientists and scientific equipment, operate in bad weather and high seas, and is adaptable to the research needs of the scientists onboard. It's an important vessel for gathering scientific knowledge."

"The Tommy Thompson has a rich history of science and exploration, and now she's better equipped than ever to travel the world's oceans and help students and scientists make new discoveries," said Virginia Armbrust, professor and chair of the UW School of Oceanography, when the ship was returned to service following its overhaul.

The Navy also has two Ocean-class oceanographic research ship, R/V Neil Armstrong (AGOR 27) (operated by WHOI) and R/V Sally Ride (AGOR 28) (operated by SIO) entered service in 2015 and 2016 respectively, as well as R/V Kilo Moana, which was delivered to the Navy in 2003 and is operated by the University of Hawai'i Marine Center.

In addition to the six Navy-owned oceanographic research

vessels, Sparrock manages the historic deep-submersible vehicle ALVIN; and the Floating Instrument Platform, or FLIP, which are charter-leased to U.S. academic research institutions to operate and maintain in support of Navy and U.S. ocean research objectives.

First entering service in 1964, deep diving ALVIN may seem old. But Sparrock said ALVIN has been systematically modernized and upgraded over the years to remain quite youthful. She has made more than 5,000 dives, and her depth capability has recently been upgraded her 6500-meters. "She's been rebuilt so often that it's not a 60-year-old platform we're refurbishing, said Sparrock.

Like Alvin, FLIP is unique. FLIP is also a veteran, entering service in 1962.

FLIP was designed by the naval architecture firm Glosten Associates; built by Gunderson Bros. Engineering Corporation; and has been operated by the Marine Physical Laboratory of Scripps Institution of Oceanography in San Diego.

The 355-foot FLIP has no means of propulsion, so it must be towed to its working location and either anchored or allowed to drift. By means of a ballasting system, FLIP transitions from the horizontal to the vertical, so the top 55 feet is above the water. The result is an extremely stable and quiet research platform.

FLIP and her crew of five along with up to 11 scientists could remain at sea for up to 35 days. FLIP had duplicate furnishings and fixtures that could be used in either the horizontal or vertical configuration.

There are now other ways to perform much of the research FLIP used to support. ONR and its affiliated research partners employ other oceanographic platforms, such as floats and buoys, unmanned underwater vehicles and unmanned air vehicles, which are used to collect field data through the Naval Research Facilities program.

Because there are no funds for major maintenance, FLIP has effectively been retired.

"It would cost about $8 million to make FLIP useable for another five or ten years, but that funding could be better used elsewhere," said Sparrock.

While FLIP's fate may be final, Sparrock said the platform deserves to be remembered and her accomplishments appreciated.

"FLIP is so historic; it just doesn't seem right to scrap her," said Sparrock.

"I'd like to see a naval base or maritime museum adopt FLIP, and install the 55-foot section in the upright position so people can see it and actually go on it," Sparrock said. "The other 300 feet can be sunk as a reef for divers."

"I think it would be very cool to have FLIP installed vertically somewhere, with its booms outstretched, as a monument to the great science that the platform made possible," said Bruce Appelgate, Associate Director, Scripps Institution of Oceanography for Ship Operations and Marine Technical Support. "But, realizing that vision will be enormously expensive to set up and maintain, and anybody considering that should come with deep pockets."

U.S. Navy photo by John F. Williams/Released

Fifty-five feet remain visible after the crew of the Floating Instrument Platform, or **FLIP**, partially flood the ballast tanks causing the vessel to turn stern first into the ocean. The 355-foot research vessel, owned by the Office of Naval Research and operated by the Marine Physical Laboratory at Scripps Institution of Oceanography at University of California, conducts investigations in a number of fields, including acoustics, oceanography, meteorology and marine mammal observation.

NOVATECH iBCN Satellite Beacons

Tracking and locating assets up to full ocean depth

The water is unpredictable. Maybe you are an oceanographer, with a sub-surface mooring that you need to keep track of. Maybe you are in the oil and gas industry, with remote and autonomous vehicles working at icy depths. Maybe you have one vessel. Maybe you have an entire fleet.

But what do you do when the unpredictable suddenly happens? When a mooring breaks free unexpectedly, from fishing or trawling or simply environmental factors that you cannot control? How do you recover, and move forward?

For many experienced mariners, the only answer is a MetOcean Telematics NOVATECH location and recovery assist beacons. "It gives you that peace of mind," says MetOcean Global Account Manager Evan Aalders. "Once you go to recover the asset, either planned or unexpectedly, that beacon will sit high and proud at the ocean surface, turning on to provide a means of recovery."

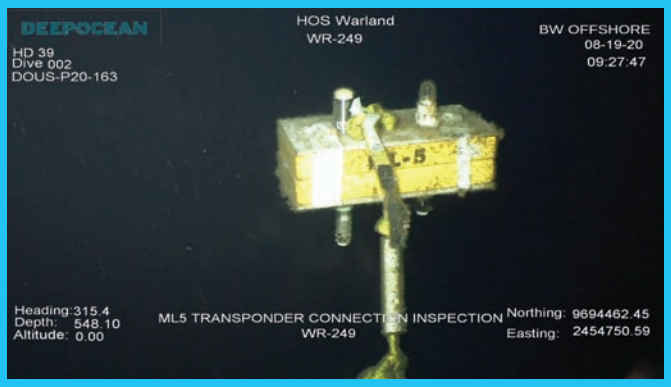
The MetOcean Telematics NOVATECH beacons are designed to last in the harshest of ocean environments, and come in what Aalders describes as three families, depending on need. For line-of-sight coverage, flashers are a high-powered visual aid. Used at either the surface level, or attached to submersible equipment, these beacons are especially helpful in dark or stormy conditions. Next up, the radio beacons can transmit up to five nautical miles, sending out an RF pulse on a specific frequency. For the most precise location and recovery services, the satellite beacons are unparalleled. With GPS mapping and bi-directional communication, the user is not required to be on-site. Instead, they will receive an email notification when one of their beacons is activated, with a precise location and consistent updates that they can control. "This really is about high-value asset recovery," Aalders says.

This is where, as Aalders explains, a global satellite network comes into play. Relying on Iridium technology, MetOcean uses 60 low-orbit satellites to provide full coverage, anywhere in the world. The satellite beacons can be used with scientific equipment, remote or autonomous vehicles, even cabling. However, they are particularly useful in the oil and gas industry.

"Most often, they are going on working class ROVs, which are huge, remotely-operated vehicles, which can be worth millions of dollars. These machines are going thousands of meters deep in the ocean for pipeline inspection or to perform repairs on subsurface platforms, and those umbilical lines can get severed, which cuts out communications," Aalders says. "It can take days, sometimes months, for that vehicle to actually surface." But with a satellite beacon, you will know when a line has been severed, and when the RV comes up again, there is no guessing where it might be. "There is potential for the oil and gas fields to use these beacons on instruments that they may never have thought about, to aid in recovery or act as an insurance policy."

Companies, like BW Offshore, are finding innovative uses for the satellite beacons, utilizing the Iridium technology to its fullest. By attaching beacons to pipeline cabling, BW Offshore has been able to isolate specific sections of their sub-surface work without having to do physical inspections. "Traditionally, you would only know there's been a break when you saw the cable come to the surface with a float," Aalders says. "This is basically giving them a real-time identification about which beacon has pinged, and at which depth, so they can start working immediately to plan repair and recovery operations."

All NOVATECH beacons are rated to 7,500 meters in depth, with the Infinity series able to sink 12,000 meters (developed for James Cameron's Challenger Deep mission, exploring the Mariana's Trench). While the ratings are impressive, what it translates to is time saved. "Iridium was a real game changer," Aalders says, in part because of the bi-directional communications. "We can actually set internal geo-fences so if the device goes into a certain area, you will get an alert. And you have the ability to send a message back to the beacon, to adjust the reporting frequency." If the beacon is pinging frequently, you



Images courtesy MetOcean

may want to scale it back to once an hour, or even once a day, until you can coordinate a recovery.

The key to the communications is the LINC software that MetOcean Telematics provides. "Anywhere you have internet access, you can log on to LINC," says Aalders. Because the messages that the Iridium network sends out are safely encrypted, this software tracks and fully decodes the information once it is received. "It also allows users to plot the GPS positions from those beacons on the building map. Not only are you getting real-time positions from the beacons, but you can actually physically see them in the software."

This is the type of client-focused solution that MetOcean Telematics thrives on. There is a company focus on niche solutions and developing custom products within the satellite communications industry. The head office in Dartmouth, Nova Scotia, Canada allows incredible access to both the Bedford Basin and the open ocean, providing engineers with a test facility that cannot be replicated in any lab. Satellite offices around the globe provide 24-hour customer support. It's these factors which allow MetOcean Telematics to dive into product research and data collection, working with both the military and the commercial oceanographic market.

Whether you are working with a small buoy or a fully autonomous vehicle, it is valuable. Aalders says his team works to come up with the perfect beacon and solution for each individual client, protecting assets big and small. The oceans are deep, dark, and mainly undiscovered. NOVATECH beacons are the lifeline.

Full Autonomy & A Resident Eyeball ROV

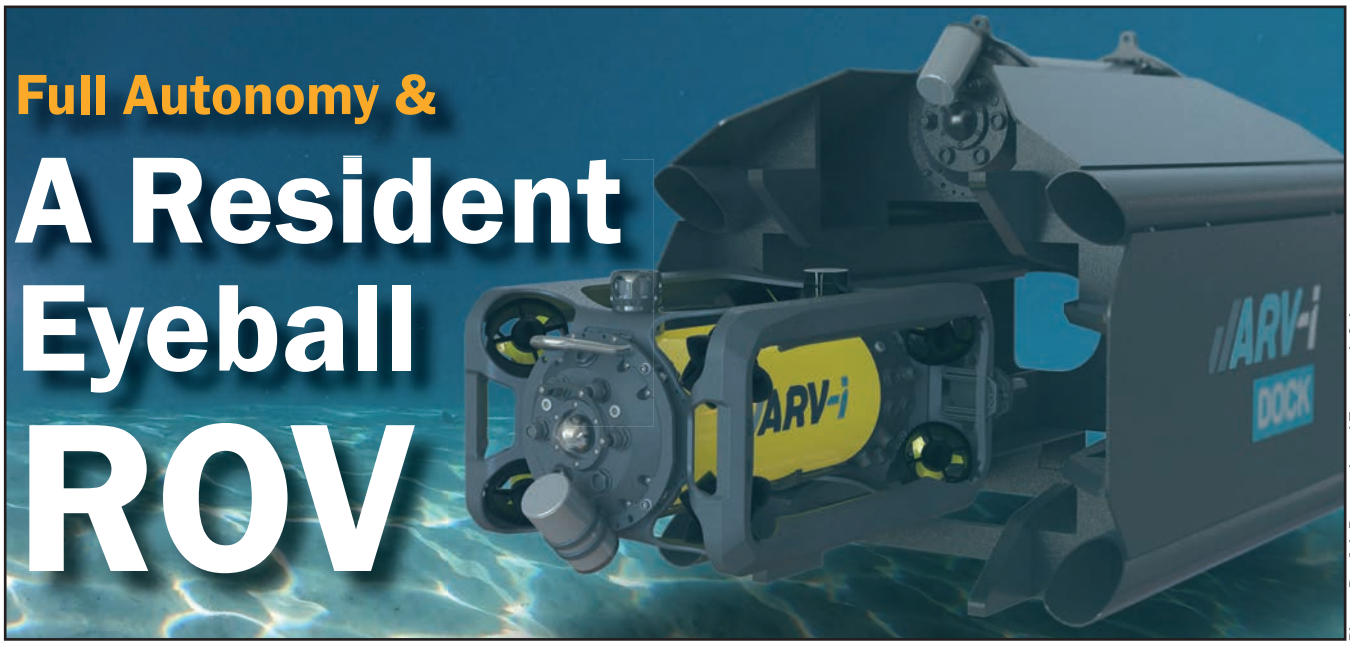


Photo: Boxfish Research and Transmark Subsea

There's also space in the market for resident observation systems, believe Boxfish Research and Transmark Subsea. The two companies signed a partnership agreement in October 2020 to deliver a fully autonomous resident observation ROV, the ARV-i.

The ARV-i combines underwater vehicle, photography and robotics technology from Boxfish Research and underwater power and communications from Transmark Subsea. The goal is for it to be able to spend up to 12 months per deployment underwater, based out of a subsea docking station with battery charging, with wireless communication of data during dive excursions. Every 12 months, it would be exchanged with a replacement and the original refurbished.

"In resident mode, ARV-i can be fully autonomous with its self-piloting systems taking advantage of the existing Boxfish ROV platform, such as the advanced stability and maneuverability of its eight-thruster design," says Craig Anderson of Boxfish Research. "Additional proprietary artificial intelligence onboard enables the ARV-i to optimize movements within its environment."

Craig says the vehicle has an array of up to six machine vision cameras and one live 4K navigation camera, and it can deliver 17,000 lumens of lighting for high quality observation underwater. The vehicle weighs only 25kg, making deployment and entry to confined spaces easier, while maximizing the power-to-weight ratio and enabling extended excursion time and range. The ARV-I can carry a range of sensors to monitor underwater assets and assist in navigation.

ARV-i can also be manually piloted using live video or via a digital twin of the environment, enabled by high-speed optical and acoustic communications between the dock and the vehicle. Piloting of the ROV away from and back to its offshore dock may be performed from distant, land-based locations.

Marcel Bras of Transmark Subsea, says applications include offshore industries that require underwater observation and inspection, including energy, oil and gas, wind farms and aquaculture.

"In fish-farming, for example, ARV-i is able to observe and monitor the whole environment inside the cage," says Marcel. "On a typical mission in autonomous mode, ARV-i will leave its dock fully-charged and use its onboard processors to detect fish and nets in real-time, allowing it to closely observe the fish while avoiding the nets and other obstacles normally present. During the dive, ARV-i will use its battery of cameras to collect data on the health of the assets including fish biomass, net integrity and water quality."

"ARV-i will return to its dock for charging via a Transmark Subsea pinless connection, simultaneously sending data to the cloud," says Mark Bokenfohr of Transmark Subsea. Undocking, docking and mission execution is performed without human intervention; ARV-i uses sonar and computer vision for the purposes of asset mapping, following and obstacle avoidance. Under manual operation, detected objects will appear in the pilot's display of the digital twin, allowing pilots to follow, inspect or avoid them as necessary."

The ARV-i is also available as a tethered solution, adds Craig, in conjunction with a subsea tether management system. Up to 8K / 50MP camera systems are be supported in the ARV-i tethered solution.

Boxfish's ARV-i prototype successfully completed trials in May 2021. Sea trials are now underway, with official market release scheduled for October 2021.

Tech File

Innovative new products, technologies and concepts

Birns Expands Millennium

Birns announced new performance characteristics in its Millennium 1V RF connector series, and the addition of all titanium connector components (pictured) to the entire Millennium line. The 1V coax series provides an ultra-compact 75Ω contact in the same footprint as a 50Ω contact. Cable assemblies in this series are ideal for HD/SD video with signal frequencies to 3GHz, for shortwave antennas, or for low-power RF needing minimal signal attenuation. The 1V will fit into any of the many Birns coax 1C configurations, offering a range of new options in a small space.

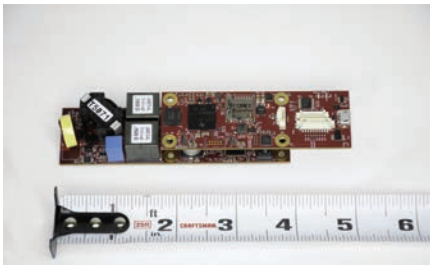
www.birns.com

New WetLink Penetrator

Blue Robotics launched its newest concept and product, the WetLink family of products and the WetLink Penetrator solution for sealing of electrical cables as they pass into enclosures or other devices. It's rated to a depth of 950 meters (3,116 feet). The first size of the WLP product is available now for $12 each and compatible with 6.0-6.5mm cable diameters.

The patent-pending design of the WLP is based on a compression gland seal design, optimized for sealing rubber jacketed cables at the high pressures seen in the ocean.

https://bypass.bluerobotics.com



Popoto Modem V2.7

Popoto Modem announces V2.7 of its acoustic modem, the industry standard for low cost, small scale, JANUS compliant underwater communications and control operations. The upgraded version offers expanded features and improved ease of deployment in both OEM and fully enclosed configurations. Version 2.7 also features an improved baseband and passband recording capability, that allows the modem to operate at the same time as the PCM data is recorded or played. V2.7 is available with new Popoto Modem purchases, or as a free upgrade to existing users.

www.popotomodem.com

"Stealth Cleaner" keep Fish Farms Clean

KystDesign AS signed a contract with Ocein AS for supply of 15 Stealth Cleaner net cleaners.

The net cleaner "Stealth Cleaner" is a remote-controlled subsea vehicle for gentle cleaning of fish farms and moorings and has become an important tool for lice control and to safeguard the welfare of farmed fish.

The development of the Stealth Cleaner's is based on KystDesign's experience in ROV and subsea robotics in addition to Ocein's broad expertise within sea-based fish farming.

"We see this contract, combined with previous contracts to supply nearly 60 Stealth Cleaner's, as a confirmation that our investment in aquaculture have proven successful. The close collaboration with a serious company such as Ocein together with KystDesign's unique technology within ROV and subsea robotics are vital factors which has contributed to Stealth Cleaner has become such a great success in both Norwegian and international fish farming industry," said Åge Holsbrekken, Managing Director of KystDesign AS.

"Ocein is experiencing a high demand for these products both in the Norwegian- and international market and is now well established both in Norway and Chile. Together with KystDesign our aim is to deliver the best quality on the market, both regarding the quality of the product, after sales service and support. This is one of the most vital success criteria, and we look forward to a continued close collaboration with KYSTDESIGN through supply and further development of the Stealth Cleaner" said Erik Aspen, GM of Ocein AS.

Tech File

Innovative new products, technologies and concepts

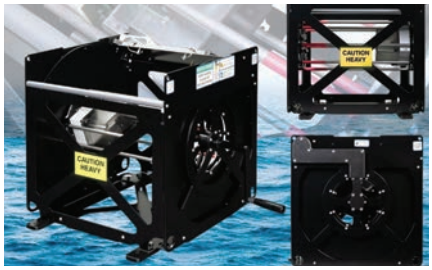
Photo courtesy Blueprint Subsea

Manipulators Expanding Inspection Class ROV Capability

A Seaeye Falcon-mounted Bravo 7 conducts ocean clean-up activities. INSET: The Bravo 7 mounted on a dedicated skid with buoyancy for the Seatronics VALOR, ready for and cavitation blasting.

The Reach Bravo robotic arm from Blueprint Lab is predominantly available as a 7-Function or 5-Function system and combines speed and dexterity into a compact size. This makes it ideal for inspection-class ROVs and, combined with master arm controller technology, offers a previously unavailable level of dexterity for this size of vehicle. Since commercially releasing the Reach Bravo manipulator system in 2020, Blueprint Lab has been working to validate the system in the real world through integrations onto Inspection Class ROVs. The light logistic footprint of the system makes the manipulator ROV-agnostic and easy to retrofit (there is no additional power or control box).

Over the past 6-12 months, the Reach Bravo has been integrated and validated on leading inspection class ROVs, including the Seatronics VALOR and the SAAB Seaeye Falcon. Some of the deployments and trials of the Reach Bravo tech-

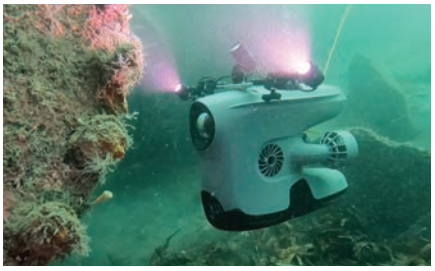


The Sea Otter Reel

The all new Sea Otter Reel represents a leap forward for Inspection Class ROV Tether Management Systems from SEAMOR Marine.

New levels of modularity allow huge labor savings both in the field and in serviceability, with innovations simply packed throughout, including a fully removeable reel hub, connector-based designs and a clear future upgrade path.

www.seamor.com



New ROV from Blueye

Blueye Robotics launches the X3, its third Blueye ROV model. Some features of the new X3 model include: 3 guest ports supporting eight different communication protocols; software integration in the Blueye App for grippers and manipulatorss; upport for navigation and positioning systems; Blueye external-camera and Blueye external-lights (up to 10,000 lumens).

www.blueye.com

3D Printing Subsea

Kongsberg Ferrotech has joined forces with Equinor, SINTEF and Gassco to develop 3D printing technologies for subsea equipment repair and maintenance. The company has already developed a subsea robotic system, Nautilus, that can be used to carry out remotely operated composite repairs on subsea pipelines.

www.kferrotech.no/.com

Bravo 7

The Bravo 7 is a robust, electric 7-function manipulator designed for Inspection-Class ROVs. With 10-20kg lift capacity and almost 1m of reach, this dexterous manipulator makes complex tasks possible while also having a low logistics footprint for easy retrofitting to existing vehicles. The Reach Bravo range of manipulators are available with customizable end-effectors, including a cutting tool, and are designed for control with Blueprint Lab master arm controller technology. A leap in capability for service providers conducting NDT Inspections, close visual inspections, equipment recovery and deployment, and other tasks usually reserved for human divers.

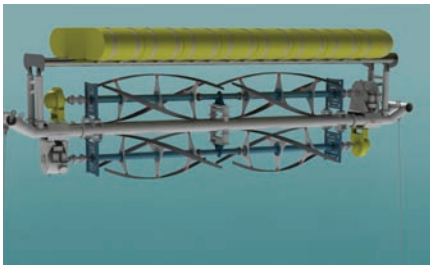
nology to-date include: cleaning using cavitation blasters and the FlexiClean Micro, equipment deployment/recovery with ROV hooks, ocean clean-up, and use on novel autonomous Inspection, Maintenance, and Repair (IMR) projects, such as on the Atlantis Testing Platform for Maritime Robotics (ATLANTIS).

Following the release of the Reach Alpha (which found early success with military and commercial portable ROV operators), Blueprint Lab designed the Reach Bravo with the vision of enabling more dexterous intervention and inspection akin to that achievable by human divers. For many industries, include offshore energy, there is a big push to make operations safer by keeping humans out of harm's way. Systems that can start to approach and exceed the capability of humans, at equal or smaller sizes, are critical and the Reach Bravo is part of Blueprint Lab's continuing contribution to achieving this goal.

Xsens MTi-600 Series

Xsens announced two new products in its MTi 600-series, extending the choice of products with and without an integrated satellite positioning receiver. Xsens is adding a new GNSS/Inertial Navigation System (INS) module, the MTi-670G, and a Attitude and Heading Reference System (AHRS), the MTi-630R to the MTi 600-series.

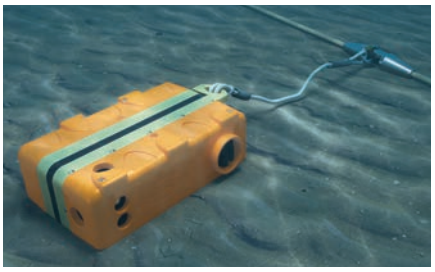
www.xsens.com



Anchoring for TideGen

ORPC engaged Sustainable Marine's Swift Anchors division to provide its rock anchoring system for ORPC's Advanced TidGen Project set to launch in Maine. Swift Anchors one-ton steel anchor are designed to provide the same holding force as 750 tons of concrete. Its complete turnkey offering can generate up to 70% in cost savings compared to traditional systems for small arrays.

www.sustainablemarine.com



Sercel GPR300

Sercel launched the GPR300, a nodal seismic acquisition solution for deployment in shallow waters to depths of 300m. GPR300 features Sercel's QuietSeis broadband digital sensor tech for ultra-quiet performance. Its ability to record high-fidelity low-frequency signal also makes it the ideal choice for high-end seismic imaging with full-waveform inversion (FWI).

www.sercel.com

Tech File

Innovative new products, technologies and concepts

Live Streaming Ocean Exploration via BlueComm

The Triton 7500/3 series submersible, reported to be the world's deepest diving acrylic hulled manned submersible, will be outfitted with Sonardyne's BlueComm optical communications link to enable live streaming of deep ocean expeditions.

The acrylic hulled submersible is designed to carry three people down to 2,286 m water depth, and will operate from the research vessel REV Ocean, being built now for the Norwegian non-profit organization of the same name.

BlueComm is designed to allow the occupants of the Triton submersible to live stream high-definition video and audio to the surface, supporting its missions by transmitting data using high power light emitting diodes (LEDs) that are rapidly modulated. By using light, BlueComm is able to stream up to 10 Mbps over up to 150 m.

www.sonardyne.com

Images courtesy Sonardyne

Giant Piston Corer Breaks Deep-Ocean Records

Ocean Scientific International Ltd. (OSIL) reports that one of its Giant Piston Corer systems has broken two records in scientific ocean drilling & coring on the International Ocean Discovery Program (IODP) Expedition 386.

The expedition was staged by the European Consortium for Ocean Research Drilling (ECORD) to gain an insight into the seismic history of the study region off the Japanese coast, and is supported by the Japan Agency for Marine-Earth Science and Technology (Jamstec). Earlier this year the team on board the RV Kaimei recorded an historic sampling water depth of 8,023m (26,322 ft.), and recovered a 37.74m core in a 40m barrel string, a 94.3% recovery rate and record deepest sub-sea level sample (from 8060.74m below sea level) from the Giant Piston Corer that was produced, installed and supported by OSIL. The Giant Piston Corer operates in a very similar manner to traditional gravity coring systems, with the exception of the piston itself, which plugs the core barrel once the corer has been fully deployed into the sediment and, in combination with the core catcher, holds the sample securely inside. The piston also reduces internal friction within the core liner and prevents clumping of the sample.

www.osil.com

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Latest People & Company News

Ezekiel David

Jorge Ibaceta

Scott Olson

Griffiths Joins aae Technologies

Rovco Survey Solutions Launched

SEA-KIT's USV get LR Certification

David, Ibaceta Join Subsea Europe Services

Ezekiel David (30) has joined Subsea Europe Services GmbH as a marine surveyor. David holds an M Sc. with Distinction in Surveying and Geoinformatics with Specialization in Hydrography and Geodesy from the University of Lagos in Nigeria, will complete his second Masters at Hamburg Hafencity University, in tandem with his position at Subsea Europe Services.

Jorge Ibaceta was appointed Operations Manager Offshore, a new role. He is a Master of Civil Engineering, joining from the National Marine Dredging Company (NMDC), Abu Dhabi UAE, where he worked as a Survey Data Processor, Hydrographic Surveyor and Chief Surveyor on various offshore campaigns.

Olson joins Inspire Environmental

Inspire Environmental hired Scott Olson as Senior Field and Innovation Manager. Olson took up SCUBA as a teen, and his love of diving took him to Florida Institute of Technology where a diverse program of study allowed him to find his niche as an underwater technologist. After a decade or so in the field, deploying and maintaining ROVs and piloting submersibles, he brought his skills back to dry land to develop new technologies for both private and military applications.

Griffiths Joins aae Technologies

aae Technologies welcomes Paul Griffiths to its sales team as Business Development Manager. He has more than 20 years' experience within the industry, bringing a wealth of knowledge in subsea positioning across many industry sectors.

Rovco Survey Solutions Launched

Rovco launched a new hydrographic services division, "Rovco Survey Solutions," pledging an investment of $13m in the new divisiont over the next 24 months, including the addition of eight new survey staff members. Rovco Survey Solutions will offer a broad range of hydrographic services, from wind farm site and cable route surveys, spanning seabed mapping, geophysical and shallow geotechnical services, to hazard surveys and UXO target identification.

www.rovco.com/services/survey

SEA-KIT's USV get LR Certification

The first ever Unmanned Marine Systems (UMS) certificate has been awarded to SEA-KIT International by Lloyd's Register. SEA-KIT worked closely with Lloyd's Register since early 2020 in an effort to achieve the highest standards for the Unmanned Surface Vessel (USV) sector, culminating with their latest 12m X-class USV for leading geo-data specialist, Fugro, being awarded the new UMS certification on 28 June 2021.

NOARC Launches Autonomous Special Project Class at PRCC

A workforce development initiative with the National Oceans and Applications Research Center (NOARC) and the Pearl River Community College (PRCC) Hancock Campus was launched in early

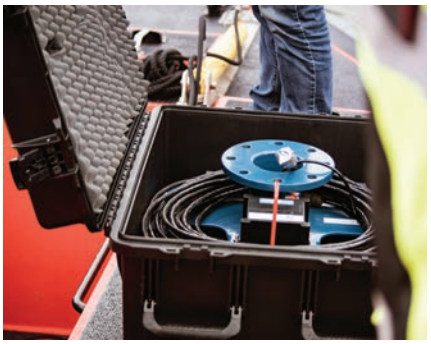
Who's News?

Latest People & Company News

NOARC

June 2021 to connect students to new jobs in autonomous coastal mapping and monitoring. The special project class is navigating the maritime world of autonomous systems. NOARC and PRCC have signed a five-year Collaborative Applications Research Agreement to support this development initiative.

"There is a need for coastal mapping technicians, with experience in precision, unmanned environmental monitoring systems and this is critical to new business opportunities on the Mississippi Gulf Coast.", said David Brannon, President of NOARC.



Seatronics, SES Ink Deal

Ashtead, Hydromea ink Partnership

Ashtead Technology entered into a global rental partnership with Hydromea, whereby Ashtead will actively promote and use Hydromea's LUMA high-speed through-water wireless optical modems as an integral part of its AMS+ and DMS (Autonomous & Deflection Monitoring Systems) for the global subsea construction market.

Seatronics, SES Ink Deal

Subsea equipment rental company Seatronics, an Acteon company, and hydrographic equipment provider Subsea Europe Services (SES) have signed a re-

Clark Named CTO @ Ashtead

seller agreement, Under the deal, the duo said it would share capabilities, mutually expand their rental and sales portfolios and optimize access and logistics for in-demand marine and subsea equipment rental.

Clark Named CTO @ Ashtead

Ashtead Technology appointed Graham Clark to the newly created position of Chief Technology Officer (CTO). Prior to joining Ashtead Technology, Clark was Group IT & Business Performance Director at Regenersis Plc, where he led a digital transformation program for thousands of users across multiple sites.

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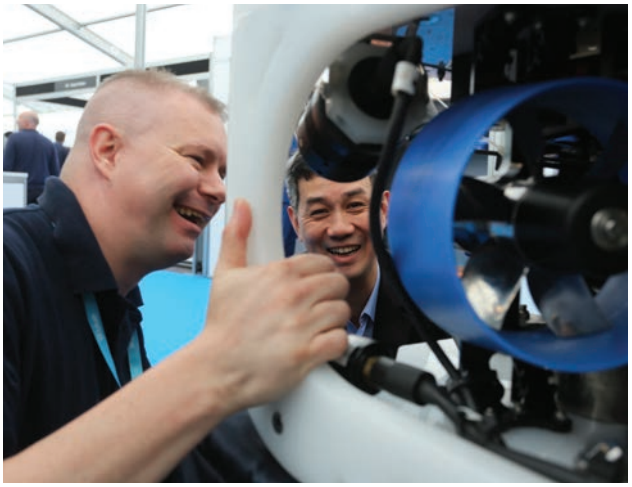

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– Douglas Webb, Founder of Webb Research






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