MARINE TECHNOLOGY REPORTER

January/February 2018

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Carlo Zaffanella discusses General Dynamics Mission Systems M&SS' full-throttle charge toward truly connected, multi-platform unmanned autonomy

Volume 61 Number 1

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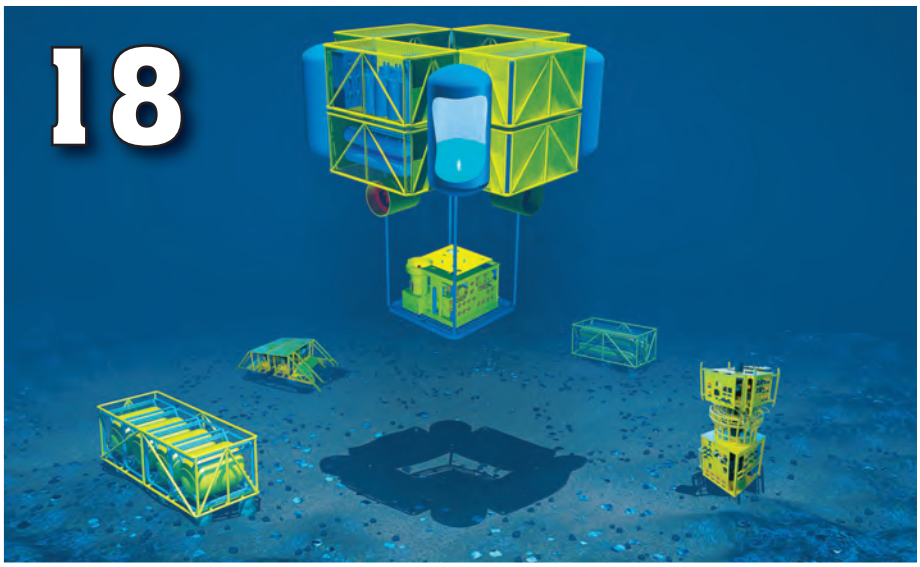

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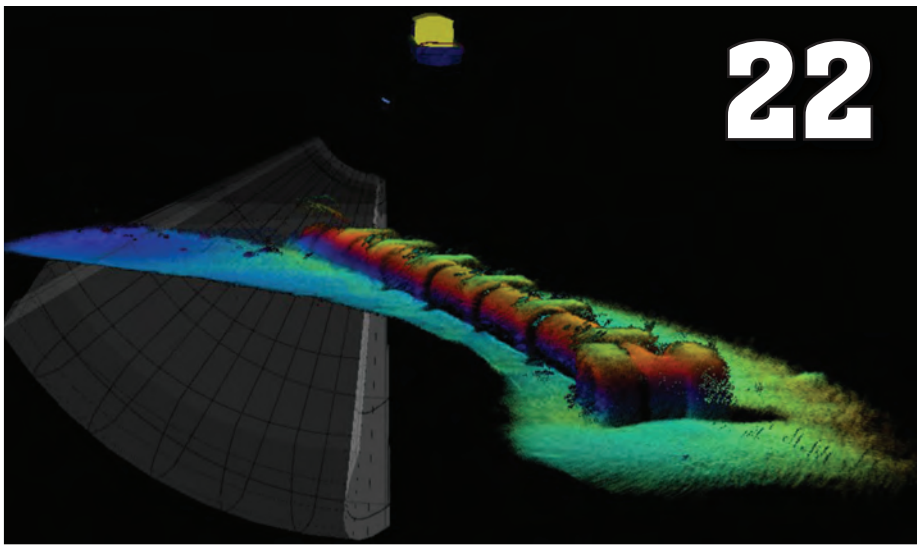

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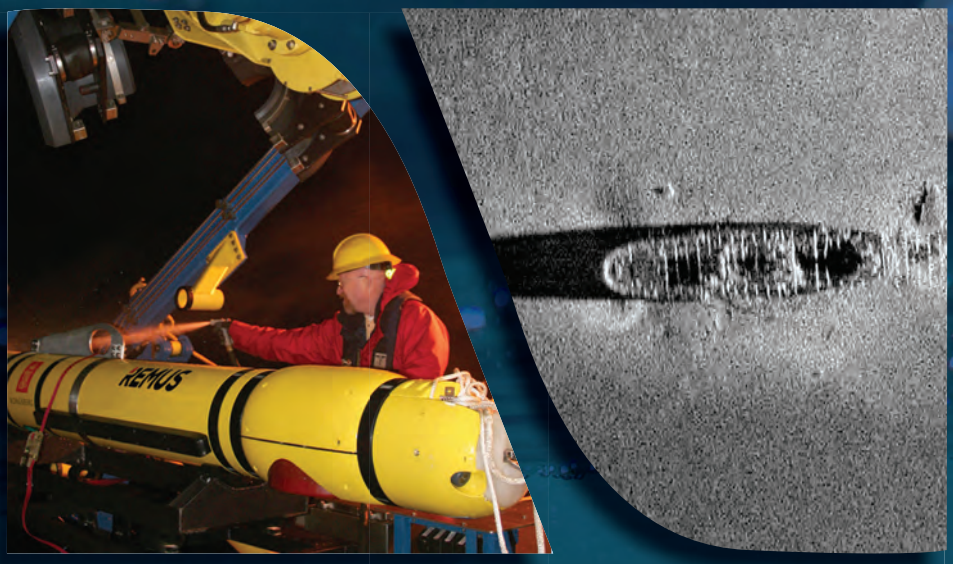

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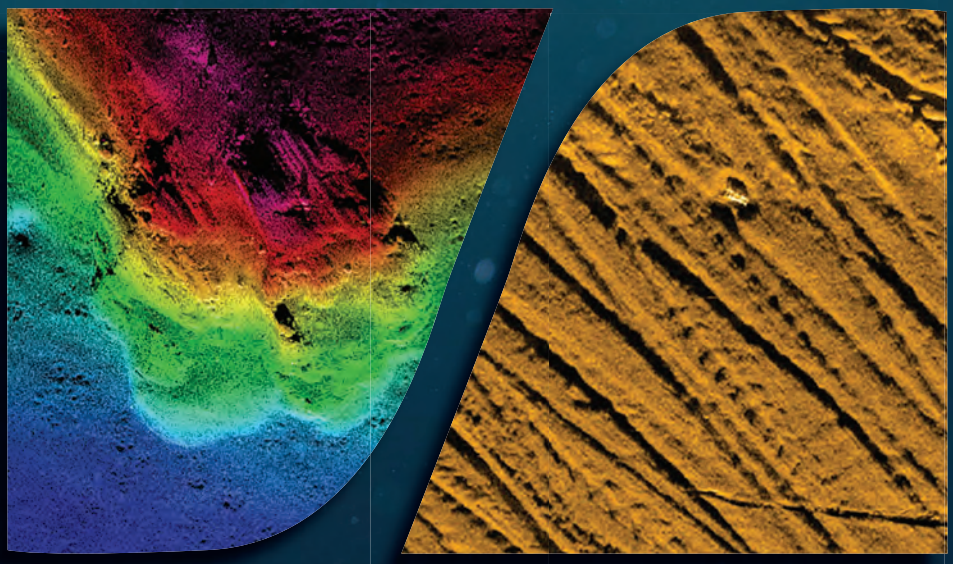

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Editorial

Gregory R. Trauthwein
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It is my true pleasure to welcome the readers of *Marine Technology Reporter* to 2018 with one of the most enlightening, informative and entertaining interviews I have had in some time in the form of our cover story, **Carlo Zaffanella**, vice president and general manager of Maritime and Strategic Systems (M&SS) for General Dynamics Mission Systems. Those who know me know that I don't play favorites, but I encourage you to meet Carlo if the opportunity presents itself — particularly as he is particularly amenable to working with innovative outside solution providers.

Much of what we write about — in the physical pages of *Marine Technology Reporter* and daily online at **MarineTechnologyNews.com** and *MTR eNews* — revolves around 'stuff': the equipment, products and systems that are designed, built and operated to not only withstand, but to increasingly be efficient and cost-effective in the demanding subsea environment. But as you all know, and as Carlo Zaffanella hits dead center, the conversation in the subsea market is rapidly evolving past equipment and into networks; networks of assets in and under the water, in the air, on the land and in outer space; networks seamlessly connected and communicative to achieve the mission at hand, whether it be for commerce, science or defense. I invite you to read the interview, starting on page 36, and let me know what you think.

Unbelievably we again are about a month away from another Oceanology International in London. For those of you that have never attended an OI, you are missing the biggest and arguably the best subsea exhibition in the world. In step with OI '18 *MTR* will, in its March 2018 edition and online, profile all of the new technologies set to debut on the trade floor. We recently passed the 30 mark, so if your company is introducing a new or refreshed product or system in London, give me a call or send me an email for full details.

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Coley

Haun

Adams

Williams

Paschoa

van Essen

Adams
Richard Adams joined Coda Octopus Products Ltd. in 2014 and is now the Sales Director and looks after the European, African, and Asian markets.

Coley
Kira Coley is a freelance science writer and regular contributor to MTR.

Haun
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Paschoa
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van Essen
Sanne van Essen is Project Manager at the Business Unit Ships at MARIN, the Maritime Research Institute Netherlands.dyne RDI, Europe.

Williams
Jessica Williams is an analyst at S&P Global Ratings, where she contributes to environmental and climate risk research focused on energy transition risk, energy storage, climate policy, and ESG risk.

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In case you missed it, recent highlights from the industry's most popular website & ENewsletter • **www.marinetechnologynews.com**

The $70 Million Hunt for MH370

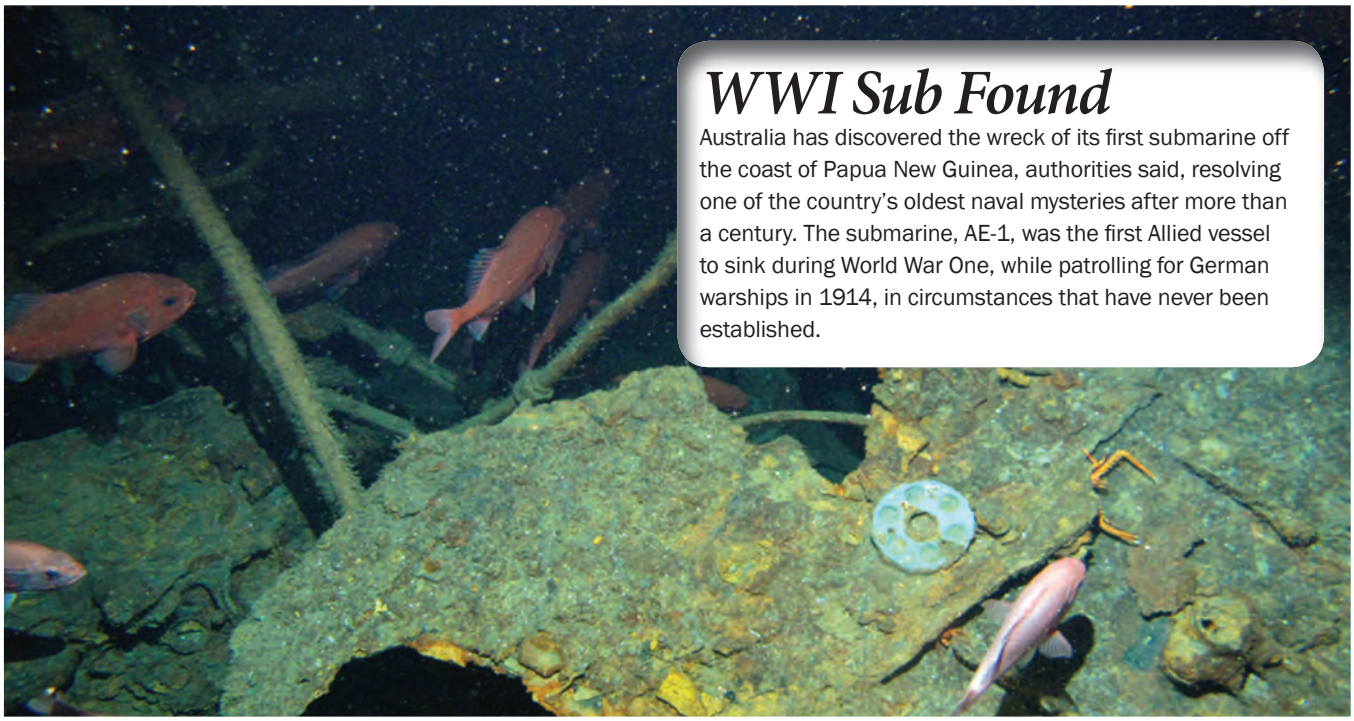
Malaysia signed a deal to pay a U.S. seabed exploration firm up to $70 million if it finds the missing Malaysia Airlines aircraft MH370 within 90 days of embarking on a new search in the Southern Indian ocean. The disappearance of the aircraft en route from Kuala Lumpur to Beijing in March 2014 with 239 people aboard ranks among the world's greatest aviation mysteries.

Photo: Ocean Infinity

www.marinetechnologynews.com/news/malaysia-mh370-found-555920

WWI Sub Found

Australia has discovered the wreck of its first submarine off the coast of Papua New Guinea, authorities said, resolving one of the country's oldest naval mysteries after more than a century. The submarine, AE-1, was the first Allied vessel to sink during World War One, while patrolling for German warships in 1914, in circumstances that have never been established.



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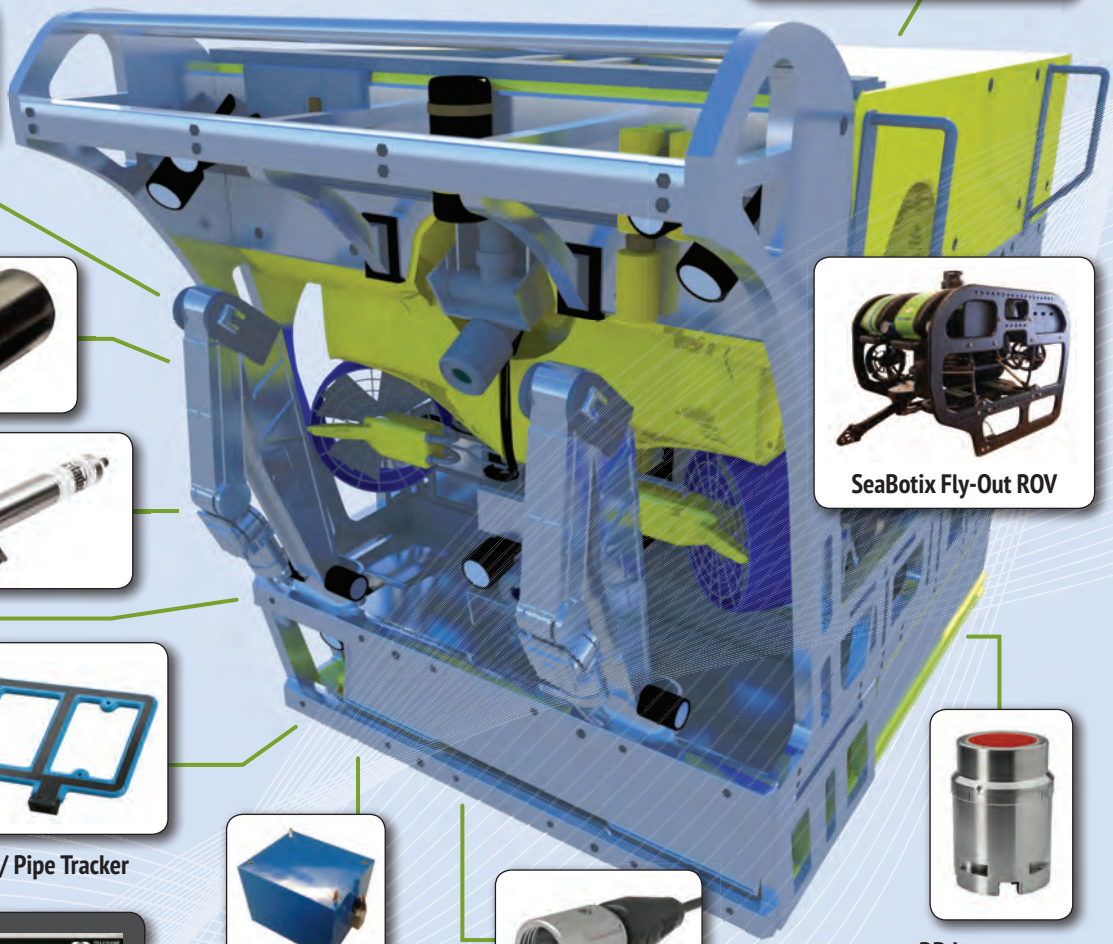

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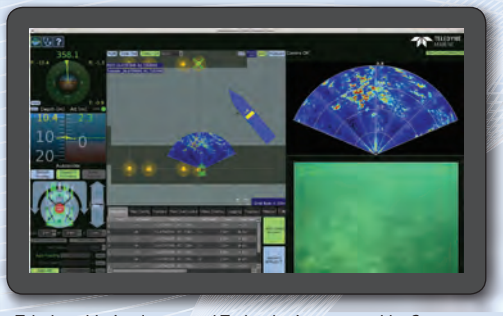

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Wreckage of USS Ward Found in the Philippines

The U.S. Navy warship that famously fired the first American shot in World War II has been found resting on the seabed in Ormoc Bay near Ponson Island in the Philippines. USS Ward was discovered and documented by Microsoft co-founder and philanthropist Paul G. Allen's expedition crew aboard Research Vessel (R/V) Petrel, who released video images of the wreck just prior to the anniversary of the December 7, 1941 attack on Pearl Harbor.

Photo courtesy Paul G. Allen

www.marinetechnologynews.com/news/wreckage-found-philippines-554935

BSEE

Arctic Open

Eni began drilling a new well in U.S. waters off the north coast of Alaska, becoming the first company to do so since 2015.

The oil and gas firm is working from an artificial island in the Beaufort Sea about three miles off Oliktok Point in the Arctic Ocean. The well is expected to run more than 6 miles (10 km) long.

www.marinetechnologynews.com/news/begins-drilling-alaska-beaufort-555520

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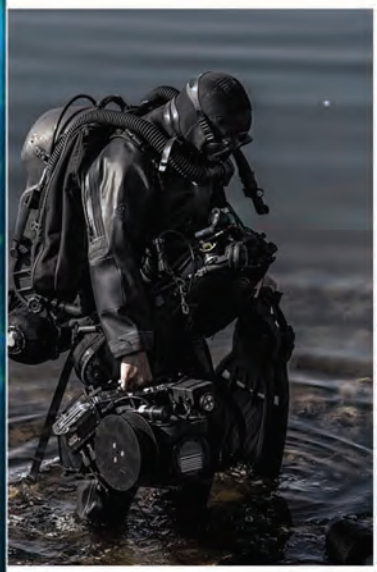

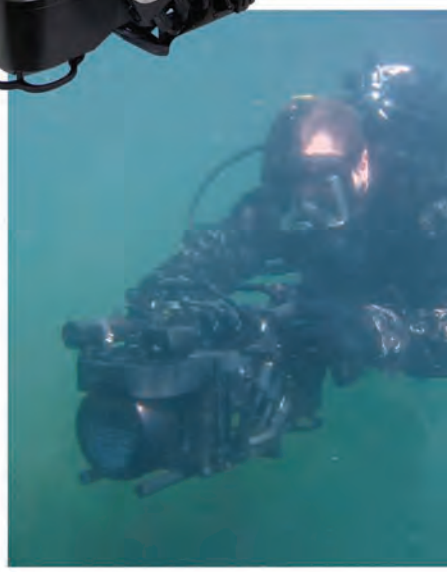

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Hexapod

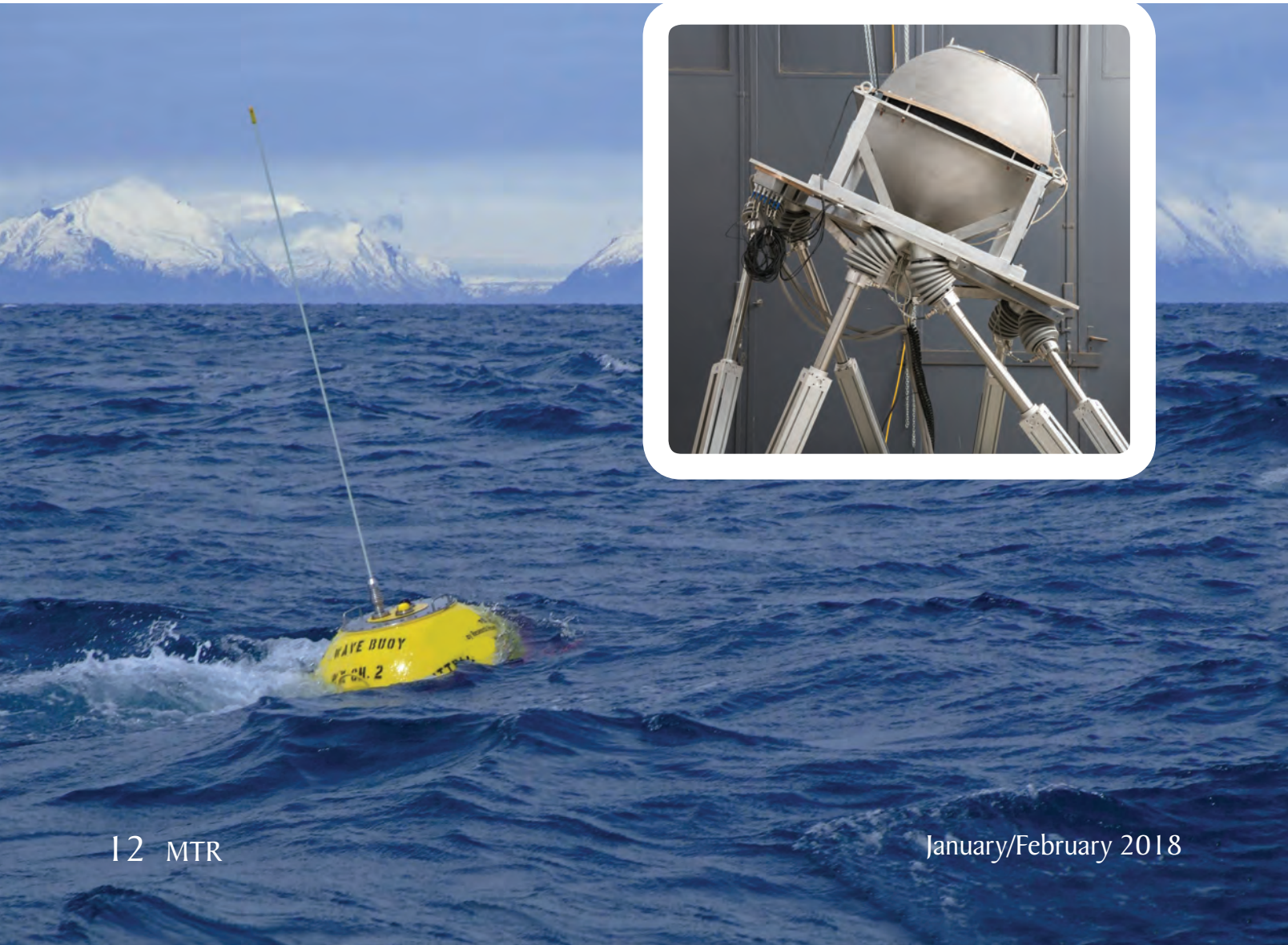
Wave Buoy Measurements on a Hexapod

By Sanne van Essen

MARIN has recently expanded its facilities with a hexapod. This system can be used to generate forced oscillations in six degrees of freedom, either on a standalone basis or under the carriage of one of our basins. It is a useful tool to assess the efficiency of anti-roll tanks, sloshing in liquefied natural gas (LNG) tanks, safety of cruise ship swimming pools or drop tests with a free-fall lifeboat from a moving platform.

As the positioning system of the hexapod is very accurate, another useful application is the validation of measurement equipment. Recently, MARIN used it to evaluate the measurement accuracy of a Datawell wave buoy for Shell and Woodside. Wave buoys are occasionally

Images: MARIN



used in conditions outside their design range, in very long or short waves. The hexapod tests proved very useful to gain more insight into the limits and properties of buoy measurements, by comparing them to the hexapod motions and a set of independent MARIN acceleration sensors.

A first challenge during the project was the need to synchronize measurements from three different sources: the MARIN Measurement System (hexapod motions, MARIN accelerations), the direct buoy acceleration and rotation measurements and the derived motions in the buoy log files (which are stored every half hour). Each of these files was sampled at a different frequency. Synchronisation was done based on a trigger signal that was recorded by all systems. In this way the synchronisation was limited only by the lowest sample rate.

The vertical acceleration sensor inside the buoy was compensated for rotations, while the compass and horizontal acceleration sensors, hexapod motions and MARIN acceleration sensors were not. Alignment of the buoy and determining the zero positions were not as easy as they would be for a dedicated setup, therefore comparing the measured signals required a careful setup and extensive analysis work.

Although the measurement setup is not a perfect representation of the buoy response in a real-life wave environment, we were able to make a good assessment of the accuracy of the wave buoy for different motion periods, amplitudes and degrees of freedom. Additionally, we have learned a lot about the buoy properties and limits, and gained valuable experience in the measurement procedures with the hexapod.

The Author

Sanne van Essen is Project Manager at the Business Unit Ships at MARIN, the Maritime Research Institute Netherlands.

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Roadmap for Renewable Energy

By Jessica Williams

Thanks to increasing levels of debt financing for climate-aligned projects, wind-generated power has become one of the fastest-growing green industries. Jessica Williams, an Infrastructure Analyst at S&P Global Ratings, considers the submarine technologies that are making this progress possible. Renewable energy is making an increasing contribution to the electrical grid. By the end of 2016, "green energy" sources accounted for almost a quarter of the world's electricity supply, according to REN21.

Wind power has contributed significantly to this shift and is second only to hydropower in terms of renewable capacity. And largely thanks to decarbonization efforts worldwide, wind energy's market penetration is increasing; the Global Wind Energy Council (GWEC) estimates global capacity will reach 817 gigawatts (GW) by 2021, a 68% increase from 2016.

A strong pipeline of technologies is driving this growth. As the technologies improve, this pushes down costs, making wind energy more viable. For example, enhanced technology allows for bigger wind turbines and foundations, which increases manufacturing and production efficiency. Taking advantage of these efficiency gains, undersea cables are thereby addressing the challenges of inconsistent supply and demand; they enable power generated offshore – or in remote geographical locations – to be transmitted to the urban areas that need it most.

The Geography of Renewables

Take the state of New York, for example, which has four densely populated counties, two that are part of New York City, located on Long Island. The island faces significant challenges meeting its substantial electricity demands due to legacy issues of gas and electric transmission constraints, as well as limited geographical access to renewable alternatives (such as solar or wind). Nonetheless, New York State has made renewable development a primary policy goal under its Clean Energy Standard – which mandates that 50% of its electricity originates from renewable sources by 2030.

So, although the target is ambitious, New York State's carbon reduction goals are flexible enough to incorporate green energy transmitted from elsewhere. This is particularly significant for Long Island, which benefits from the Cross Sound Cable, an undersea transmission line that transmits excess clean electricity across Long Island Sound from renewable-rich New England.

In addition to its vast hydrologic and wind resources, New England has its own state-level carbon reduction policies that date back over a decade. The Cross Sound Cable can transmit 330 MW of hydrologic and wind power originating in New England to Long Island, which equates to substantial carbon savings on par with about 600MW of wind capacity.

Ultimately, this not only provides Long Island with enhanced grid stability but it also provides a use for New England's excess wind energy.

Transmissions Overseas

In Europe, comparable projects are underway. For example, the Western Link initiative – a £1 billion project located in the U.K. – will transmit electricity generated by Scotland's abundant onshore and offshore wind resources to England and Wales using undersea and underground cables.

Similar to the Cross Sound Cable, the Western Link is also bi-directional. This means that, while these cables enable certain areas to benefit from excess renewable power generated elsewhere, electricity can also flow in the opposite direction, according to electricity supply and demand requirements. In turn, this promotes grid stability at both ends – and the longevity of the cable. In Germany, the transmission system operator (TSO) TenneT Holding B.V (TenneT), has raised €1 billion of green bonds to finance transmission lines connecting offshore wind projects in the North Sea to the German grid. Indeed, an increasing number of projects in the North Sea are contributing to impressive European wind power growth; according to WindEurope, the region enjoyed a record year in 2017, adding 14GW to the renewables grid.

In the Asia Pacific area, too, a substantial proposal is underway. The Asian Renewable Energy Hub encompasses 7,000 square kilometers of land in the East Pilbara region of Western Australia, and is set to house both solar and wind power generation facilities for the purpose of transmitting the energy produced to South East Asia.

The Asian Renewable Energy Hub entails the construction of 1,200 300m-high onshore wind turbines, with a further 2400MW from solar panels – all of which will be exported via high voltage undersea transmission cables to Jakarta and Singapore. The project will generate power for 7 million homes in Indonesia, and will offset almost 1 billion tons of carbon emissions over its lifetime.

Careful Construction

However, due to the speed of technological development, there is ever-changing technology risk to consider – as well as the environmental impact of construction and implementation.

For example, with more robust undersea cables come greater distances to shore and harsher sea conditions – two important considerations when it comes to both the construction and operation phases of offshore wind projects. These risks become accentuated when there are discrepancies between the technologies proposed at the bidding phase and those that are, in fact, installed during the construction phase. Indeed, some German utilities – in structuring their assumed costs – have put their faith in technology improving between now and 2021, when future offshore wind projects will be built. Reducing environmental impact at the construction phase of a wind project is a key priority, too. For this, comprehensive environmental impact assessments (EIAs) and low-impact construction techniques – such as soft start procedures and noise reducing technologies – can be employed.

The TenneT projects in Germany are a case in point. As well as enhancing the usability of sustainable energy, TenneT aims to minimize the physical impact of its North Sea-based operations. On top of using EIAs and low-impact technologies, all contractor ships installing the TenneT undersea transmission cable must attain certification to prove that they do not discharge effluent into the sea.

Ultimately, undersea cables are enabling the distribution of renewable energy to areas that can benefit. These projects could help to drive a global shift in the power grid, which may see an increasing number of homes and businesses make fuller use of renewable energy sources – thereby reducing their carbon footprints.

The Author

Jessica Williams is an analyst at S&P Global Ratings. Environmental and climate risk research focused on energy transition & storage, climate policy & ESG risk.

ROVs

Volcano Eruption Study via ROV

The remotely operated vehicle (ROV) Jason lands on the seafloor at Havre submarine volcano to retrieve a heat flow monitor.

Photo: Multidisciplinary Instrumentation in Support of Oceanography (MISO) Facility, ©Woods Hole Oceanographic Institution

In July 2012, airline passengers flying over the Southwest Pacific Ocean spotted a large and unusual object floating on the water's surface.

That object, which turned out to be a giant raft of pumice, was evidence that an underwater volcanic eruption had occurred. And as the raft continued to grow to roughly the size of Philadelphia, scientists observed that the eruption was extraordinarily large.

The eruption had occurred at the Havre volcano northeast of New Zealand, and was the largest to take place underwater in the past century.

"We knew it was a large-scale eruption, approximately equivalent to the biggest eruption we've seen on land in the 20th century," said Rebecca Carey, a volcanologist at University of Tasmania and co-chief scientist on the expedition to investigate the historic silicic eruption—a particular type of eruption that produces viscous, gas-filled lava, that often occurs explosively.

In 2015, the University of Tasmania led a mission to explore, map and collect erupted materials from the Havre volcano, together with scientists from Woods Hole Oceanographic Institution (WHOI), the University of California Berkeley, the University of Otago in New Zealand and others on board the research vessel Roger Revelle operated by the Scripps Institution of Oceanography.

Their paper published January 10, 2018 in the journal *Science Advances* describes the first up-close investigation of the historic volcanic eruption and reveals several surprises. "Heading to the site, we were fully prepared to investigate a typical deep-sea explosive eruption," said Adam Soule, WHOI associate scientist and chief scientist for the National Deep Submergence Facility.

"When we looked at the detailed maps from the AUV, we saw all these bumps on the seafloor and I thought the vehicle's sonar was acting up," Soule said. "It turned out that each bump was a giant block of pumice, some of them the size of a van. I had never seen anything like it on the seafloor."

Seeking new information on the events at Havre, the research team in 2015 deployed the autonomous underwater vehicle (AUV) Sentry in a series of 11 dives that mapped more than 19 square miles (50 square kilometers) of seafloor. The team also conducted 12 dives totaling 250 hours with the remotely operated vehicle (ROV) Jason to collect samples of erupted material and to capture high-resolution imagery of the seafloor inside the crater.

The scientists discovered that the Havre volcano's eruption history was much more complicated than they previously thought, with the most recent eruption alone consisting of lava from 14 volcanic vent sites between 900 and 1,220 meters below the surface.

They also discovered that, what they thought was initially an explosive eruption that would produce mainly pumice, also created ash, lava domes and seafloor lava flows. Of the material that erupted, which was nearly 1.5 times larger than the 1980 eruption of Mount St. Helens, about 75 percent floated to the surface and drifted away with winds and currents, while the rest was spread across the seafloor up to several miles away. "Ultimately we believe that none of the magma was erupted in the ways we assume an explosive eruption occurs on land," Soule said.

Material collected using ROV Jason confirmed the diverse nature of the eruption, bringing samples of dense lava, ash, pumice and giant pumice to the surface, including one piece measuring 5 feet (1.5 meters) in diameter that is the first of its kind ever collected and is currently on display at the National Museum of Science and Nature in Tokyo.

The physical and chemical composition of these samples are now helping scientists learn how the eruption proceeded, what made it act the way it did, and how the material changes over time.

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MUM's the Word

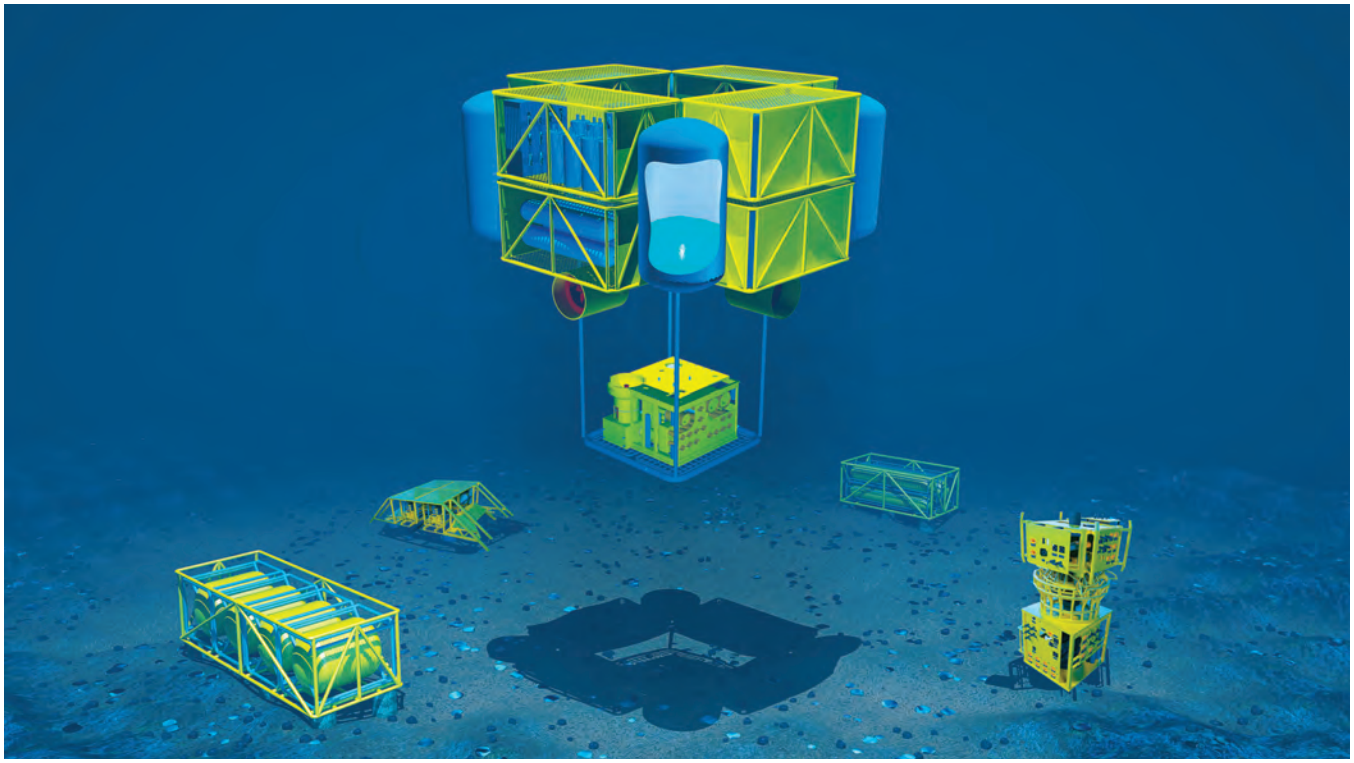
MUM's the Word: New UUV Takes Shape in Germany

By Greg Trauthwein

As the world of autonomous vehicles flourishes on land and in the air, subsea applications have proven more challenging, despite great strides in recent years to deliver fully autonomous, efficient systems at sea. A team of engineers from Germany, engineers teamed from industry and academia, are aiming to drive the subsea vehicle market further faster courtesy of a project known as the Large Modifiable Underwater Mothership, or MUM.

"Today's AUVs are usually limited with regard to energy, payload capacity and autonomy," said Hendrik Wehner, Design Engineer, thyssenkrupp Marine Systems. "For a sole autonomous movement of the ships, smart software solutions are needed. Our partners from University of Rostock and ATLAS ELEKTRONIK are setting the pace there. Large autonomous underwater platforms that can be configured around a payload do not yet exist. MUM will be engineered in such a manner that future payload modules can be designed by anyone. We see a great potential to reduce costs in the industrial and scientific sector, if a vehicle is not engineered to a specific task, but can be configured. The project's sole focus is on the civil sector."

The project brings several notable entities to the table, including engineers from thyssenkrupp, Berlin Technical University, the University of Rostock, Atlas Elektronk and EvoLogics, all working together to develop a new type



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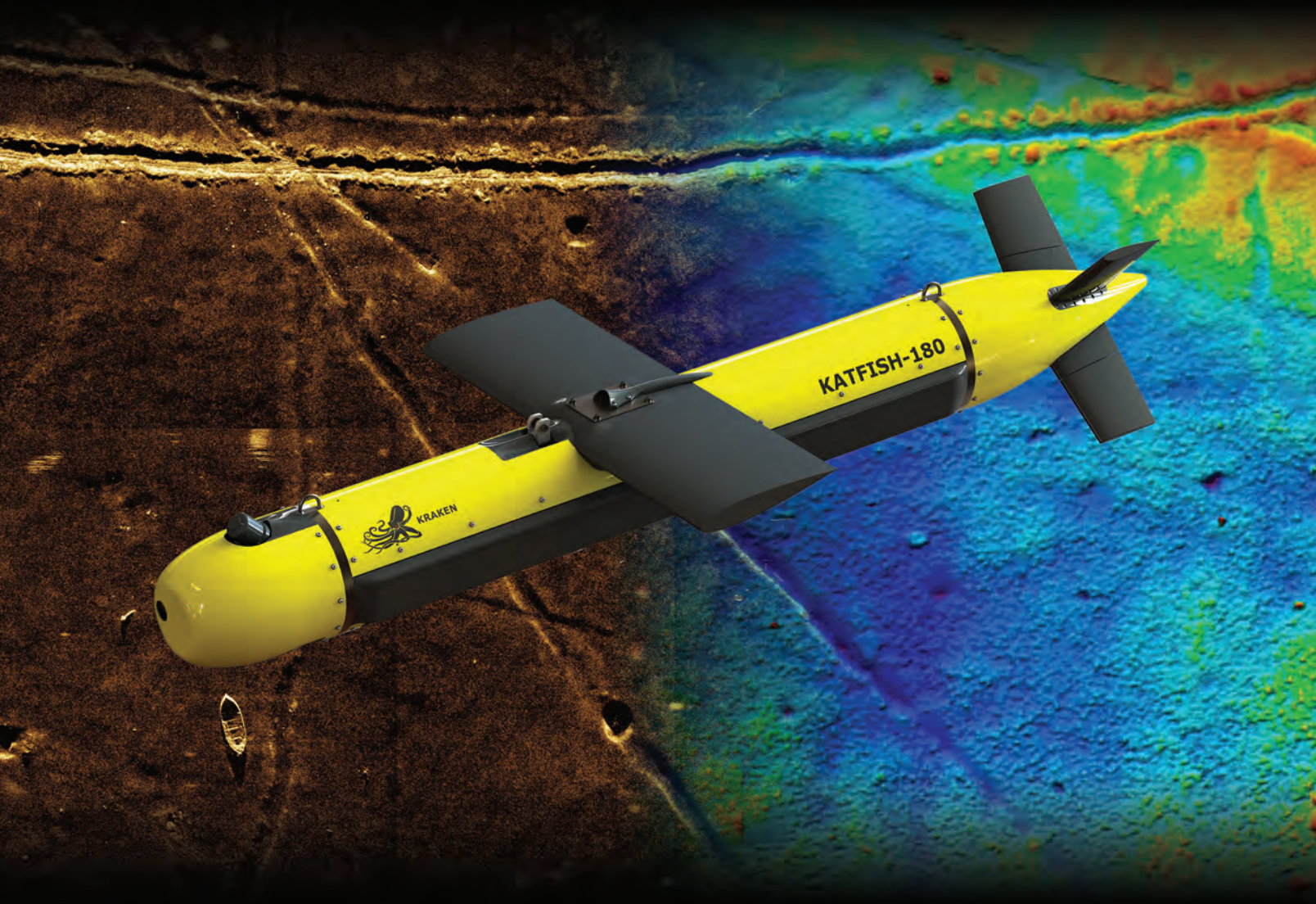

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Image: thyssenkrupp

of unmanned underwater vehicle.

MUM will receive funding from the German Federal Ministry for Economic Affairs and Energy over three years, and its aim is to open up new ways to explore and harness the potential of the world's oceans.

Meet MUM

According to the partners, MUM is breaking with old conventions: The modular, unmanned underwater vehicle performs its tasks largely autonomously, with an innovative modular design enabling the new vehicle class to be customized cost-efficiently for each mission. Individual base modules can be freely combined with specific mission modules to form large systems, enabling even unusual and highly specialized tasks to be performed quickly and easily. "The kind of modularity we are envisioning is a challenge for complex systems, especially due to the physics of the underwater space. We are talking about vehicles that will change in configuration and shape from job to job," Wehner said. "To get from a functional architecture to a proof of principle of a new class of underwater vehicles with our scaled model tests at Berlin Technical University in two years from now is ambitious. It will be a challenge for the hardware and software teams. But we have the best people working on it and we are confident to reach our goals."

Possible activities range from payload transportation and operations to research missions and stationary deep-sea tasks, able to tackle jobs on the industrial and scientific fronts.

A chief limitation in subsea autonomy is addressing the issue of power, and in this regard MUM will look to incorporate an emission-free fuel cell propulsion system to allow for deep dives and long range duration.

"The world's oceans present a wide range of tasks and questions that cannot yet be addressed because we don't have the appropriate vehicles and systems," said Marc Schiemann, project manager at thyssenkrupp Marine Systems. "MUM offers a wealth of new options for industrial marine engineering and scientific ocean research. We will equip the floating, wireless underwater vehicle with an air-independent fuel cell propulsion system. Our goal is to develop a vehicle which allows diving depths of up to 5,000m and continuous operation for several weeks."

With a payload capacity of several tons, MUM is capable of handling even heavy-duty tasks. The individual modules can be reused, permitting a significant reduction in costs compared with conventional vehicle concepts and much quicker development cycles. Newly developed mission modules are also easy to integrate.

MUM 2025

Research and development work for the project is expected to be completed by 2020, with a 1:5 scale model built and tested. The partners are targeting market readiness by 2025. As the project coordinator, thyssenkrupp no stranger to the subsea market. "thyssenkrupp is the market leader in non-nuclear submarines. A team of engineers within the company is dedicated to apply the cutting edge submarine technologies to the civil subsea industry. Within recent research projects, we for example developed a concept for electrical subsea power generation and storage based on non-nuclear air independent submarine propulsion technologies as well as a concept for a manned multipurpose submarine for arctic offshore operations," Wehner said. "The latter project was conducted together with Statoil ASA and can be seen as the starting point to think about a new class of large unmanned underwater vehicles that now concluded in the MUM project." thyssenkrupp is the project coordinator and will among other things develop the overall operating concept for MUM and translate it into a draft design for the vessel in close collaboration with Berlin Technical University. The company will also develop and test the fuel cell energy supply. Atlas Elektronk is responsible for the guidance and navigation system (GNC) incorporating the control func-

MUM Project manager Marc Schiemann (left) and design engineer Hendrik Wehner.

> **"The kind of modularity we are envisioning is a challenge for complex systems, especially due to the physics of the underwater space. We are talking about vehicles that will change in configuration and shape from job to job."**
>
> **Hendrik Wehner, Design Engineer, thyssenkrupp Marine Systems**

tions provided by the University of Rostock and communications developed by EvoLogics. Berlin Technical University will integrate the hardware into a vehicle concept and test scaled models of MUM. EvoLogics will be responsible for developing a telemetry network to enable the autonomous and accurate underwater navigation, positioning and communication of the new vehicle.

The University of Rostock will develop an intelligent and fault tolerant control system.

Get in Touch with MUM

According to Wehner, the project team is always scouting for innovative thought and development in the subsea space:

"We have an advisory panel in place to informally discuss their view of the future of undersea autonomy with. The panel comprises of subsea industry and research stakeholders. We encourage everybody to get in touch without any obligation (www.mum-project.com). We are particularly interested in forward thinking organizations that see potential applications for these vehicles and act as sparring partners for our unconventional ideas. When the project succeeds, we plan to team up to develop, build and test a prototype."

Echoscope4G Surface

Coda Octopus Products Launches the New Echoscope4G Surface; *the future of Visualization and Mapping Sonars*

By Richard Adams, Sales Director, Coda Octopus

The uncertainty that lies below the surface of the sea provides a number of industries with incredible challenges when conducting their daily business. From offshore structure installation and inspection, to the defense of our ports, and construction of national power generation assets, all subsea industries are plagued with a dynamic set of problems they must address. The industry standard technology that is utilized for underwater inspection is the multibeam sonar which was introduced in the market around 20 years ago. The multibeam at the point of its introduction to the market was revolutionary because it could generate clearer images of the underwater environment than the precursor technology, the single beam. The multibeam however has limitations as its outputs require post processing to render useful 3D images of the area being inspected and cannot image moving objects. Many subsea applications require technology that can facilitate real-time 3D decision making of both static and dynamic operations.

Coda Octopus Products Ltd. has recognized this market requirement and has been at the forefront of marine survey operations for nearly 25 years. The company started as the first pioneer of digital acquisition and processing for geophysical survey, and this innovation and emphasis on research and development (R&D) has characterized the company ever since. Coda Octopus has continued to lead the geophysical acquisition and processing market with its GeoSurvey, DA and Survey Engine product ranges. In addition it has developed a unique range of patented real-time 3D volumetric sonar systems marketed under the brand name of Echoscope® and are leaders in real-time 3D visualization subsea. This world first technology allows the user to generate a real-time 3D image of the underwater environment regardless if low or zero visibility conditions prevail and has been successfully used on a wide variety of complex subsea projects and operations across the globe including in oil and gas applications, breakwater construction, asset placements and landings, port and harbor security, defense, mining and diving applications Our real-time 3D and geophysical product ranges are complemented by GNSS aided inertial navigation systems. The F180 series has a proven track record in the marine survey industry for accuracy and reliability and is a preferred asset found on survey vessels across the world.

Our existing third generation of real-time 3D sonar products includes the standard Echoscope®, the Echoscope® and Echoscope® C500. All these variants have a standard depth rating of 600 meters and can be supplied with 3,000 meter ratings; we also have the capability to take these down to 6,000 meters on request. We continue to innovate and develop new application products within the real-time 3D sonar arena. Led by

All images Coda Octopus

Fig 1 – Echoscope® XD, Echoscope® and Echoscope®C500 Sonars

many years of experience in the subsea market coupled with feedback from our customers, and directed by our R&D department, we never stand still. All of our real-time 3D sonars use a proprietary technology and remain the only true real-time 3D imaging sonar, transmitting a large volumetric pulse of sound energy which generates typically over 16,000 beams for every acoustic transmission or 'ping'.

We have made significant steps forward in innovating our fourth generation (4G) of these products and the company is launching the new Echoscope4G® Surface sonar in January 2018.

The reimagined, reengineered and repackaged Echoscope4G® Surface comes in a new form factor and is 50% lighter, 40% smaller and draws 30% less power than our third generation (3G) of technology. Following feedback from our customers and a clear understanding of the key applications and environments in which they use our unique technology – the Surface enters a new distinct market space for shallow water system operation. Our standard Echoscope entry product is 600m rated making it at home on ROV, AUVs and vessels alike. In developing the Echoscope4G® Surface we focussed specifically on shallow water operational needs and were able to dramatically reduce the key size, weight and power (SWaP) characteristics of the system. This new Surface product is designed for underwater operations not exceeding 20m water depth. The new Surface is also more a plug-and-play application as it requires less tuning than our existing Echoscope® .

Fig 2 – New Echoscope4G® Surface Real-Time 3D Sonar

Benefits of the Surface for shallow water applications and small platform operations are huge, all without compromise on image fidelity and performance or capability. The Echoscope4G® Surface generates true real-time 3D images and mapping as the larger Echoscope®.

Technology

The Echoscope® technology has now developed such that offers unparalleled application, versatility and performance. This includes, simultaneous imaging and mapping and generation of survey grade mosaics and bathymetry of subsea areas without any post-processing and visualization of both static and moving objects. With the recent introduction of our XD model and capability – we now provide wide swath volumetric mapping over and above the real-time 3D camera imaging and high resolution 3D real-time inspection we are widely acclaimed for.

This unique capability gives users many benefits, including 'eyes' underwater where water visibility is poor, the ability to visualize in 3D moving objects so precise control of dynamic operations is possible, the ability to instantly visualize complex structures and the ability to generate survey grade bathymetric data without post-processing.

The Echoscope® range of sonars use proprietary techniques to transmit and receive a large volumetric pulse of sound energy up to 12 times per second. This volumetric pulse which is typically 500 x 500 at 375kHz is then subsequently detected by the receive array, which segments each return into over 16,000 soundings for every ping. This exceptionally high data density in the water column enables the USE software to instantaneously render a 3D image on the topsides PC or laptop.

In addition to real-time 3D visualization of static objects, the volumetric pulse generates a large Field of View (FoV) which enables any moving object within the FoV to be constantly visible. This will remain true even in waters where the visibility is low, preventing the use of subsea cameras. Further, the angle of the volumetric beam, enables enhanced imaging of complex objects and structures to be rapidly generated, with significantly less acoustic shadowing compared to a standard multibeam

All images Coda Octopus

Fig 3 – Real-Time 3D Volumetric Pulse

set-up and without any post-processing. The image below is of a vessel loading pier in Tianjin Harbour in China, and was captured using an Echoscope® XD, used in conjunction with our 1-box F185 GPS and Motion system. **The images below were generated in a single pass of the survey vessel, without any post-processing of the data required and significant detail around the piles is clearly visible.**

The patented Echoscope® range of real-time sonars are more than visualization tools, as they enable the capture of hydrographic quality data in real-time from the same sensor. This enables an operator to use the sonar for a multitude of purposes, such as visualization of a valuable asset as it is accurately placed on the seabed, and then simultaneously using this data to provide the as-built or as-laid survey.

The range of real-time 3D sonars are now differentiated by the depth rating, the frequencies and resolution available. The highest performance system, the Echoscope® XD, is supplied with both a wide angle 900 x 440 240kHz projector, and a multi-frequency 550 x550 to 200 x 200 projector offering eight different frequency settings from 340 to 700kHz. This system gives the operator the widest range of flexibility with a broad range of frequency, opening angles and

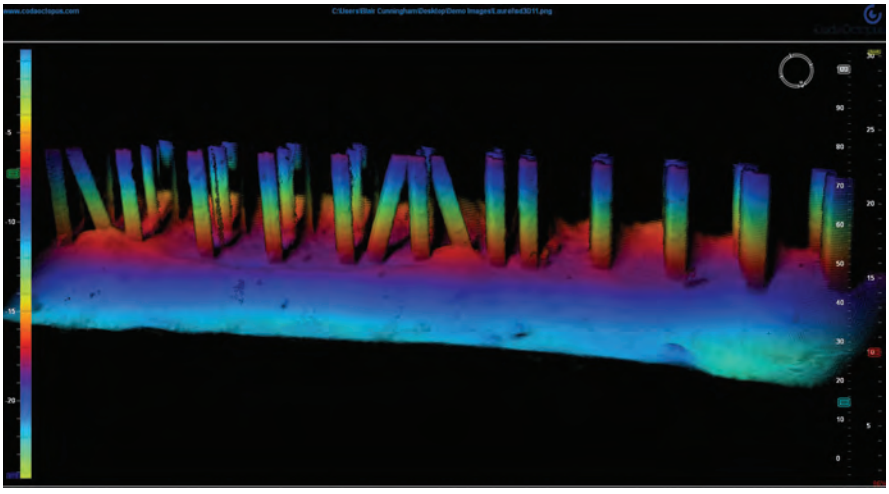

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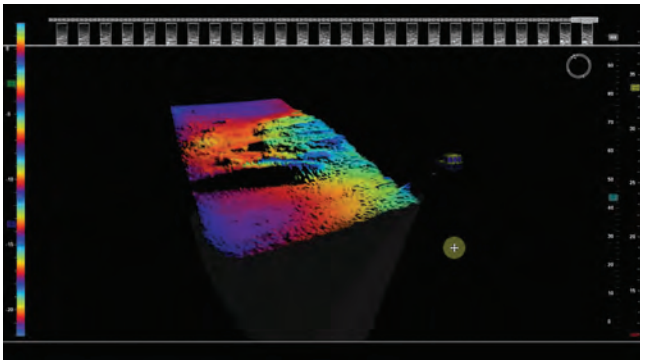
Fig 4 – Complex Structure Imaging

Fig 5 – Real-time 3D Bathymetric Data



resolution available for wide angle mapping, visualization and surveying. The Standard Echoscope® can be supplied in either a dual-frequency or a multi-frequency configuration, and the compact C500 in a lower resolution dual-frequency configuration.

The new Echoscope4G® Surface is available in either single, dual and triple frequency models offering unique combinations of frequency at 240, 375 and 630 kHz and opening angles of 900 x 440, 500 x 500 to 240 x 240. This combination of frequencies and opening angles give the new Echoscope4G® Surface a unique set of capabilities which can be deployed in a range of operations and tasks. The new Echoscope4G® Surface features our latest signal processing technology, which changes how the software processes data, making the system more intuitive and simpler than ever to operate, making it more of a 'plug and play' system.

The range of real-time 3D sonars is complemented by the different software applications. The standard USE software will operate with all of our sonar systems. USE offers additional features to enhance operations including the ability to insert geo-referenced models to enhance and visually augment the acoustic sonar data, the ability operate with and without GNSS position and motion data and the ability to export raw or binned point-cloud data for processing in third party hydro-graphic software.

We have further developed our proprietary visualization software to add the ability to track targets for the breakwater construction market and our construction specific software CMS. This unique software enables both the visualization of large concrete blocks as they are placed in the water, and also automatically tracks and overlays a 3D model of the block to assist the operator with accurate placement of the block. Our software also records the as laid x,y,z position and the orientation of each block, building up a 3D model of the constructed breakwater. The versatility of the sonar/hardware combination has been further demonstrated by our customers using the same Echoscope® as used for visualization of the installation, being used to carry out the complete as-laid survey, a method which has now been accepted and validated by the block design consultants.

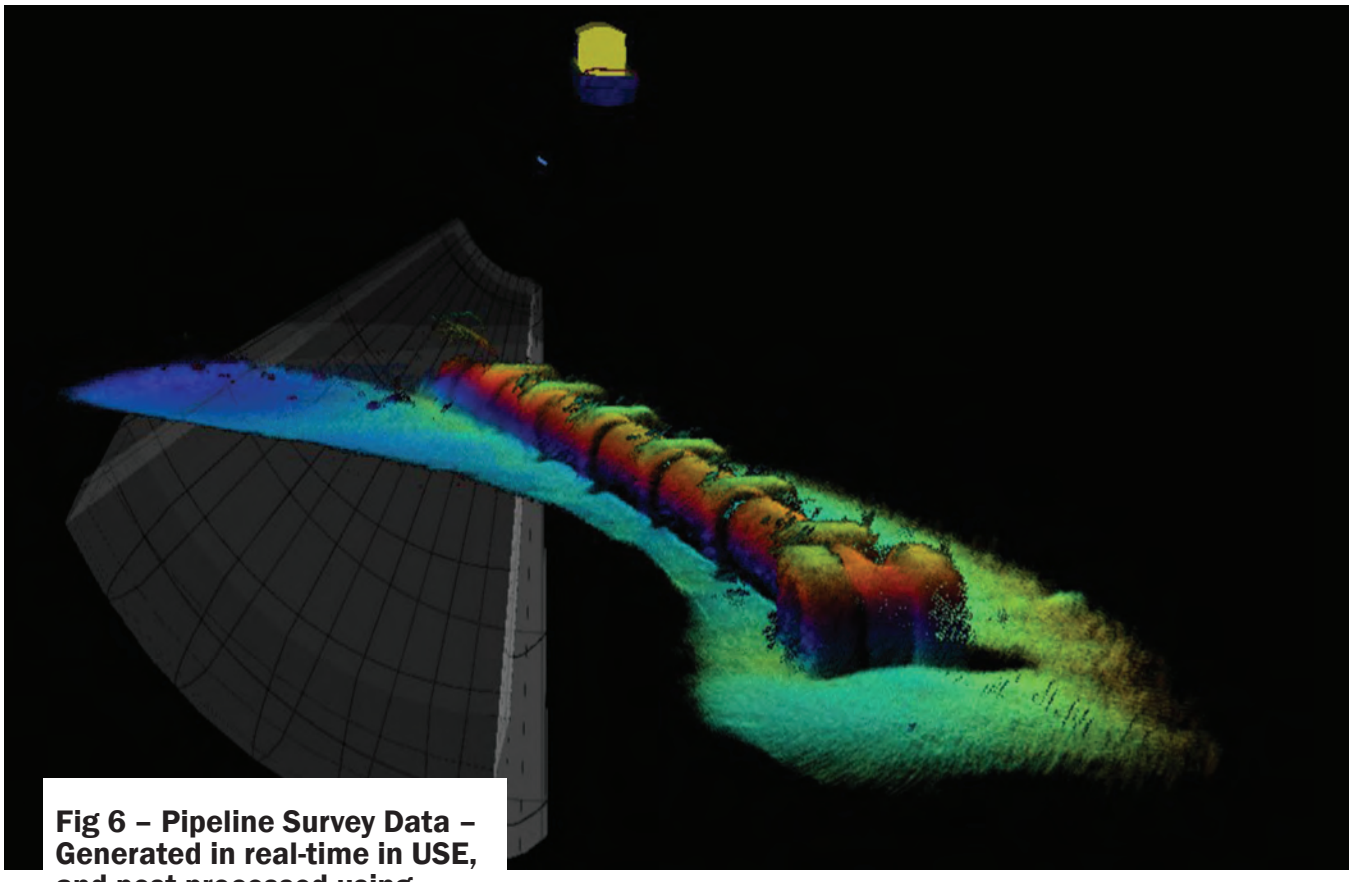
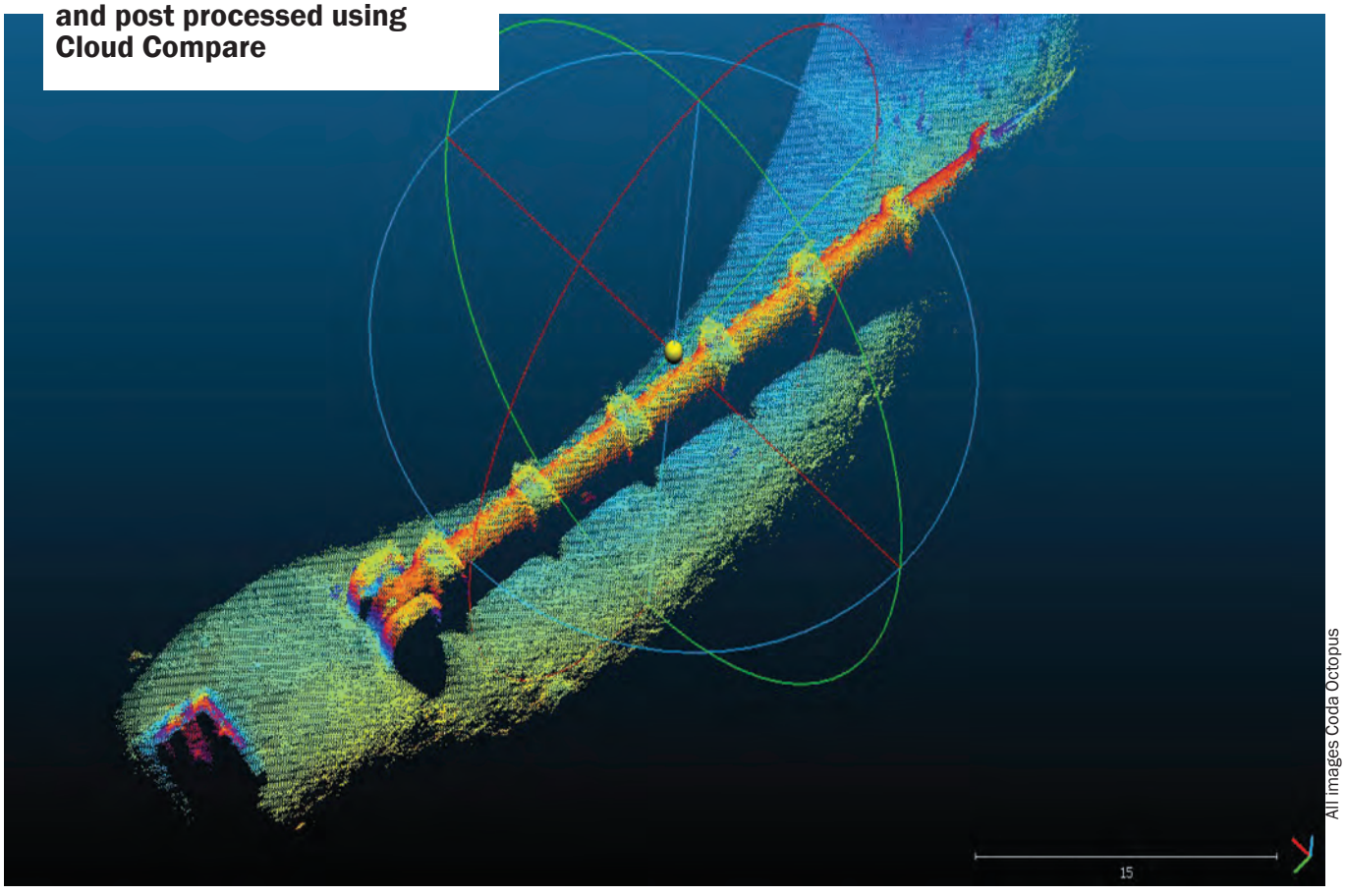


Fig 6 – Pipeline Survey Data – Generated in real-time in USE, and post processed using Cloud Compare



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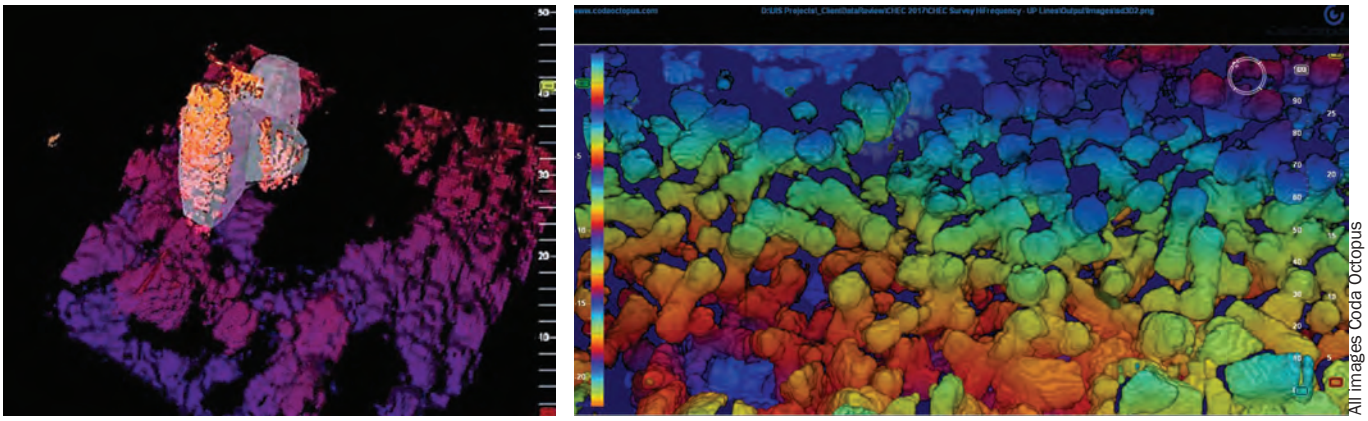

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Fig 7 – Real-time 3D Block Tracking and 3D As-Laid Survey

Projects and Applications

With the ability to both visualize and map data and image moving objects in 3D under the water in low or zero visibility conditions, our range of sonars have a huge and important number of different markets and applications across the world. One of our key markets has been subsea construction, either through imaging and survey of dredging and construction sites, ROV based oil and gas projects for key infrastructure installation through to installation of structures including breakwater construction. The ability to 'see' what is happening under the water can significantly improve the efficiency of the operation enabling operators to increase the speed and safety of the process.

The new Echoscope4G® Surface has been designed with these type of shallow water construction project in mind, offering a cost effective route to delivery these types of projects. The new Surface system can be used with both our proprietary software packages, USE and CMS software, giving the options of deploy-

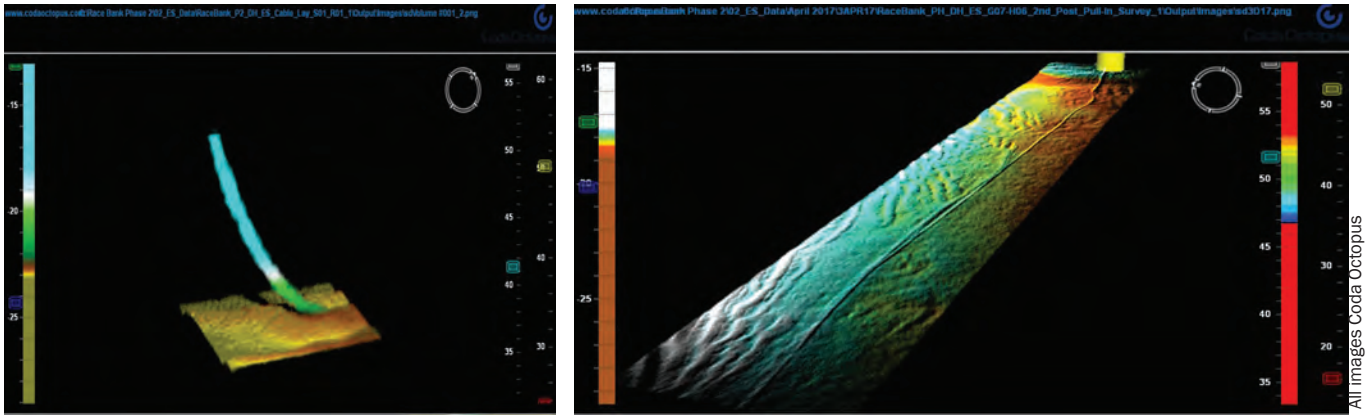

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Fig 8 – Power Cable Catenary and TD Monitoring / As-Laid Survey of Cable

ment on cranes, barges or survey vessels to image and map breakwaters, inshore bridges, piers and complex structures providing real-time assessment the accuracy of the asset placement, any damage to the structure and the effects of any environmental condition such as scour.

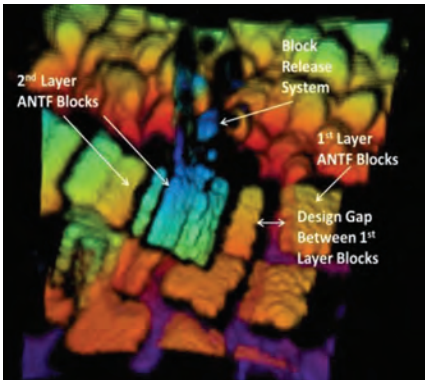
A number of our customers have reported significant productivity gains when using real-time 3D technology included in offshore wind energy projects. These have included recent cable installation projects such as Race Bank inter-array installation with DeepOcean. In this project the real-time 3D output was invaluable in being able to both image the power cable as it was laid to ensure none of the vital cable properties were exceeded and additionally to record the as-laid position of the cable on the sea bed as the cable was installed. This removed any requirement for a subsequent multibeam survey of the cable and the recorded as-laid position was then utilized by the trenching team to guide the cable trenching operations. The ability to visualise what was happening under the water, irrespective of poor water visibility, reduced the reliance on ROVs to support the project and the number of tasks carried out by the real-time 3D system rapidly increased as the project progressed.

Our breakwater customers, such as SGTM-STFA and Van Oord have also reported significant project success using the Echoscope®. This has included operation by Van Oord on the Kuwait National Petroleum Company project to construct a port and breakwater. The breakwater was armoured with 24,000 Core-LocTM concrete blocks and the Echoscope® real-time 3D sonar was mounted on the installation excavator to provide imaging of each block. Productivity rates of up to 200 blocks per day were subsequently reported by Van Oord.

On the Port of Safi project, the operator SGTM-STFA installed three separate Echoscope® systems on wire crawler cranes and by removing the requirement to use divers to monitor the blocks under the water, were able to work 24 hour shifts, thereby tripling the productivity

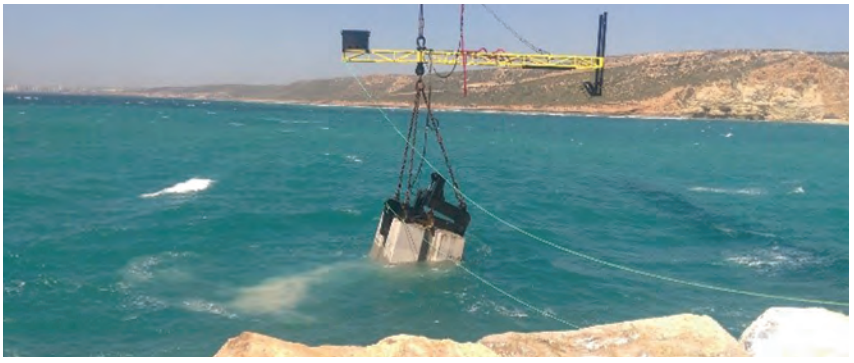
All images Coda Octopus

Fig 9 – Echoscope® Excavator Installation in Kuwait



The Author

Richard Adams joined Coda Octopus Products Ltd. in 2014 and is now the Sales Director and looks after the European, African, and Asian markets.



All images Coda Octopus

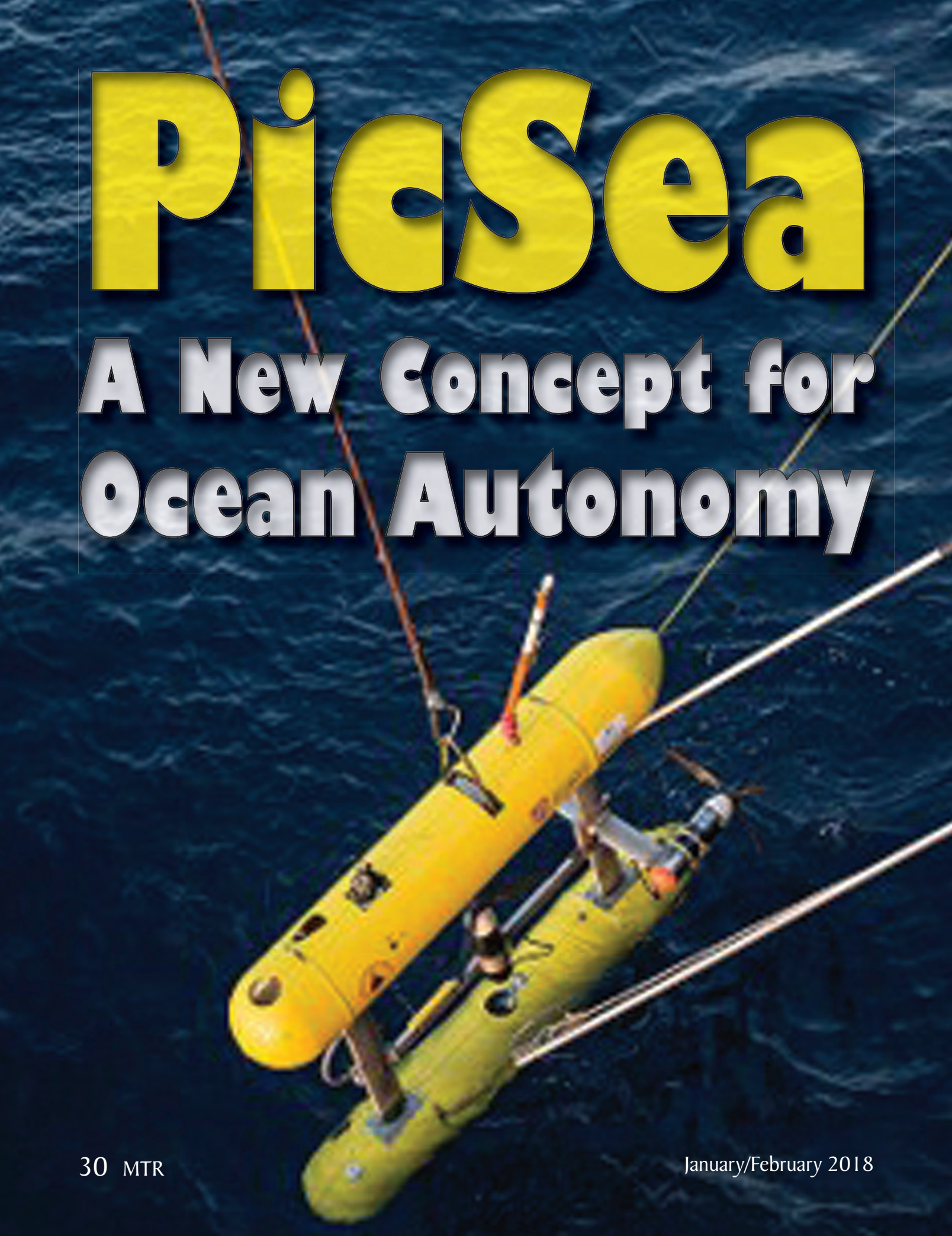
Fig 10 –
Safi Wire Crawler Crane / Echoscope® Antifer Block Data

rate on the site.

Future Developments

The launch of the new Echoscope4G® Surface is an important milestone for Coda Octopus and we continue to innovate our products with the aim of standardizing real-time 3D solutions in the subsea market – for various applications and different price points. The unique volumetric pulse, the wide FoV and volume of data generated by this unique technology make it well suited to autonomous operation including autonomous assessment and identification and classification of unknown objects required by autonomous underwater and surface vehicles.

The world of subsea engineering will always be a challenging one, but with the right approach, equipment and ability to visualize the operations in real-time and 3D, the challenges can be managed and reduced to acceptable levels. As a leader in real-time 3D acoustic imaging and mapping, the new Echoscope4G® Surface is an example of how Coda Octopus will continue to innovate and develop both hardware and software to continue to be at the forefront of subsea engineering and survey operations.

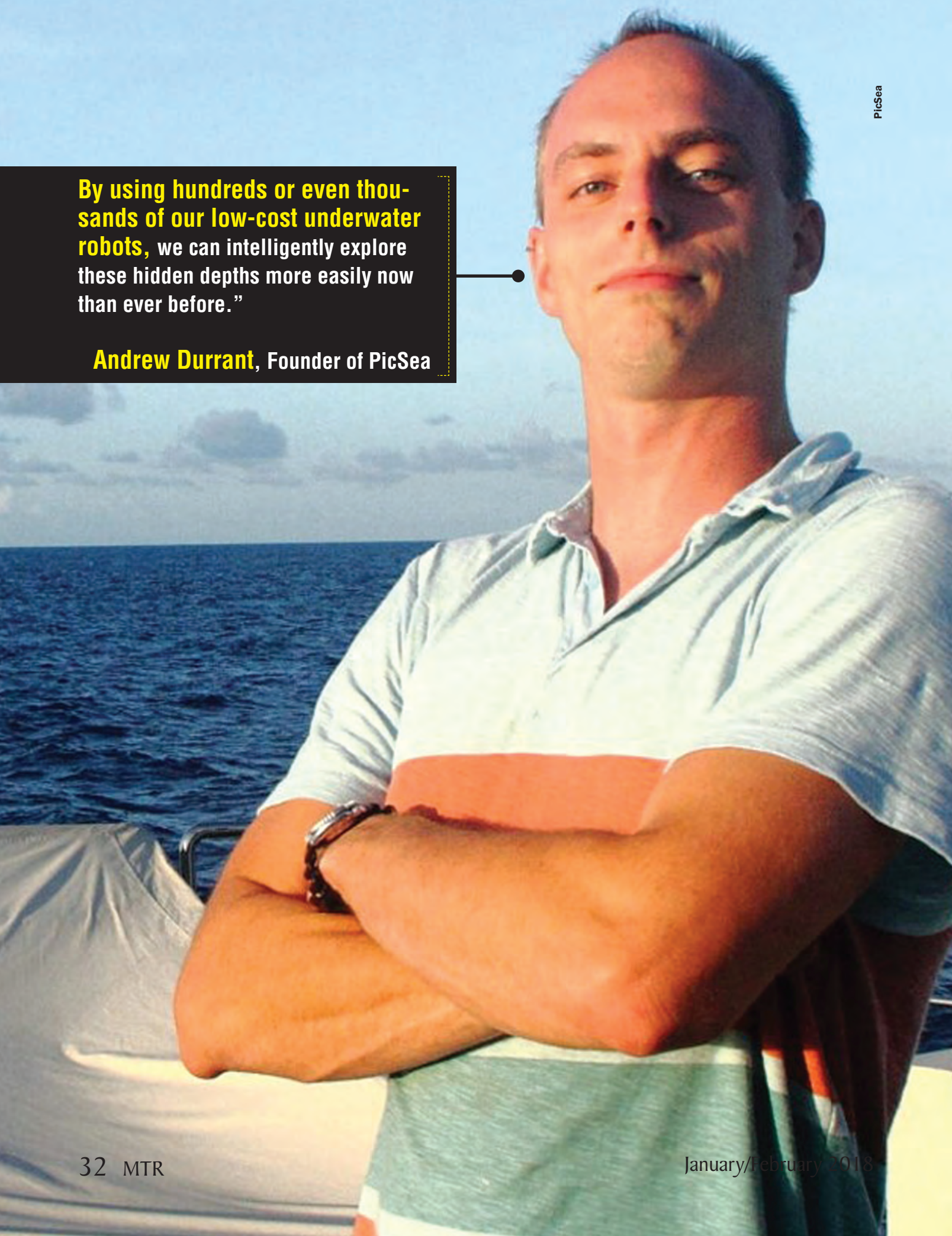


PicSea

A New Concept for Ocean Autonomy

By Kira Coley

PicSea



PicSea

By using hundreds or even thousands of our low-cost underwater robots, we can intelligently explore these hidden depths more easily now than ever before."

Andrew Durrant, Founder of PicSea

"I just can't believe that 70 percent of the world's surface is underwater, but it remains almost entirely unexplored. We offer a solution that could make a huge difference to underwater survey, exploration and research. By using hundreds or even thousands of our low-cost underwater robots, we can intelligently explore these hidden depths more easily now than ever before," said Andrew Durrant, Founder of PicSea, a new design concept for a small autonomous underwater vehicle (AUV) with a big mission.

Eight years ago, Durrant came up with an idea of producing small, low-cost robots that could not only intelligently enter unexplored areas of our planet but also open the technology to communities who could never access it before. "Back then I was a researcher at CSIRO working on habitat classification using their AUV. They were already working on what they thought at the time was a low-cost AUV, and this gave me the idea to go even further: I could make an AUV that was even more low-cost and more usable. I got a job at the University of Sydney for five years designing, maintaining, and deploying underwater robots and processing the data for clients. I was able to identify the things that make it difficult and expensive to collect underwater data. Because of those experiences, and almost a decade later, I now have a solution."

After working in underwater robotics, imaging, photogrammetry, data processing and logistics, Durrant created PicSea – a new design concept for an underwater robot that collects data at a fraction of the cost of other AUVs. Through PicSea, Durrant aims to make underwater data more accessible to those within the scientific community that lack access to large budgets or advanced technological resources.

Durrant said, "There's a very limited subset of people who not only want ocean data but can afford access to AUV technology. For example, I know a group of biologists who want to carry out lots of environmental surveys using AUVs, but their budgets just don't allow for it. This sort of thing is widespread across the scientific community, and it's something I am hoping to change with the PicSea concept. Our groundbreaking technology has dramatically reduced the cost and complexity of creating autonomous underwater vehicles."

Introducing PicSea

Durrant's idea is simple: PicSea increases ocean exploration and access to the technology by dramatically reducing the cost and risk associated with data collection technology.

Swarms of these new low-cost PicSea robots – deployed in hundreds or thousands – will communicate with each other and intelligently complete tasks such as seafloor surveys with capabilities beyond what is available today, said Durrant.

"It's not the first micro-robot concept out there, and the others are excellent tools, but we have a 'magic' source that

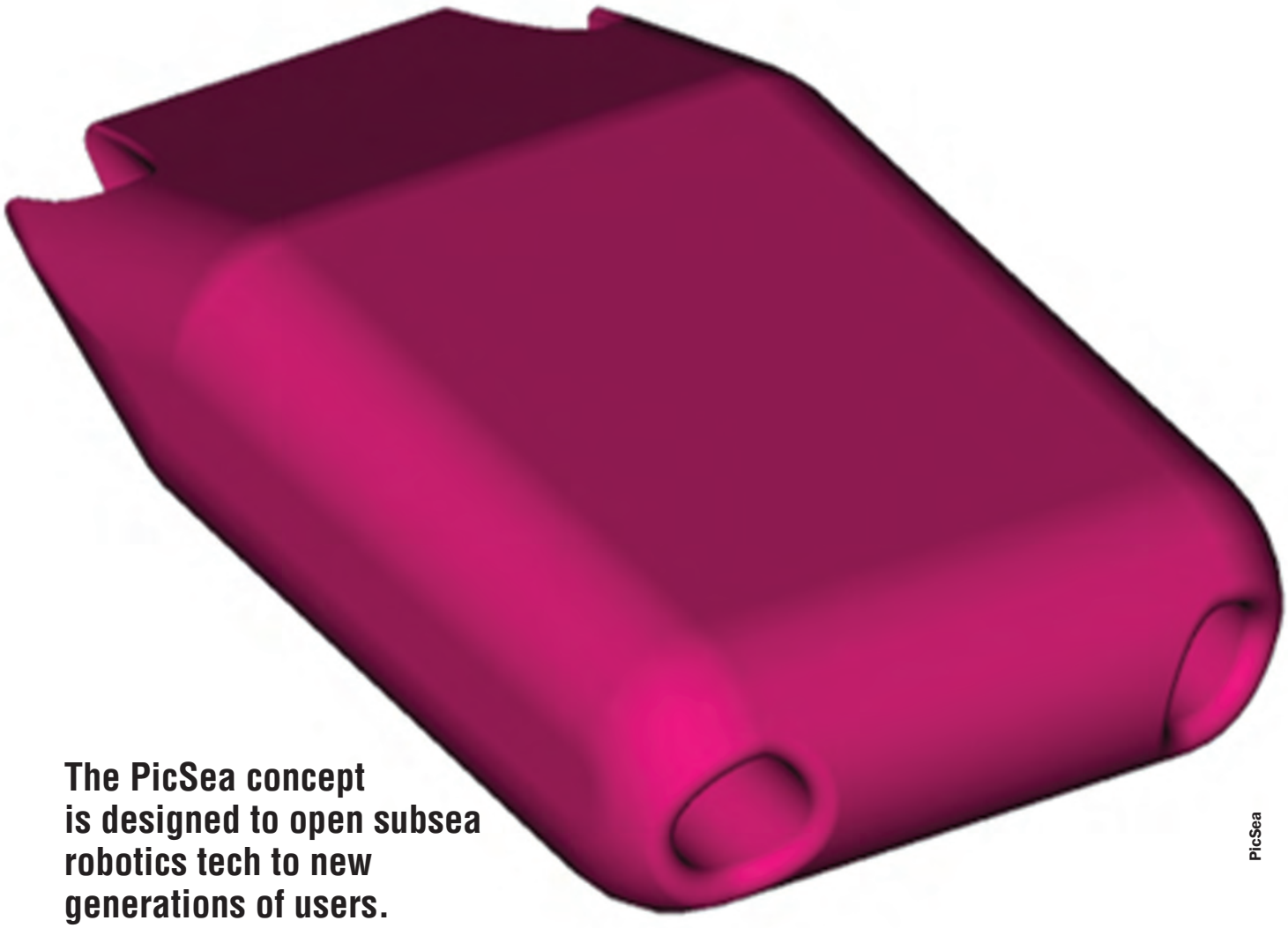
delivers innovative navigation and communications systems which isn't part of anyone else's design. Each of these small robots will have their own role to play in the future of ocean exploration and discovery; it's the way the industry is moving. For example, the other micro-AUVs are mostly designed more for water column sampling, but PicSea specializes in seabed mapping. We have a unique way to navigate, and the design of the vehicle is very different to anything that exists. That means they are mass manufacturable in a way that is very low-cost. We are one-of-a-kind."

Durrant's concept will enable him to produce robots the size of a briefcase, that can work on their own or in coordinated groups, without the need for the constant monitoring or expensive insurance required by other vehicles. The PicSea's will have a payload that can include cameras for photogrammetry, laser scanners, and multibeam or side scan sonars as well as oceanographic sensors. The design allows custom versions to easily be manufactured for specific use cases and users will have several deployment options including from a ship, airplane, helicopter, aerial drone or unmanned surface vessel (USV).

By using PicSea, Durant believes inspection tasks such as pipeline, seafloor asset and offshore wind scour surveys can be completed accurately, much faster and at a fraction of the cost. In environmental monitoring, whole areas can be surveyed in high detail instead of interpretations from transects, paving the way for protection, exploration and discovery.

The autonomy of the system as a whole will allow surveys to be planned, executed and the data collected remotely, and the swarm to adapt to changing conditions while on a mission. This enables the AUVs to be permanently installed in a location or take advantage of ocean currents and solar recharging to operate perpetually.

"I've spent the last year making sure that the technology that was needed to make this happen is possible. I've developed the propulsion, communications, and navigation systems and we are working with customers to understand the kind of data that they want. We've had a great response from all different sectors, and we expect to have something in the water by June 2018," explains Durrant.



PicSea

The PicSea concept is designed to open subsea robotics tech to new generations of users.

The Time for Ocean Start-Ups

The recent surge in underwater robotics has clearly demonstrated to both the industry and scientific communities how automation can be used in the data collection process. In the last few years alone, the industry is shifting from larger slow-adopting organizations to small innovative start-ups taking advantage of the latest trends in miniaturization and the relatively low-cost entry into the market.

"If I were trying to do this five years ago, it would have been a lot more difficult, and that is probably why more start-ups are entering our market now. There is 3D printing, satellite technology, battery technology and miniaturization on these elements that means in the short-term future it's going to be much easier to collect ocean data and to mass produce affordable underwater robots to complete all sorts of complex tasks. It'll be very disruptive to the industry in general. A sea of robots; this is how the industry is going to look."

Since launching PicSea, Durrant has found that the companies ready to embrace this dawning era of ocean autonomy are also eager to engage with start-ups like PicSea and see what new services they can bring to the industry. While more and more companies are entering the market with novel technologies and innovative ideas, independent start-up's still need more support from the industry in the form of small grants or access to facilities.

Durrant said, "It is difficult being a start-up in this industry. After working in a fully equipped institute, one of the biggest challenges for me was starting my own laboratory and having to make do with whatever I could assemble myself. There are grants and support, but a lot of that gets eaten up by larger institutions, and addressing this gap should be a priority for funders. It is an exciting time for ocean exploration, and I'm looking forward to the day when we have a much better understanding of the ocean and how to use their resources sustainably. Start-up and embracing new technological concepts will be a big part of that. Further down the line, my dream for PicSea is to create a Google Maps underwater, but for now, it's about promoting diverse solutions and getting more people to ask themselves how do we collect ocean data and make it faster, lower cost and less risky? PicSea is the answer."

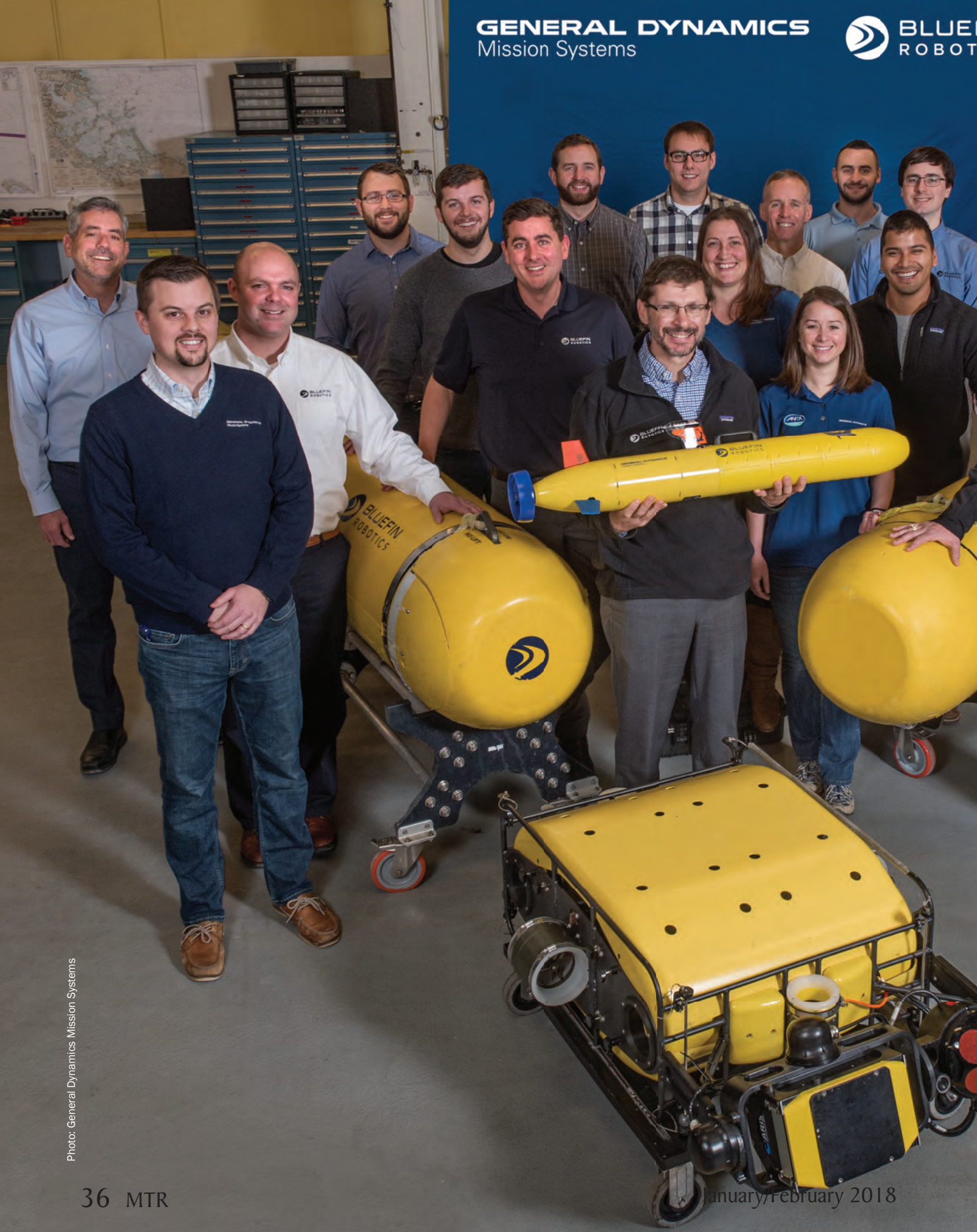


Photo: General Dynamics Mission Systems

Meet the Family

Carlo Zaffanella is vice president and general manager of Maritime and Strategic Systems (M&SS) for General Dynamics Mission Systems. The M&SS business includes submarine and surface ship electronic systems integration as well as the design, build and support of a broad array of subsurface, surface, air, airport and strategic subsystems, meaning he is perfectly positioned to lead MTR's 'vehicles' edition, as in 2018 our attention turns from a specific products and systems, to the holistic web of connectivity between subsea, surface, land-, air- and space-based assets.

By Greg Trauthwein

Please give a description of the business unit you lead and your responsibilities.

I run the Maritime and Strategic Systems (M&SS) line of business for General Dynamics Mission Systems, part of General Dynamics Corporation. M&SS is a pretty broad, large, and steeped in the traditional maritime business that has been on a strong and sustainable growth curve for 20 plus years. Basically we do electronics – especially mission systems – system integration, and product development for many maritime programs. And then the word "strategic" that's in that acronym, as well, "strategic" meaning "nuclear" so think Navy nuclear. I have four businesses – Navy Air, Navy Surface, Navy Undersea, and Strategic. In total we are about 3,000 people in about two dozen locations across the country.

OK, let's start broad. Looking at the world of UUVs, AUVs, unmanned systems, by broad geographic region or market, where do you see opportunities in the years ahead and why?

Let's rewind roughly 20 years, back to the mid-late 1990s, and think about UAVs. If you would have asked about UAV business (and looking ahead), would they have told you:

- *"We see a private company delivering packages to your doorstep using drones."*
- *"We see power line and wind turbine inspection, aerial construction."*
- *"We see window cleaning in Dubai."*

It is unimaginable what has happened in the last 20 years to UAVs. Why did that happen? Because they became really useful as the technologies fell in line, making it possible to do things that we simply could not imagine back then. So I'm going to caveat my answer to tell you that I think that's where we are with UUVs – technologies are falling in place. And the answer I give you today will probably seem horrifyingly myopic 10 to 20 years from now and probably unimaginative. But having said all that, what do we see in near-term? UUVs give us access and give us data that manned systems simply can't. We keep people out of harm's way, we get into niches and places that manned systems can't get to. So anywhere you see an application – whether it's keeping a sailor safe, or keeping a diver safe, inspecting infrastructure, inspecting vehicles – things that are tedious, those tend to be great things for unmanned systems. One obvious area is mine warfare. It is a nasty business, and in addition to keeping sailors safe, it also can do a lot more. You have a stand-off distance that is tremendous, and you can do things persistently that would have been very hard to do with a man in the loop. We've taken some major strides in maturing the technologies so that now it's gone from pretty good theory to real practice.

From oceanography to inspections under the Polar ice cap, to pipeline monitoring, to ship hull inspection and searching for lost vessels, unique applications continue to emerge. Simply put, the technology is just getting better – and it's getting better quick. Twenty years down the road my answer today will feel incredibly short-sighted. At least that's my hope.

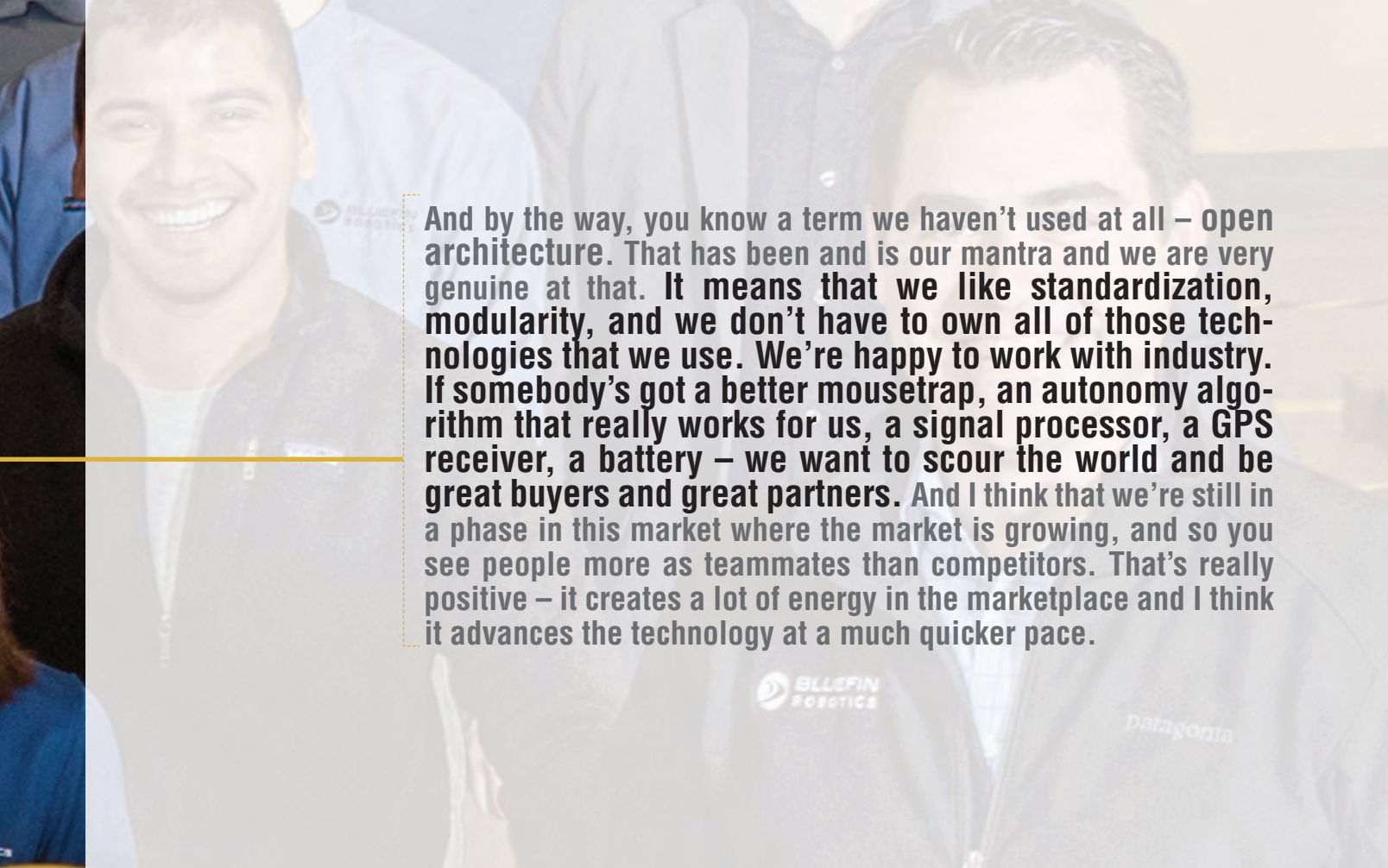
Looking at the last five years, what do you see is the most significant technology advance that has really helped to take the tech to the next level?

That's an interesting question. So I'm going to give you the "GD answer" in the sense of what has mattered to us, as opposed to the world of UUVs. We are largely a defense company, although our interest from a UUV standpoint is defense and commercial. There is no question that the most important things that we have been doing is to turn theoretic, fairly scientific and "research-y" vehicles into reliable, usable, predictable, GD-quality products that the Navy can buy and rely on to do their job. I know that doesn't sound "sexy" and perhaps you look for answers like autonomy, power, and distance communications, for example. All of those are important, but underpinning them is that these things can't be toys – they can't be things that are disposable or unreliable.

They need to be serious instruments and that's what we are developing. It doesn't do you any good to have spectacular autonomy, great power and tremendous power densities if every four hours you have to take your vehicle out of the water and repair it. And frankly, that's where a lot of UUVs were for the military recently. I think we're breaking that barrier.

So obviously there have been a lot of great strides both on and under the water in autonomy. But it could be argued that maritime has trailed the trajectory of land- and air-based sys-

Photo: General Dynamics Mission Systems



And by the way, you know a term we haven't used at all – open architecture. That has been and is our mantra and we are very genuine at that. It means that we like standardization, modularity, and we don't have to own all of those technologies that we use. We're happy to work with industry. If somebody's got a better mousetrap, an autonomy algorithm that really works for us, a signal processor, a GPS receiver, a battery – we want to scour the world and be great buyers and great partners. And I think that we're still in a phase in this market where the market is growing, and so you see people more as teammates than competitors. That's really positive – it creates a lot of energy in the marketplace and I think it advances the technology at a much quicker pace.

tems. Do you agree or disagree with that statement, and why?

Certainly it has trailed, but I think that the same ingredients (that drove UAVs 20 years ago) are now falling into place. Power density is coming way up, as it is a limiting factor for UUVs, just like it is for UAVs.

We've put in excellent resources toward making the kind of batteries that are modular, replaceable, high density, usable, transportable – and that has helped us immensely. Autonomy is complicated under the water in the sense that you can't communicate the same way, so when a system goes out there (underwater), its ability to sense is more limited, taking you to the need to signal process at very advanced levels.

Well, good news! Signal processing technology is progressing rapidly, and a company like GD that makes signal processors for all sorts of applications. We are able to, in a much smaller package, do much more onboard processing. That means that not only can we help the vehicle itself with autonomy, vehicle management and energy management – but the payload, too, whatever that payload might be. As a result we're seeing a substantial increase in real money being put towards buying these products to use them in real systems, especially on the military side. I think signal processing is a big part of that.

And then there is reliability. As I mentioned, the Navy makes assumptions that when you deliver a system like this, it's going to work exactly as advertised delivering the kind of reliability that they need. And I think if you look at our products, you're seeing that tremendous change is really high-end reliability, and that's going to make those other technologies much more useful.

While your responsibility and experience transcends underwater systems, when you look at the biggest challenge to delivering an effective, cost-efficient product or system for operation in the world waterways, what do you consider to be the number one challenge today?

Let's say you solved the problem of making your UUV reliable; it's developed, it's trusted, it's autonomous. So now what is it doing? If it is collecting a tremendous amount of data but shipping it back with a low bandwidth of undersea comms, that's a challenge. If it just sits there and stores data and gives it to you later when it comes home, that's a different challenge and it is hardly real-time.

As we push the frontier of reliability, as we push the frontier of autonomy, as we push the frontier of power, and so now you get to Nirvana, right? Your UUVs can be out there for a super long time, but what are they doing if they can't give you back the information that matters?

Our job is to solve missions, so we have a much broader view of what it takes to make a UUV useful – from launch and recovery, to cyber security, to data management, to the data fabric that allows the communication under and above the water – these are all parts of the problem. And I think that the UUV community, largely, is focused on solving the "put a vehicle under the water and make it autonomous" problem. That's just a piece of the puzzle – we want to solve the puzzle.

Looking at the vehicles, can you give us an overview of the 'fleet' under your guidance?

You can't make an infinite array of products; it's just not a reasonable way to run a business. So what we've done is we've been working with engineering and business development to understand the market need. We focused on a family, starting with the smallest offering which is Sand Shark – low cost, single person portable, leveraging miniaturized sensors. Then we have "intermediate diameters" and we're productizing those now. They existed already in the Bluefin suite, but we've taken a hard look from the ground up, re-engineering them to make them modular and cost-friendly, a repeatable, producible device.

Then there's the 21-inch diameter which is the basis for Knifefish.

If you had to pick one of the products in the family and tell me what you think has the best near-term potential, which one and why?

I would say it's the 21, as it has been the beneficiary both of the Navy's investment and our own. It has a lot of payload flexibility. It is capable of being launched and recovered from existing Navy assets, and it is also capable of launching its own UUVs. I see it as a building block not just for us, but for the Navy, and in doing that, as we standardize on that product, we drive its price down and its commercial viability goes up. This is a 4500 meter vehicle that takes you to the vast majority of the ocean's waters. And you can do a whole lot with that, both commercially, scientifically and militarily.

(NOTE: Late last year a specialist team from General Dynamics Mission Systems demonstrated the unique capabilities of the Knifefish, a medium-class mine countermeasure (MCM) unmanned undersea vehicle (UUV), during contractor trials for the U.S. Navy. The tactical UUV is designed using an open architecture concept that can be quickly and efficiently modified to accommodate a wide range of missions that may face future naval operations. The Knifefish UUV, which is intended for deployment from Navy vessels such as the Littoral Combat Ship, is based on the General Dynamics Bluefin Robotics Bluefin-21 deep-water autonomous undersea vehicle).

So concisely, what is unique about the KnifeFish platform?

Two things. I've already told you that we have brought it to where it is a producible, usable, reliable – and at a price point – that nothing else is (at).

So now we are talking KnifeFish as opposed to BlueFin 21. KnifeFish is designed so that the coupling between the payload – which is a Navy-designed payload – and the product is unique. The hydrodynamics, the acoustic properties of the unmanned vehicle, are extremely well-matched to the needs of the sonar. And with the signal processing we are capable of delivering, it's a combination that isn't easy to replicate. This is really understanding the physics of how the sonar interacts with the UUV. We are able, and have proven, mine detection performance that has never been seen before. So it's much more than just making it reliable, producible and inexpensive (but those are really important, too!). The KnifeFish takeaway: It's so easy. It just works. You put it in water, you tell it what to do, it goes and it does it, it comes back, you recover it, and it feels solid and repeatable.

We talk about individual systems, we talk about holistic systems and solutions from the land, the air and the water. How specifically does General Dynamics view and drive this multi-platform connectivity?

It is a really good question, but let's step away from UUVs for the moment. I told you kind of the scope of the business that I run, and one of the things that you learn as you get more into solving mission problems is eventually it's about the data: the sharing of data, the data fabric that allows you to communicate among land, air, sea, space. How reliable

Our job is to solve missions, so we have a much broader view of what it takes to make a UUV useful – from launch and recovery, to cyber security, to data management, to the data fabric that allows the communication under and above the water – these are all parts of the problem. And I think that the UUV community, largely, is focused on solving the "put a vehicle under the water and make it autonomous" problem. That's just a piece of the puzzle – we want to solve the puzzle.

is that data? How secure and cyber-secure is that data?

So cross-domain data sharing is a big deal. We are putting real energy there and it's not just UUVs. It's exploiting data fabrics that were developed for ground systems to put them into our UUVs so that we can really, intelligently share information from a submarine to a UUV, to maybe an unmanned surface vehicle, and relaying up to a satellite and back down to some other effector. That's a big deal.

We have "an explorer business" that takes what you know, your organic business, but it looks way out of the box? We have a great out-of-the-box thinker, an undersea expert, and we've chartered him to go with a small team and really work on how to take our UUV business, our command and control business for submarines, our undersea-cabled business, and put those things together in intelligent ways to solve our more complex, higher end problems. I think this question is as vital as any of the ones that you asked, because I think that's where this market goes for the military. It's about making the UUV useful – not making it work.

We live in an increasingly connected world, where cyber threats and cheap-to-produce asymmetrical threats are the norm. Can you put in context the growing cyber threat?

Let's put a caveat around the whole thing: anything associated with cyber security starts to get pretty sensitive pretty quick.

... Understood ...

One of General Dynamics Mission Systems' six businesses is called Cyber and Electronic Warfare Systems. That's all they do, and that business is enormous. So we work extremely closely. Of course, that gives us access to products and to experts that are dealing with the modern cyber threat. In the case of the UUV, I think you could, as a minimum, rapidly get your head around categories of threats – there is nothing particularly sensitive about that. But imagine that you have a supply chain threat; we have that in everything that we build. Unless you absolutely control your supply chain all the way down to the foundry, there's always going to be some risk that there is some cyber threat inherent in any product that you buy.

There's the insider threat: Somebody using the UUV would have that intent. The UUV itself is a unique thing: you send it out to do its job, and it's now out of your sight. When it comes back, how do you know what's happened? And then we have the other complication that is shared by all military assets that communicate, which is what is your defense of your cyber, of your comms? So we look at all of these categories of challenges. We work closely with the Navy and with other agencies to try to understand them, assess them, mitigate them. I would call GD "experts" – truly experts – in this. Having said that, it's one of the toughest challenges that we face.

One final question. If you had to pick the area of the greatest focus of investment from a technology standpoint, or a product standpoint, where is it in 2018 and beyond?

I think I started to tip my hand on this when I was outlining the different diameters of vehicles. Having successfully come through the productization of Sand Shark, and the productization of our 21, we're finishing the productization of the 9 and 12. They are for sale now, but we're really taking that holistic look at making them the absolute best that exists in those diameters. That's a pretty big focus, we're right in the middle of that, and that will take us through the bulk of 2018.

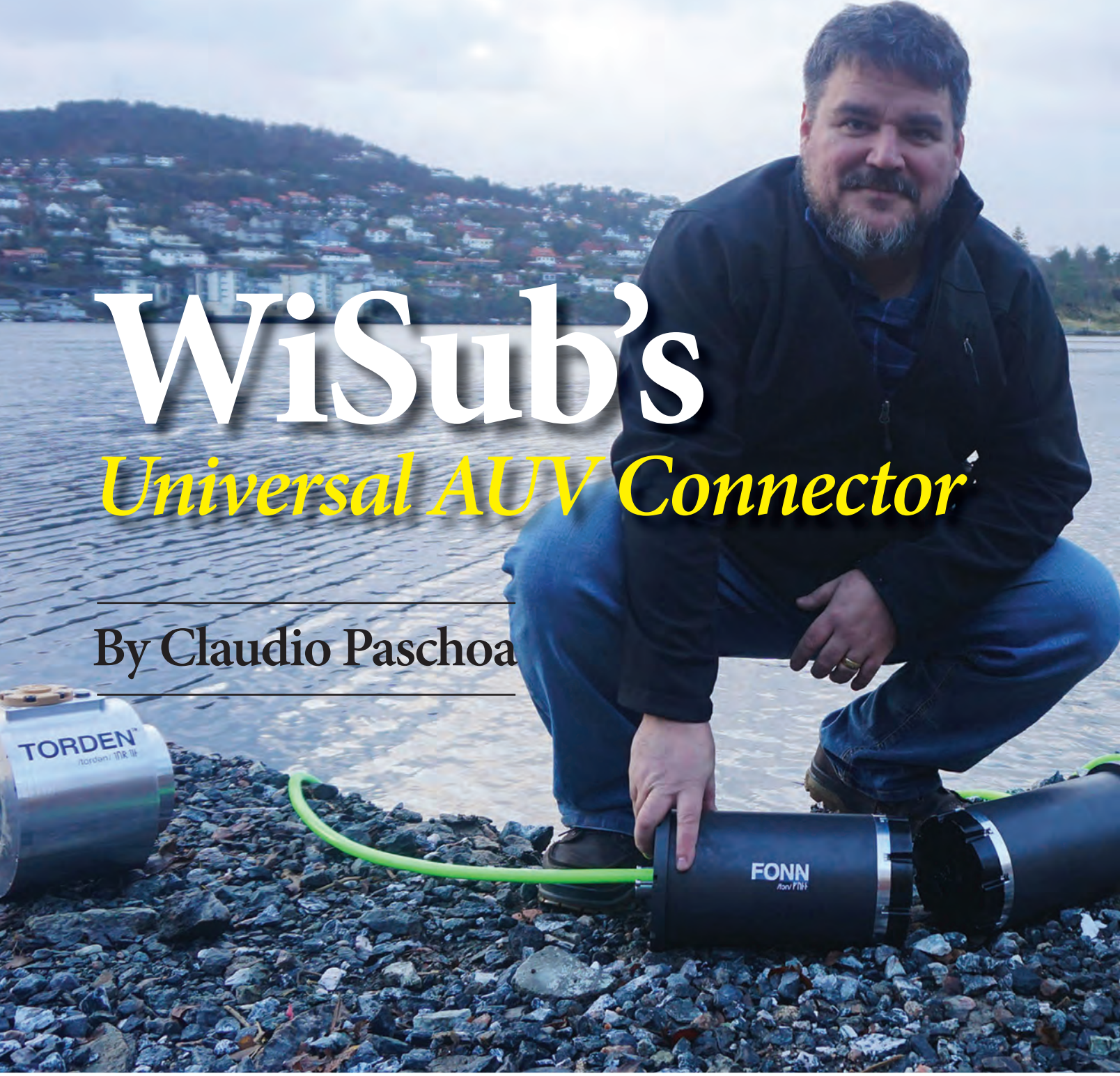
On the other hand, we have a very rich technology roadmap and it has all the things you might expect and maybe some that you don't. It is things we've talked about today – cyber security, autonomy, energy, propulsion, miniaturization and signal processing.

And by the way, you know a term we haven't used at all – open architecture. That has been and is our mantra and we are very genuine at that. It means that we like standardization, modularity, and we don't have to own all of those technologies that we use. We're happy to work with industry. If somebody's got a better mousetrap, an autonomy algorithm that really works for us, a signal processor, a GPS receiver, a battery – we want to scour the world and be great buyers and great partners.

And I think that we're still in a phase in this market where the market is growing, and so you see people more as teammates than competitors. That's really positive – it creates a lot of energy in the marketplace and I think it advances the technology at a much quicker pace.

WiSub's
Universal AUV Connector

By Claudio Paschoa



CEO Mark Bokenfohr with WiSub products.

AUVs are increasingly used in the O&G industry, especially for subsea field monitoring. One of the limiting factors in its use has been the need to recover it to the surface after relatively short periods of time. WiSub believes it has a definitive solution to this problem. AUV systems have always been a target application for pin-less power and data transfer, due to the significant challenges posed with using conventional connectors for this type of connection. WiSub combines the latest methods in resonant power transfer with a revolutionary application of very high frequencies underwater to transmit data and power over short gaps of seawater, reliably maintaining the ability to connect and disconnect without increasing the risk of connection failure or degraded performance, a potentially game changing subsea technology.

WiSub CEO Mark Bokenfohr's early career was based in the development, delivery and offshore operation of work-class ROVs and related systems, where the limitations of underwater connectors

Photo: WiSub

can be readily observed. "Having used low-speed inductive modems as an ROV pilot during oceanographic science operations, I was convinced that pin-less connectors should be developed for the oil and gas industry as well, though it took another decade, a few changes of country, and the right timing before I took the leap to build a company that would deliver such solutions. Officially the UAC project is named "Universal AUV Pin-less Charging and Data Transfer Interface". Internally we call this project "Pin-less AUV Interface" or PAX." WiSub has developed significant advancements to the advancement of state-of-the-art underwater connection, however we must share credit to the development of earlier pin-less connection technologies for providing us with the inspiration to go farther and dream bigger," said Bokenfohr.

When speaking to Bokenfohr, you immediately feel the passion and knowledge he has for the potential of the Universal AUV Connector (UAC). It's important to look at the history involved in this breakthrough. "Pin-less inductive connectors have been in use underwater for decades, developed to overcome the significant limitations of pinned wet-mate connectors. Some of the earliest applications in this area were simply split transformer halves, delivering wireless power based on the principles patented by Nikola Tesla a hundred years earlier. Data has also been transferred wirelessly through water via electromagnetics (EM) for decades," explains Bokenfohr. Yet in order for the UAC concept to come of age, key technological developments were necessary. "Significant and relatively recent developments in through-air technologies have enabled a leap forward in the state-of-the-art for EM-based underwater connection. The commercial availability of electric cars has also spawned the development of higher-power wireless charging; WiSub developed our Torden product in collaboration with one such developer who was transferring 18kW into a moving electric car. WiSub marries the latest methods and circuits possible in resonant power transfer with the revolutionary application of very high frequencies underwater to transmit data and power over short gaps of seawater. We have seen further by standing on the shoulders of giants."

According to Bokenfohr, there are some specific characteristics of the pin-less connection that allow the UAC to maintain reliable data and power transfer underwater, which are vital in enabling a dependable AUV docking station – "Maintaining reliable connection means maintaining the ability to connect and disconnect without increasing risk of failure or degraded performance. Legacy pinned connections can perform

reasonably reliably if handled carefully and plugged in only once; some might consider them like a solder joint – connected once and not intended to be separated. To keep the connector's precision moving parts safe and the connection reliable over several wet-mate cycles is much more challenging due to the need to seal dynamically against corrosive high-pressure water, align pins perfectly every time while attempting to seal and re-seal without incurring ground faults or failure. Contaminants in the water and rough operator handling exacerbate the problem of sealing and alignment. The basic physics of pin-to-socket construction also limits the speeds possible for data transfer due to the long unshielded, untwisted pin lengths that introduce the possibility of interference. Pin-less connection is inherently more reliable over multiple mating cycles since there are no dynamic seals that wear out, a far more forgiving mating tolerance, immunity to contamination and no pins to align, break or bend. A reduced mechanical complexity is valuable in increasing reliability, and justifies the application of solid-state electronics. There are further enhancements that an intelligent connector can provide which 'simple' pins cannot, such as localized network diagnostics."

One of the vital breakthroughs that made the UAC concept viable relates to WiSub's patented high-speed, high frequency microwave electronics technology – "EM-based communication has been known for decades in the radio-frequency range (below 300 MHz), and has been applied to low-speed data transmission over short distances (some meters). High frequency data transmission has been ignored due to its very high attenuation in seawater – GHz-level EM wave propagation is not possible beyond 10 centimeters through seawater, and more practically only useful under 5 centimeters. This was never considered a practical distance for 'wireless communication' since 'transferring over some distance' was always understood for 'wireless' technology. High-frequency EM works very well for pin-less connectors though, and since it was never obvious to others, we were able to secure patents for this inventive step in underwater communication," explained Bokenfohr. It is also interesting to note the advantages of this technology over traditional low-frequency RF, inductive or acoustic technologies. High data transmission speed over wide bandwidth is the main advantage offered by WiSub's microwave-based underwater data link, starting at 100Mbps and extending past 1Gbps in development. "This high-speed advantage is possible due to the frequencies involved, which requires small (micro) wavelengths, which also happens to be the same feature that prevents long-distance travel of these waves. Microwaves are defined to operate in the 300MHz to 300GHz frequency range; the other technologies applied in the field of underwater communication typically operate at far lower frequencies, and correspondingly lower data rates. Data speeds of kbps (kilobits per second) are possible with acoustic communications. Radio-frequency communication links (within the 3 KHz to 300 GHz range) are able to achieve similar data speeds over some meters. Inductive links used for power transfer are often also used for data transfer, with small separation between frequencies, which presents some risk of interference as well. An additional practical benefit of using microwaves at GHz for data transfer and longer wavelengths at kHz for power transfer is the large separation between frequencies, which avoids interference issues. Additionally, acoustic communications are adversely affected by turbidity and noise in the water column, which does not affect EM-based systems," said Bokenfohr.

The search for a robust and reliable subsea AUV docking station has been going on for at least a decade. With the increase in size, depth and complexity of subsea oil and gas production fields, the need for long term AUV and ROV docking has greatly increased. In terms of simplifying operational logistics and decreasing support vessel costs, the possibilities offered by the UAC may truly be a game changer. According to Bokenfohr "AUV docking is extremely risky unless established via a pin-less connector. Docking has previously been demonstrated by others using wireless underwater technologies, but these developments have been limited in compatibility with other systems and specific to certain vehicles and networks. The PAX connection system will increase the viability of long-term subsea docking stations by delivering a universal connection system that is compatible between multiple AUV systems, encouraging deployment and proliferation of the technology throughout all subsea industries internationally. An additional result of the project will be the ability to deliver power from the AUV to distributed sensors in the underwater environment, as well as harvesting data gathered by such sensors. Sensors deployed underwater and not connected to an expensive cabled network are limited in battery life, data transmission speed and communication distance. Enabling the AUV to be 'subsea resident permits localized power distribution without need for a cabled network, shortening the communication distance to centimeters while increasing the data communication speed to Mbps instead of the limits imposed by acoustic communication physics."

The main characteristics and capabilities of the UAC and its depth rating showcase the many possible uses it may have for the O&G industry. "The PAX project will deliver two discrete interfaces, technology within these systems both based on WiSub's award-winning Torden and Maelstrom products. The Torden PAX development will be used for charging the AUV, and the new development Fonn will be used for charging from the AUV. Both will apply WiSub's patented half-duplex 100Mbps microwave-based data link."

These are the gap tolerances on the connection and its data and power transfer capabilities - 10mm gap. 100Mbps data transfer, 250W@24vdc (Fonn instrument interface) and 3kW@300vdc (Torden PAX AUV interface). "We have

not observed that depth affects pin-less connector performance, except in the case where materials compress (e.g. encapsulation material around transducer heads) and seawater gap increases. Further research in the project will confirm operational parameters of the project's results. The project's planned research into calcareous deposits is expected to yield additional useful information on environmental factors that might influence pin-less connector performance." Bokenfohr also pointed out the diversity and importance of his partners in the project: "The PAX project brings together a diverse group of participants, some who are in direct competition with each other, but will all benefit from the developments. Several of the project participants have existing commercial relationships, and they include AUV manufacturers, AUV operators, acoustic communication systems providers, subsea infrastructure stakeholders and academia, who all play a role in the project. Each brings their own unique competence and their invaluable experience and advice to the development of the most relevant results."

WiSub believes it will have UAC technology operational for use in a deep-water AUV docking station in the near future, with one system to be deployed by the end of this year. "The Fonn 250W development is in its final stages now, the first hardware to be deployed within December 2017. Torden PAX 3kW will be deployed in Q2/Q3 2018. Both resident ROV and AUV systems will be enabled via these developments. WiSub's existing products are however already deployed and in use as AUV docking interfaces with customers in North America. WiSub's innovation in high-frequency data transfer has added an essential component to enable faster data transfer speeds, an advancement which was recognized at OTC 2015 through a panel of industry experts awarding WiSub's Maelstrom connection system a Spotlight on New Technology Award. Maelstrom was developed to be our first flagship product to demonstrate the capabilities of high-speed pin-less communication over microwave frequencies, coupled with inductive power transfer methods to meet industry needs for repeatable reliable connection. Torden also took home its own Spotlight award in May of 2017, confirming that the industry continues to see great value in pin-less underwater connector solutions," concludes Bokenfohr.

Fonn represents the convergence of patented high-speed microwave-based data transfer technology with innovative power transfer techniques.

Photo: WiSub

Case Study

3DSS-DX-450 Sonar

Before coming to rest at the bottom of Lake Union in Washington, J.E. Boyden was a common sight along the shores of Puget Sound and Vancouver Island. The 85-ft. vessel served as a cargo hauler and tug vessel for almost half a century during the final days of the tallship bulk carriers. Originally laid as one of the Seattle steamer fleet in 1888, the Boyden quickly made a name for herself as a powerful and capable tug, transporting coal, coke and lumber between ports on Vancouver Island and Puget Sound. The J.E. Boyden was also involved for many years as a tug for sailing ships entering the variable waters of the Strait of Juan de Fuca and Puget Sound. Scuttled in 1935 in 40 ft. of water in Lake Union, the J.E. Boyden wreck is still well preserved and its integrity and orientation have been documented using 3D Sidescan Sonar technology from Ping DSP.

Data Acquisition

Lake Union is a small freshwater lake situated in Seattle, between Lake Washington and Shilshole Bay, Puget Sound with a surface area of 2.3 square kilometers and an average depth of 10 meters. The 3D Sidescan Sonar survey was conducted using a 3DSS-DX-450 sonar from Ping DSP mounted on a pole over the side of a 27-ft. aluminum survey launch. The 3DSS sonar was mounted at a depth of 0.75 meters and the survey was conducted at a speed of three knots. A single pass over the J.E. Boyden with the 3DSS-DX-450 Sonar produces a 3D image of the wreck with the acoustic illumination from the 3DSS revealing its true geometry, complete with shadows.

Although the wheelhouse and cabin structure have long since disappeared, the rear deck and ornate woodwork bordering the stern is still very much intact, as are the bow and the decks surrounding the well defined hold. The image shows the J.E. Boyden lying in 12.46 meters water depth surrounded by flat, muddy terrain. Colors in the image are used to emphasize the vertical structure of the wreck which spans approximately 2 meters. The image below shows a screen capture from 3DSS sonar real time 3D Target Logger. Annotations can show the vertical height above the lakebed, overall length, and the beam of the wreck and these correspond closely to the historical record. The captured three dimensional image data is also tagged with position information, ping numbers and time and can also be saved to a catalog for later manipulation. Since the saved data is three dimensional, additional views and measurements can be made, color scales adjusted and results can be exported for import into third party software.

The wreck of the J.E. Boyden has been imaged using a new 3D sidescan technology introduced by Ping DSP that provides geometrically correct high resolution three dimensional imagery and provides a significant step forward in comparison with conventional 2D sidescan imagery. The 3DSS-DX-450 Sonar is a pole mounted 3D sidescan and combines high resolution three dimensional imagery with time synchronous motion and navigation information that offers straight-forward and accurate documentation of underwater features and objects such as wrecks.

www.pingdsp.com

Acknowledgements

The survey of the J.E. Boyden was conducted in partnership with Biosonics Inc. using the Biosonics survey launch. The history and public domain photograph of the J.E. Boyden has been gathered from the work of DCS Films of Seattle and the U. of Washington archives.

3D measurements of the wreck of the J.E. Boyden using the 3DSS sonar 3D Target Logger tool. Inset: 3DSS-DX-450 Sonar

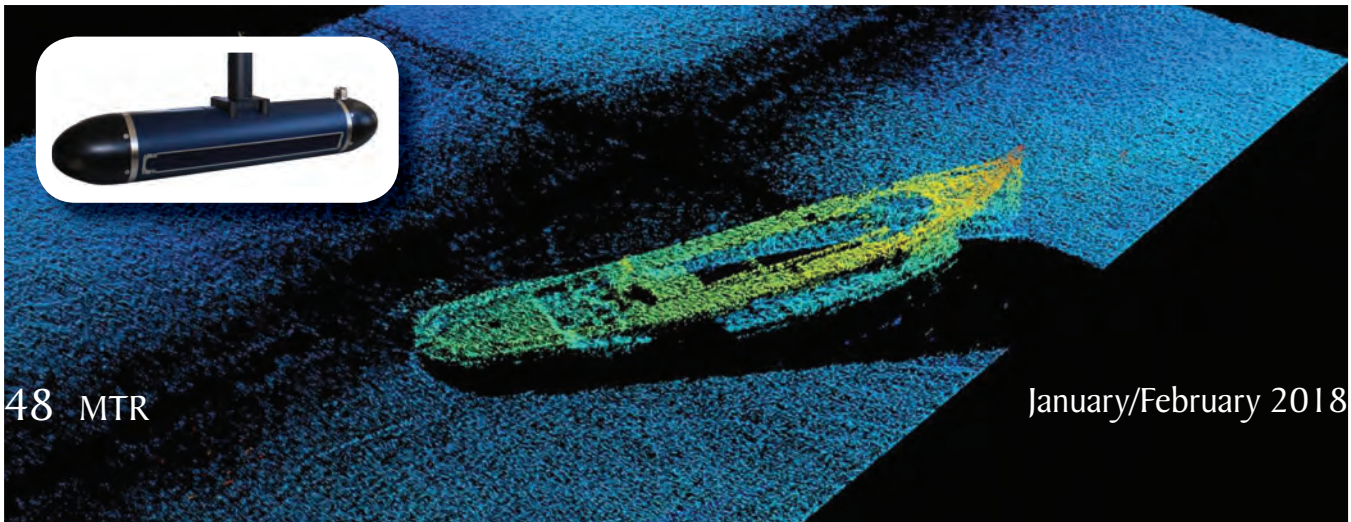


Image: Ping DSP

Real-time Sonar Fit onto Minehunting AUV

A real-time synthetic aperture sonar (SAS) system has been integrated and tested on board a U.S. Navy AUV that will perform mine hunting duties for the Naval Undersea Warfare Center. The AUV, a fully modular REMUS 600 manufactured by Kongsberg Maritime subsidiary Hydroid, was designed through funding from the ONR.

The AquaPix MINSAS SAS, developed by Kraken Robotic Systems Inc., provides the capability for "real-time, ultra high-resolution imaging and 3D mapping of the seafloor," said Karl Kenny, president and CEO of the developer's Canadian parent company Kraken Robotics Inc. "We expect this technology will revolutionize the way in which big data from Synthetic Aperture Sonar imagery and bathymetry is processed."

Image: Kraken

The U.S. Navy's REMUS 600 AUV fitted with Kraken's AquaPix MINSAS Synthetic Aperture Sonar.

The best method to detect and classify underwater mines involves obtaining ultra high-resolution target data that will quickly provide more details on the object from long ranges. For years researchers have worked toward enabling autonomous AUV minehunting through machine intelligence and automatic target recognition. Kraken said that migrating these algorithms and behaviors to operate on board the AUV in real-time holds the potential to significantly increase the speed and accuracy of mine countermeasure missions. Acquiring and processing raw data from sensors to derive actionable intelligence remains a challenge. According to Kraken, the key is an AUV's capability to create and process high resolution sonar data on board in real-time. As detailed acoustic images are created and analyzed on-the-fly by the vehicle's computers, the AUV can then decide the best way to continue the mission. Additionally, at least 5cm of target pixel resolution is required for effective mine hunting, which Kraken said can be achieved by conventional side scan sonars, although only from short range, typically limited to less than 25m. SAS, on the other hand, can achieve 5cm of target pixel resolution to ranges of more than 250m, providing up to 10x the range and area coverage rates.

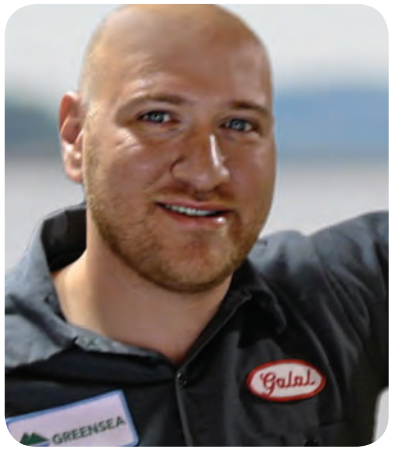
People & Companies


U.S. Energy Department

Rick Perry


NOAA

Michael Pentony



Greensea

Galal Hamdy

U.S. Invests $18.5m in Offshore Wind Research

U.S. Secretary of Energy **Rick Perry** announced $18.5 million in new Department of Energy (DOE) funding for a consortium that will conduct research aimed at reducing the cost of offshore wind in the U.S. As it seeks to capitalize on momentum in the offshore wind market, the U.S. still faces several challenges, such as deep water requiring floating foundations, the need for models predicting how Atlantic hurricanes will impact offshore turbines, and supply chain and operations and maintenance solutions to address the challenges of building and maintaining turbines at sea.

Setting out to tackle these challenges and more, the new offshore wind research and development (R&D) consortium will be a cooperative private-public innovation hub addressing wind plant technology advancement, resource and physical site characterization, installation, operations and maintenance and supply chain technology solutions.

Under the competitive funding opportunity announcement, DOE said it intends to select an administrator to coordinate the collaborative R&D activities conducted by the consortium. The consortium will include members of the offshore wind industry, who will contribute funds to the consortium and use the research findings to further advance technologies. In addition to this $18.5 million funding opportunity announcement, $2 million will also be allocated to research at DOE's national laboratories to support consortium R&D activities.

NOAA Names Pentony

NOAA has named **Michael Pentony** as the new Regional Administrator for the Greater Atlantic Regional Fisheries Office in Gloucester, Mass. He will assume his new duties on January 22, 2018. Pentony has been with the agency since 2002, serving in a series of positions including as the Assistant Regional Administrator for the Sustainable Fisheries Division since 2014. He succeeds retiring Regional Administrator John Bullard who had been in the position since 2012.

Greensea Names Hamdy VP

Greensea hired Galal Hamdy in the newly created position of Vice President, Business Development and Partnerships. Hamdy has spent the past eight years working for Cox Automotive leading business development for the company's digital marketing business unit. Greensea has increased its staff by 40 percent in the past six months

Hydroid Names Rogers VP

Dr. Andrew K. Rogers has joined Hydroid Inc. as vice president of engineering, responsible for leading all engineering and program management activities at the Kongsberg Maritime subsidiary, including R&D, new product development, program planning and execution and product support.

Dr. Rogers brings to the role more than 28 years of experience that spans a broad range of technologies and markets. Dr. Rogers holds Ph.D. and M.S. degrees in applied marine physics from the University of Miami and a B.S. in physics from Siena College. He received an executive education from the Advanced Management Program, Harvard Business School; the Sloan Business School, Massachusetts Institute of Technology; and the Scheller College of Business, Georgia Institute of Technology.

Siegel Joins RBR

RBR hired **Eric Siegel** as its new sales director. In his new role, Siegel will focus on enhancing the sales and representative network to enable RBR to continue its global market growth with new products , as well as customer service and support. Siegel joins RBR with 20 years of experience in oceanographic and subsea technology, measurements and science, and has been involved in academia, government and private industry.

RBR

Eric Siegel

Aleron Subsea

Mike Bisset

"This was a complex working environment within which the AUXROV has been able to demonstrate its value and efficiency. The system can be used for a vast range of subsea excavation, clearance, survey and tooling tasks and on this project."

Mike Bisset,
Aleron Subsea Technical Director.

Gold Rush: A $194B Gold Salvage Op

During World War I and World War II there were an estimated 7,500 merchant ships were sunk, 700 of which were carrying shipments of gold under U.K. Government direction, leaving an estimatd $194 billion in gold lying underwater. Britannia's Gold Ltd. was created to finance the recovery of targeted cargoes and return them to the U.K. for the benefit of the government, investors and merchant marine charities, and Aleron Subsea – a Remotely Operated Vehicle specialist – has been chosen to participate in the hunt, using its AUXROV subsea system.

Aleron and the AUXROV were selected by James Fisher Marine and Britannia's Gold Ltd. to assist with a high-profile salvage operation.

The AUXROV work scope comprised more than 850 lifts, moving over 500 tons of debris with three different hydraulic grabs, and providing real time information on the grabbed materials. During simultaneous operations with two work class ROV systems, it then provided power and assistance in dredging operations on the wreck. Remaining in the water for up to 90 hours at certain stages, the AUXROV was able to enter several constrained, hard to reach areas of the site assisting in the overall efficiency of the operation.

Kreuz Subsea

Kreuz Subsea Wins Contract

Kreuz Subsea said it has been awarded a contract to deliver subsea completion work for Indian multi-national conglomerate, Larsen & Toubro (L&T) from the start of 2018. The contract will see Kreuz Subsea support L&T to install all riser clamps, risers, crossing works, tie-ins, subsea trenching and hydro-testing of pipelines which are part of the Oil & Natural Gas Corporation's (ONGC) Pipeline Replacement Project (PRP4) and Daman Field development projects off the west coast of India. The five vessels to be utilized throughout the campaign in the Mumbai High and Daman fields in the Mumbai Offshore region, include the DP2 purpose-built SURF vessel, Kreuz Installer, and the diving support and construction work barge, Kreuz Supporter.

DOF Secures ROV Work

DOF ASA said its subsidiary DOF Subsea has been awarded two new contracts by Petrobras in Brazil for remotely operated vehicles (ROV) to be installed on board Skandi Angra and Skandi Paraty. The new contracts commence in April 2018 and end in September and November 2020, respectively. Additionally, Petrobras has extended two contracts for the ROVs on board Skandi Iguacu and Skandi Urca until the end of 2018. The new contracts and contract extensions add 1,630 days of ROV services for DOF Subsea and increase the backlog by approximately $24.7m.

RV Gets Engine Refit

The diesel engines on MBARI's research vessel Rachel Carson were recently replaced with new Caterpillar engines that are expected to reduce emissions by 8.4 tons a year. This work was completed under a grant from California's Carl Moyer Memorial Air Quality Standards Attainment Program (or Carl Moyer Program, for short), through the Monterey Bay Air Resources District (MBARD).

MBARI's Director of Marine Operations, Mike Kelly, first learned about the Carl Moyer Program in an advertisement in a maritime newsletter. The program began in 1998 with a goal to reduce air pollution from vehicles and equipment

by providing funds for businesses to purchase cleaner-than-required engines or other emission-reducing technologies. Grants are administered by local air districts, and projects can range from agriculture equipment to off-road equipment to marine vessels.

The program's application process requires documentation of engine usage (both hours run and fuel consumption) and an estimate of cost to replace current equipment. The local air resources district (in this case, MBARD) then conducts a cost-benefit analysis based on the amount of projected emission reductions and the cost of the replacement engines. Since research vessels are currently not required to reduce emissions, the Carl Moyer Program will reimburse up to 85 percent of the Rachel Carson's engine costs as a way to incentivize voluntary equipment upgrades.

The ship's engines were replaced at Bay Ship and Yacht.

Finnish RV Undergoes Propulsion Refit

The 28-year-old research vessel Aranda is the first Finnish vessel to be modernized with a diesel-electric hybrid propulsion system. The 59.2 x 13.8 m wide ice-going vessel is to be fitted with a 3 MW generator. While the conventional shafting is being retained, an electrically powered Schottel Pump Jet (SPJ) of type SPJ 132 RD will be installed as a new auxiliary propulsion unit. It features an input power of 400 kW, is installed flush with the bottom of the research vessel and provides maximum thrust over the full 360 degree range, with no resistance, even in shallow water.

The Aranda is owned by the Finnish Environmental Institute and is intended for year-round research and surveying missions. Besides the propulsion assistance provided by the auxiliary drive, the SPJ is also used for dynamic positioning with an accuracy of half a meter. The resilient mounting means that the steel and cast-iron structure of the Pump Jet is completely isolated from the vessel's hull, thus eliminating high-frequency excitations. In addition to extremely quiet operation, this property is a prerequisite for undisturbed seismic measurements, which will be one of the many tasks of the research vessel.

Schottel Hydro Evolves

Schottel Hydro and its wholly owned subsidiaries TidalStream Ltd. (TSL) and Black Rock Tidal Power (BRTP) have revised their business strategy. The group of companies will continue to provide Schottel Hydro turbine technology and power take-off systems to tidal energy projects in Canada and globally. Following a comprehensive review, BRTP will initially plan to use smaller floating platforms, such as Sustainable Marine Energy Ltd.`s (SME) PLAT-I platform, for its FORCE project in the Bay of Fundy.

"Schottel Hydro and its subsidiaries remain convinced about the positive future of the tidal energy sector in Nova Scotia, and around the world. We remain committed to tidal energy power generation and firmly believe in its viability. We will initially focus on modular, scalable floating platforms. Schottel Hydro will also continue to provide services as a tidal turbine and power take-off systems expert," said Niels A. Lange, Managing Director of Schottel Hydro, the tidal power division of the Schottel Group.

BRTP's commitment to the FORCE project in the Bay of Fundy, Canada's leading test center for in-stream tidal energy technology, has been significant. To date, the company has invested several millions in this project and employs a team in BRTP's Bedford office.

It is estimated that as much as 2,000 MW of electricity can be harvested from the Minas Passage alone. BRTP had been exploring the use of its innovative technology, the TRITON, that can generate up to 2.5 MW through the use of many smaller turbines instead of one large turbine, as is traditionally used.

SYKE/MRC

The 59.2m long and 13.8m wide ice-going research vessel Aranda has retained the conventional shafting, while an electrically powered Schottel Pump Jet of type SPJ 132 RD is to be installed as a new auxiliary propulsion unit.

N-Sea Develops UXO Detection System

Subsea IMR provider N-Sea has launched Magsense, a vertical gradiometer array specifically designed for highly accurate Unexploded Ordnance (UXO) campaigns. Developed in-house by N-Sea, the system has been designed to collect and record high resolution data in magnetically noisy subsea environments and hostile conditions, delivering improved accuracy, efficiency and safety in the detection of UXO.

Used in conjunction with a remotely operated tow vehicle (ROTV), the MagSense frame can be towed through the water in ways previously not feasible, ensuring even the most uneven of terrain is tracked accurately and consistently, N-Sea said.

Carousel Turns Over New Leaf for ESS

Ecosse Subsea Systems (ESS) said it has reached an agreement with a subsea contractor to buy back its 800-ton carousel which can be deployed on a range of specialist subsea projects. The carousel was originally built and used on an offshore renewable project in 2014 after ESS identified a supply chain issue surrounding the availability of carousels required for renewable and oil and gas work scopes. ESS also own complimentary cable lay tensioners (2x10 metric tons) as well as trenching equipment and have the option to adapt or upgrade the capacity of the 800-ton carousel to 2,000 metric tons at their fabrication facility in County Durham.

Aqueos Wins GoM Contract

Aqueos Corporation was awarded a contract for a large pipeline installation project located in the Gulf of Mexico. Aqueos said the contract, which commenced in December 2017 and will be completed in the first half of 2018, will support shallow-water pipeline installations in water depths up to 100 feet. The work scope will utilize the Aqueos diving support vessel (DSV) SPLASH, with surface dive teams utilizing its jet propulsion and built in NITROX diving system.

SEAIOCMA Extends Cable Contract

Global Marine said its maintenance contract with SEAIOCMA (South East Asia and Indian Ocean Cable Maintenance Agreement) has been extended for five-years, running to the end of 2022. The SEAIOCMA maintenance zone agreement, which is a cooperative club managed by 46 cable owners, provides the repair of submarine cables that carry international telecommunications traffic. SEAIOCMA spans the area between Djibouti in the west, Perth in the south, Guam in the east and the northern tip of Taiwan.

Image courtesy of the North Carolina Department of Natural and Cultural Resources

Was Blackbeard an Avid Reader?

What did Blackbeard and his pirate crew read on board Queen Anne's Revenge?

Artifacts unexpectedly discovered in the wreckage of Blackbeard's sunken flagship are helping researchers to determine if the infamous pirate captain and his 18th-century crew were literate and what sort of books they kept on board.

While performing conservation work on artifacts recovered from the centuries old shipwreck, archaeological conservators with the North Carolina Department of Natural and Cultural Resources' Queen Anne's Revenge Conservation Lab discovered 16 tiny fragments of paper – some still with legible printed text – in a ball of wet sludge lodged in one of the ship's cannons.

Although very few words were visible and the largest fragment was only about the size of a quarter, conservators working to preserve the fragile paper were eventually able to identify where they were from.

Months of research revealed that the paper fragments were from the 1712 book, "A Voyage to the South Sea, and Round the World, Perform'd in the Years 1708, 1709, 1710 and 1711," a voyage narrative by Captain Edward Cooke describing his adventures on the high seas.

Voyage narratives were popular in the late 17th and early 18th centuries, and the DNCR said books like the one found on Queen Anne's Revenge would have been fairly common on ships of the time, yet archaeological evidence for them is exceedingly rare as paper usually disintegrates very quickly under water, meaning the material is rarely found on shipwrecks – especially one that is 300 years old.

"The historical record has several references to books aboard vessels in Blackbeard's fleet, but provides no specific titles; this find is the first archaeological evidence for their presence on QAR," the DNCR said. "This find represents a glimpse into the reading habits of a pirate crew,"

A display to showcase the find is being planned as part of the department's Blackbeard 300th anniversary events during 2018.

New Products

New Software from EIVA

EIVA released NaviSuite Workflow Manager for automatic data processing of large amounts of subsea data, with minimum human involvement. With the Workflow Manager, repetitive tasks are automated and executed in parallel by the software. The first performance measurements on real-life operations data and workflow setups have shown positive results, with 50 hours of data processed in less than 2 hours. This is 25 times faster than other, typical data processing setups, where the industry has been satisfied with being able to process 1:1, that is, process one hour of data in one hour.

www.eiva.com

nke Instrumentation SAMBAT

nke instrumentation's SAMBAT multiparameter probe offers three use modes: autonomous, integrated systems and tele transmission. In autonomous mode, the SAMBAT probe can measure and record physicochemical water parameters up to year-long deployments. In integrated mode, the SAMBAT probe can be implemented to any carrier, data-buoy or seabed platform and interact with users central automat. In tele-transmission mode, thanks to a simple cable and a robust submersible GPS/communication antenna, user can parameter min and max alerts threshold for real time surveillance and automatic alerts.

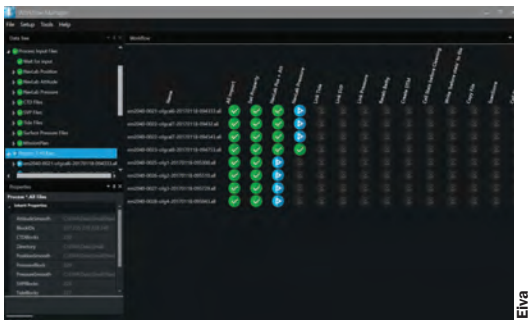
www.nke-instrumentation.com

SMD Subsea Mining Prototype

As part of a project partially funded by the European Union's Horizon 2020 research and innovation program, Soil Machine Dynamics Ltd (SMD) and its partners in the VAMOS (viable alternative mine operating system) Consortium have designed, built and tested a prototype robotic underwater mining vehicle with launch and recovery technology that aims to help uncover valuable European underwater mineral resources. After the first round of testing, the system will be transported from the U.K. to the second test site in Bosnia and Herzegovina in spring 2018.

www.smd.co.uk

EIVA



Eiva

nke Instrumentation

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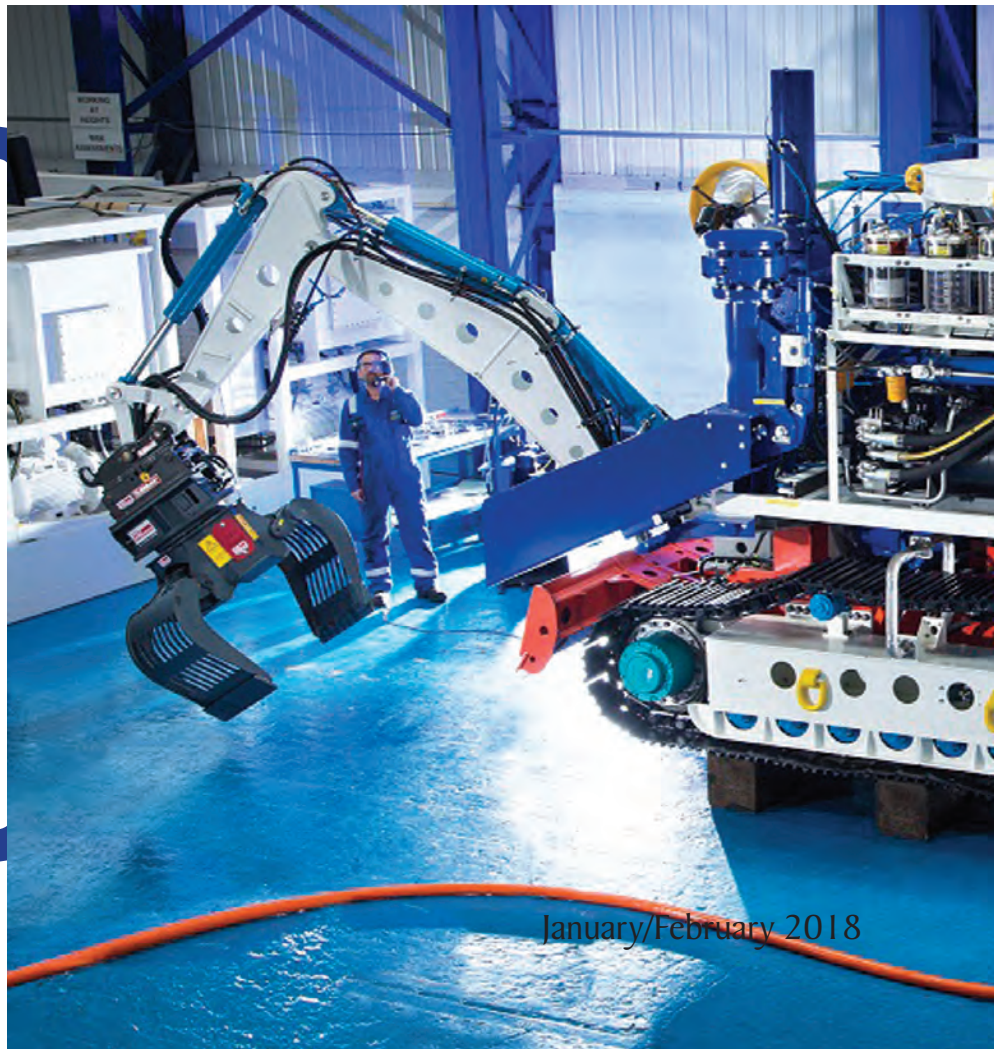


Trolex Expands Slip Rings Range

Trolex Engineering introduced the TX4849 Slip Ring, suitable for a variety of applications including ROVs, winches and seismic surveying. The Weather Protected Slip Ring is a compact 316L stainless steel unit which has a cover diameter of only 72mm. The unit can house up to 16 rings, rated 12 Amps, 1000V per ring. In addition to electrical passes, the unit can also be combined with a fiber optic rotary joint, both single and multimode options. The TX4849 has precious metal plated rings for low loss signal and is available with up to an M25 tapped entry, or connectors as a cost option.

www.trolexengineering.co.uk

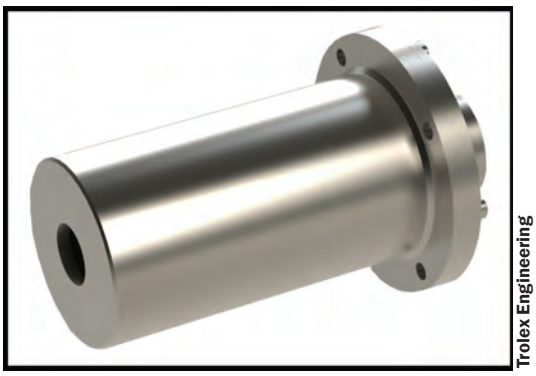
Okeanus Upgrades Nortek ADCP

Okeanus Science & Technology, LLC has upgraded its Nortek Signature55 ADCP System and purchased the software necessary for it to be able to be deployed from a vessel or stationary platforms while allowing the data to be read in real-time. Okeanus worked with Nortek, along with Automasjon og Data (A&D) who developed the DADAS software which allows the ADCP to read the profiling data in real-time.

www.okeanus.com
www.nortek-as.com

SMD

Trolex



Trolex Engineering

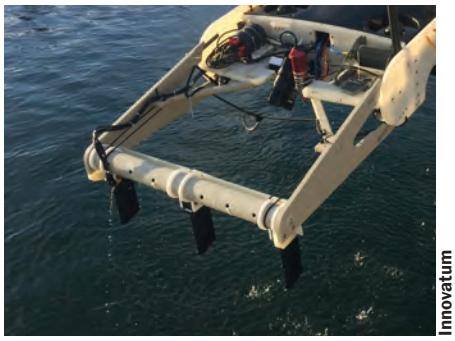
Okeanus

Okeanus

Track Cables & Pipes

AUVs can now be prepared for cable and pipeline tracking missions using survey tool Smartrak from U.K. based Innovatum Ltd. The Smartrak system deployed on the front of an AUV. The dark-colored Smartrak gradiometers can be seen mounted downwards on the white mounting frame. The sensors are fitted with fairings to reduce drag through the water. The AUV is flown close to the seabed during tasks.

www.innovatum.co.uk



Innovatum

New Products

More Winch Orders for MacArtney

Requiring a trenching umbilical winch for deployment of underwater equipment, Assodivers has placed an order with MacArtney for more winches. The scope of supply of the order for Assodivers includes a trenching umbilical winch and an electric-optical slip ring. The winch is characterized by a self-contained, all steel welded construction with protection frame, drum, level wind, gear box, electric motor and switch board.

www.macartney.com

MacArtney

MacArtney

MacGregor to Split Division

MacGregor, part of Cargotec, said it will reorganize its offshore and merchant shipping operations as part of a plan aiming to achieve $13 million in annual cost savings. Under the plan, MacGregor's Smart Ocean Technology division will be divided into two new divisions: Cargo Handling and Advanced Offshore Solutions. The measures affect MacGregor operations in Norway, Germany, China and Singapore.

MacGregor

MacGregor

Safely Unplugging Offshore

Enerpac created a Remote Hose Disconnector designed to eliminate the release of hydraulic cylinder fluid into the sea during transition piece installation on offshore wind farms, while allowing full recovery of all connected equipment for reuse. Hydraulic cylinders are a key tool in the installation of the transition piece on the monopile. Up to six fixation cylinders are used to hold the transition piece in position during grouting. They have to remain pressurized, via a hydraulic manifold, during the grouting and the subsequent curing time, which can take several days. At the end of this period, the cylinders and hoses need to be recovered.

To date, cutters have been used to cut the hose to depressurize the cylinders, releasing hydraulic fluid into the sea. Using the Enerpac Remote Hose Disconnector will allow the cylinders and hoses to be depressurized and recovered without hydraulic oil being released into the sea, as well as, avoiding the need to use a hose cutting tool and associated waste materials. An Enerpac Remote Hose Disconnector is fitted directly onto each fixation cylinder. It comprises two, non-interchangeable, hose connections: one connector ensures oil flow to the fixation cylinder, the second one operates the disconnector itself.

After the grouting has cured, an Enerpac pump is connected via the same manifold with the second set of hoses. Operating the pump recovers all hydraulic oil and ensures full retraction of the plungers, the complete hose disconnector is then released from the fixation cylinder and ready to be re-used to install a new foundation. During the disconnection, no fluid is spilled into the sea. Potential residual oil in the cylinders is sealed from making contact with seawater, making this method fully sustainable.

The Enerpac Remote Hose Disconnector is tested and certified by Lloyds to 100 meter subsea and can be reused.

www.enerpac.com

Teledyne TSS Launches New Pipe Tracker

Teledyne TSS expanded its range of subsea pipe and cable detection and tracking products with the launch of the new smaller HydroPACT 660 pipe tracking system.

The 660 has been designed to help reduce the cost of subsea pipe surveys by allowing the use of smaller classes of underwater remotely operated vehicles (ROVs). In addition, TSS is also expanding the capabilities of its larger HydroPACT 440 pipe tracking system by introducing a new 24VDC upgrade kit.

The new, compact HydroPACT 660 sports a single small form factor coil array measuring 1,200mm x 600mm at a weight of 15.8kg that offers an operating range of greater than 85 percent of that of the larger HydroPACT 440 system. This smaller and lighter coil array suits smaller ROVs such as observation class or inspection class.

The HydroPACT 660 operates to 3,000m depth, and is offered with two different power options: 24VDC or 110VAC. The installation, operating routines and information displays are identical to those used on the 440 system, utilizing the user-friendly, comprehensive DeepView operating software. The system comes complete with a choice of a vessel mounted PC or a rack mount computer.

Teledyne TSS also introduced the new 24VDC power supply pod for the HydroPACT440 system. This is the first time that a 24VDC option for the 440 has been offered, and it will help to increase the flexibility and use of the system on vehicles that only support DC power capability. This new power option is being offered in either 3,000m or 6,000m rated pods for both new 440 systems and as an upgrade kit for existing installations. This offers customers the choice of either 110VAC, 240VAC and 24VDC options for their tracking system.

www.teledynemarine.com

SMD

Rovco Trials 3D Visualization Technology

Subsea cable survey and inspection work for the offshore renewables test site, Wave Hub, was completed by Rovco. The inspection program included the first commercial trial of Rovco's 3D visualization technology to create scaled, high resolution models of subsea infrastructure with millimeter accuracy.

Located 16km from the north coast of Cornwall, at the eastern edge of the Atlantic Ocean, the Wave Hub site offers four cable connection points for testing offshore renewable energy technology as well as purpose built and commissioned grid connected infrastructure.

Rovco also delivered a detailed bathymetric survey using a multibeam echosounder (MBES), alongside a remotely operated vehicle (ROV) video inspection with ultra-short baseline tracking for Wave Hub's entire offshore cable network, off the coast of Saint Ives Bay, Cornwall. The 3D system collects raw data which is then processed to obtain 3D volumetric information, designed to ensure a true representation of the underwater environment. The system purports to help save money with short mobilizations and no need for large specialist vessels or technical support teams, according to Rovco.

3D model of a subsea dry mate connector

rovco

The project was completed in 10 days over short weather windows to avoid strong winds and rough sea conditions. The first phase utilized the MTS Xplorer vessel to carry out the MBES survey. The second stage saw the deployment of Rovco's Sub-Atlantic Mojave ROV equipped with the latest Sonardyne Nano beacons, its own prototype hi-res camera system, and a fiber optic gyro to gather accurate heading and point references. The final stage involved the Severn Sea vessel, which was used to complete the ROV visual and 3D survey.

Downed U.S. Navy Aircraft Found

A U.S. Navy team has located a C-2A Greyhound aircraft that crashed in the Philippine Sea on November 22. The downed aircraft rests at a depth of about 18,500 feet, making the salvage operation the deepest recovery attempt of an aircraft to date, the Navy said.

Eight of the 11 crew and passengers on board were recovered immediately following the crash. For the next three days, the U.S. Navy led combined search and rescue for the three missing Sailors with the Japan Maritime Self Defense Force (JMSDF), covering nearly 1,000 square nautical miles before ending the search. In December, the Navy team embarked to the crash site on a contracted salvage vessel, and searched for the aircraft's emergency relocation pinger with the U.S. Navy's towed pinger locator (TPL-25) system, which uses passive sensors to listen for the pinger's frequency.

U.S. Navy photo by Kenneth Abbate

After poor weather conditions delayed the search efforts, the team was eventually able to deploy the TPL to optimal search depths of 3,000 feet above the ocean floor December 29, marking the aircraft's location, and then returning to port. The team will soon return to the site with a side-scan-sonar (SSS) and remote operated vehicle (ROV) to map the debris field and attach heavy lines for lifting the aircraft to the surface.

Titanic to be Laser Scanned

More than a century after it sank, the RMS Titanic continues to attract explorers as one of the highest profile maritime disasters of all time. Recently it was announced that a research team is determined to capture laser data of the wreckage in its Northern Atlantic resting spot. The six-week expedition will depart from St. John's, Newfoundland in June to explore the historic wreck site aboard OceanGate's manned submersible Cyclops 2, the first to survey the Titanic since 2005.

To document the present condition of the shipwreck and debris field without physical interaction, the submersible will be equipped with 2G Robotics' dynamic underwater laser scanner, the ULS-500 PRO, which will be used to generate real-time 3D models with millimetric resolution.

"Laser scanning provides maximum detail in less time than other techniques," said OceanGate CEO Stockton Rush. "2G Robotics has provided us with a solution that will generate an entirely new perspective of the Titanic."

Cobb Heritage Center

File photo: the Titanic pictured in Cobh Harbour, in April 1912.

The team will compile the laser data with overlayed 4K images captured over the course of the expedition to create a detailed 3D virtual model of the wreck that will serve as a baseline to help researchers gauge the decay of the wreck, and to document and preserve its submerged history over time.

In addition to creating a nearly life-like digital model of the 108-year-old shipwreck and documenting its debris field, OceanGate said one of its top priorities is to do so without disrupting the habitat or any artifacts. "The expedition will be conducted in accordance with NOAA and UNESCO guidelines for the preservation of underwater world heritage sites," the company said.

JW Fishers Debuts New Marine Magnetometer

JW Fishers will release its new magnetometer, Proton 5, early in 2018.The fifth generation magnetometer with many new features is a top performing, microprocessor driven, marine magnetometer detection system, the manufacturer said.

The system is fully digitized and displays the current five-digit measurement on a new easy to read six-inch LCD screen that is backlit for night operations. Up to 80 of the previous measurements are displayed graphically in a history plot on the screen. User friendly menus allow easy configuration of all operation settings.

System tuning is now possible directly from the control box. The new "auto tuning" feature greatly simplifies set-up when operating in different locations. This will allow the user to quickly tune the magnetometer without having to disassemble and manually configure the device.

JW Fishers

With the optional altimeter, the towfish distance from the ocean bottom is displayed on the LCD screen.

Additionally, the towfish can be separated into two parts so that it easily fits into a watertight Pelican case for storage and transportation.

The base system includes a 200-foot depth rated towfish, 150 feet of Kevlar reinforced tow cable, and a topside control box.

Parallel Events Add Depth to OI '18

A series of complementary showcases are set to make 2018's Oceanology International the most comprehensive forum in the event's 49 year history.

The Oceanology International 2018 exhibition and conference is scheduled to run from March 13 to 15 at ExCel, London. The 24th edition of this biennial global forum will spotlight technological developments including robotics, advanced sensor technology and autonomous systems. The conference program, meanwhile, will include 11 free technical tracks, all chaired by prominent industry figures.

In addition to the main schedule, the 2018 event will host a series of parallel showcases.

Reed Exhibitions

The first of these, the Ocean Futures Forum, from 9:30 a.m. to 1:30 p.m. on Tuesday, March 13, and will consider long-term energy trends, ocean growth and diversification and sustainability. An introductory session will be followed by a discussion with keynote presenters including Claire Jolly, Head of the OECD Space Forum; Professor Ed Hill OBE, Executive Director, National Oceanography Centre; and Jim Hanlon, CEO, The Institute for Ocean Research Enterprise. A networking lunch will follow, and registration costs £100 + VAT.

On Thursday, March 15 from 9:30 a.m. to 5 p.m., Catch The Next Wave 2018: Frontiers of Exploration is being organized in association with The Explorers Club and will assess the intrinsic relationship between exploration and technology and how each drives the other. The program features paired presentations from industry experts discussing the role technology has played in man's ability to explore environments on the seafloor, in the oceans, on the oceans, over the oceans and into space and includes Gordon Campbell of the European Space Agency; diver, presenter and explorer Rory Golden, the first Irish diver to visit the site of RMS Titanic; and Dr Andone Lavery of the Woods Hole Oceanographic Institution. Registration costs £100 + VAT.

According to Catch the Next Wave 2018 chairman Ralph Rayner, "This creatively stimulating conference will draw upon the combined insight and expertise of a range of leading explorers and ocean professionals to highlight demonstrable technological achievements that are aiding exploration and research while stressing the ongoing importance of technological progress."

Complementing Oceanology International 2018's conference program, Ocean ICT Expo will address the demand for marine and ocean IT, communications, satellite and data storage solutions, with hundreds of highly targeted experts on hand. An additional seminar area will host presentations from global software, hardware and communication services professionals, applying ICT solutions to assist growth in ocean data acquisition, storage, transfer and analytics.

Another source of business-focused advice is provided by the Investment, Trade & Innovation Theatre. The 'Entrepreneurs' Advisory Workshop' is designed to lend assistance to entrepreneurs seeking partner funding: interested parties can even apply via the Oceanology International website to book 1-2-1 clinics with VC/PE technology investors. Applications must be received by December 15.

In addition, the theatre's 'New Technology Showcase' enables exhibitors to secure presentation slots to display their new products and technologies to the wider marine science community.

Finally, the co-located Interspill 2018 conference and exhibition will examine all aspects of future oil spills, including spill prevention, preparedness, response and restoration.

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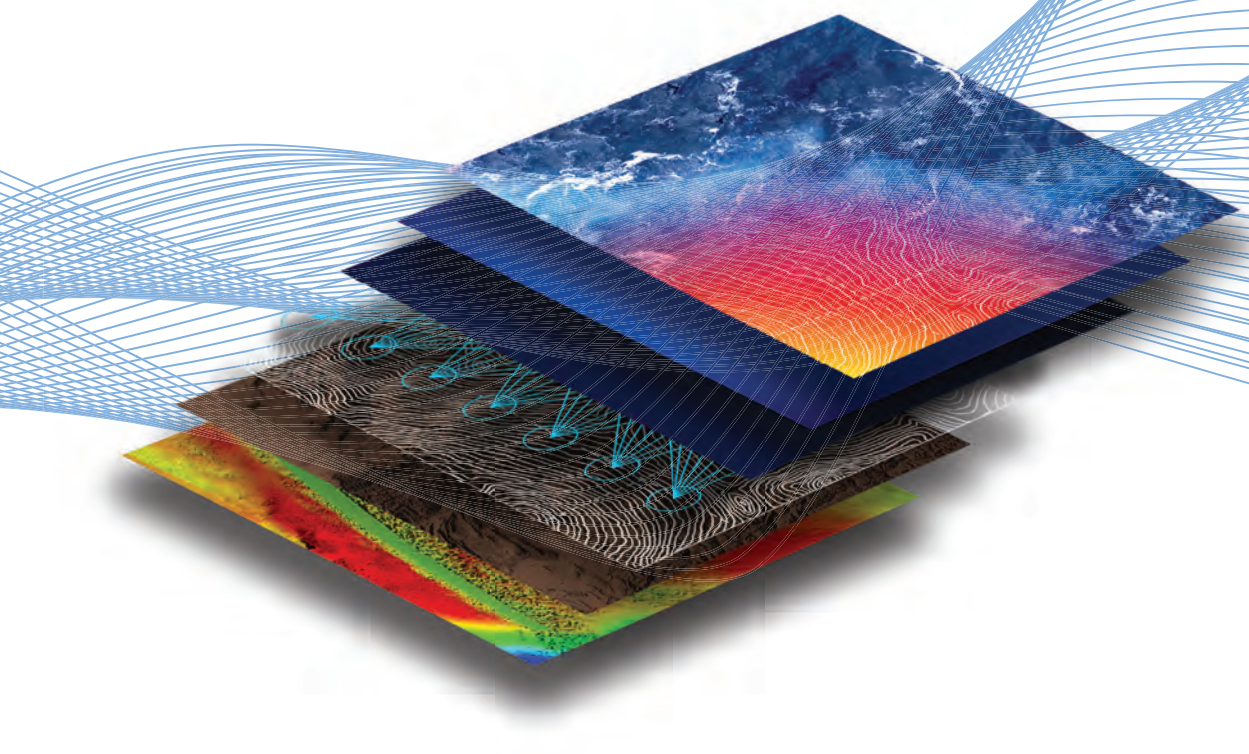

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The world's premier event for Commercial Diving Contractors, Remotely Operated Vehicles, Manned Submersibles, and all other aspects of the Underwater Operations Industry!

Check the newly revamped website for registration information and details for both attendees and exhibitors!

UnderwaterIntervention.com

ATTEND
UNDERWATER INTERVENTION 2018

Join your peers at THE industry event of the year.

- Network with leaders in the underwater industry from around the world.
- Stay up-to-date on that latest industry information, strategies and technologies through numerous education track sessions and a massive exhibit hall.
- See the latest and greatest products and services for the underwater industry.

You don't want to miss this!

Registration information is on our website at www.underwaterintervention.com.

EXHIBIT
AT UNDERWATER INTERVENTION 2018

Showcase your products and services to top decision-makers in the underwater industry!

Exhibit space is quickly running out, so don't delay!

Contact Your UI Show Management Team at (703) 259-6118 or ui@naylor.com, or visit www.underwaterintervention.com for more information.

MTR Marketplace

PRODUCT, PROFESSIONAL, VESSELS, BARGES & REAL ESTATE FOR SALE

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UNDERWATER COMMUNICATION AND POSITIONING SOLUTIONS

S2C TECHNOLOGY: COMMUNICATION AND TRACKING COMBINED

- time, space and cost-saving solutions
- low power consumption for autonomous operations
- advanced data delivery algorithms, addressing and networking, remotely configurable settings
- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions availableh

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m

UNDERWATER ACOUSTIC MODEMS

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

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

Meet us at
OCEANOLOGY INTERNATIONAL 2018!
13-15 March
London, ExCel
Stand C251

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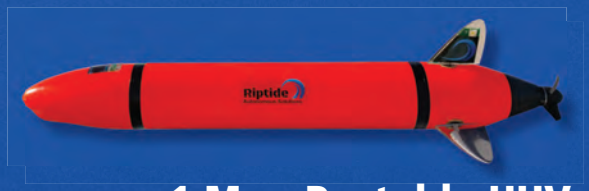
evologics.de

Riptide set out to change the undersea vehicle market by combining best in class hydrodynamics, ultra low power processing, and game changing new energy technology, while significantly reducing vehicle costs. To accomplish this, we introduced the small, yet highly-capable micro-UUV.

And now, the Family just got BIGGER

Introducing the Riptide Family of Low-Logistics, Man-Portable UUVs

Micro-UUV
4.875" Diameter
~25 lbs
300m rated



1 Man-Portable UUV
7.5" Diameter
~65 lbs
300m rated

2 Man-Portable UUV
9.375" Diameter
~120 lbs
600m rated

Visit us at
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13-15 March
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BOOTH F571

Riptide
Autonomous Solutions

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