MARINE TECHNOLOGY REPORTER

November/December 2016
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Methane

Prof. Jürgen Mienert drives CAGE's pursuit of **the Arctic's buried treasure**

Voices
BG Group's
Rosane Zagatti

AUVs
Great Lakes Mission

Technology
Subsea Imaging

Volume 59 Number 9


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Contents

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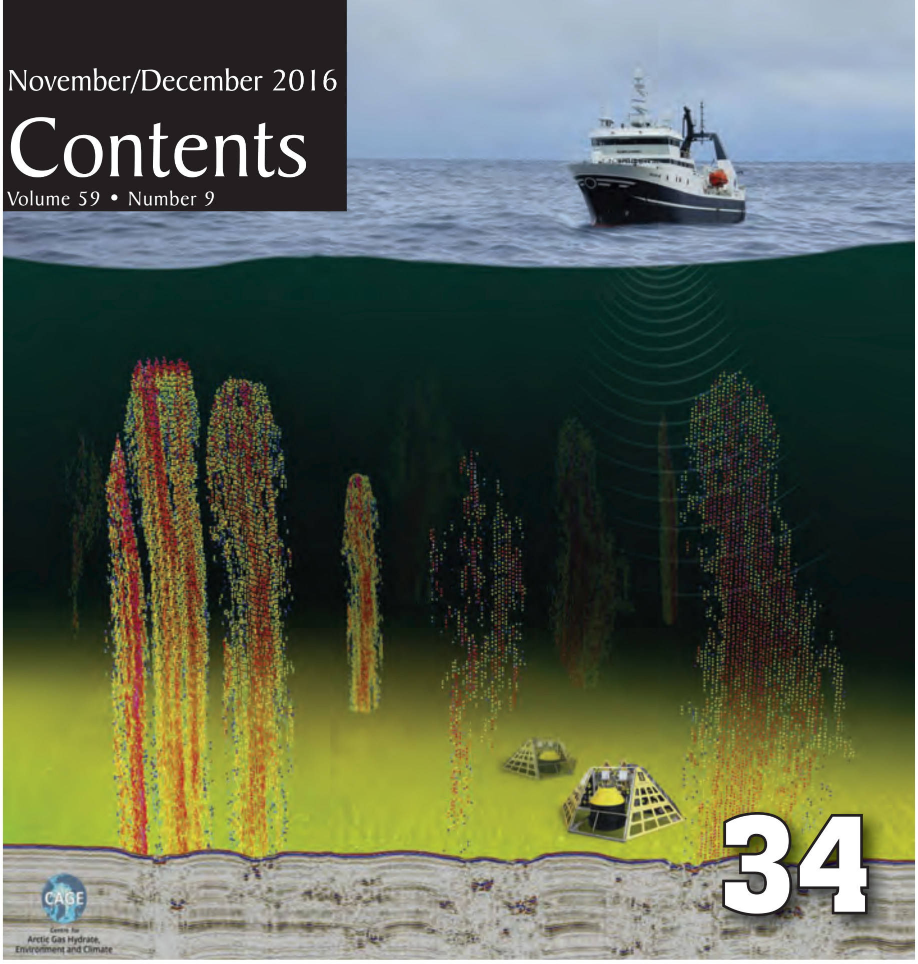

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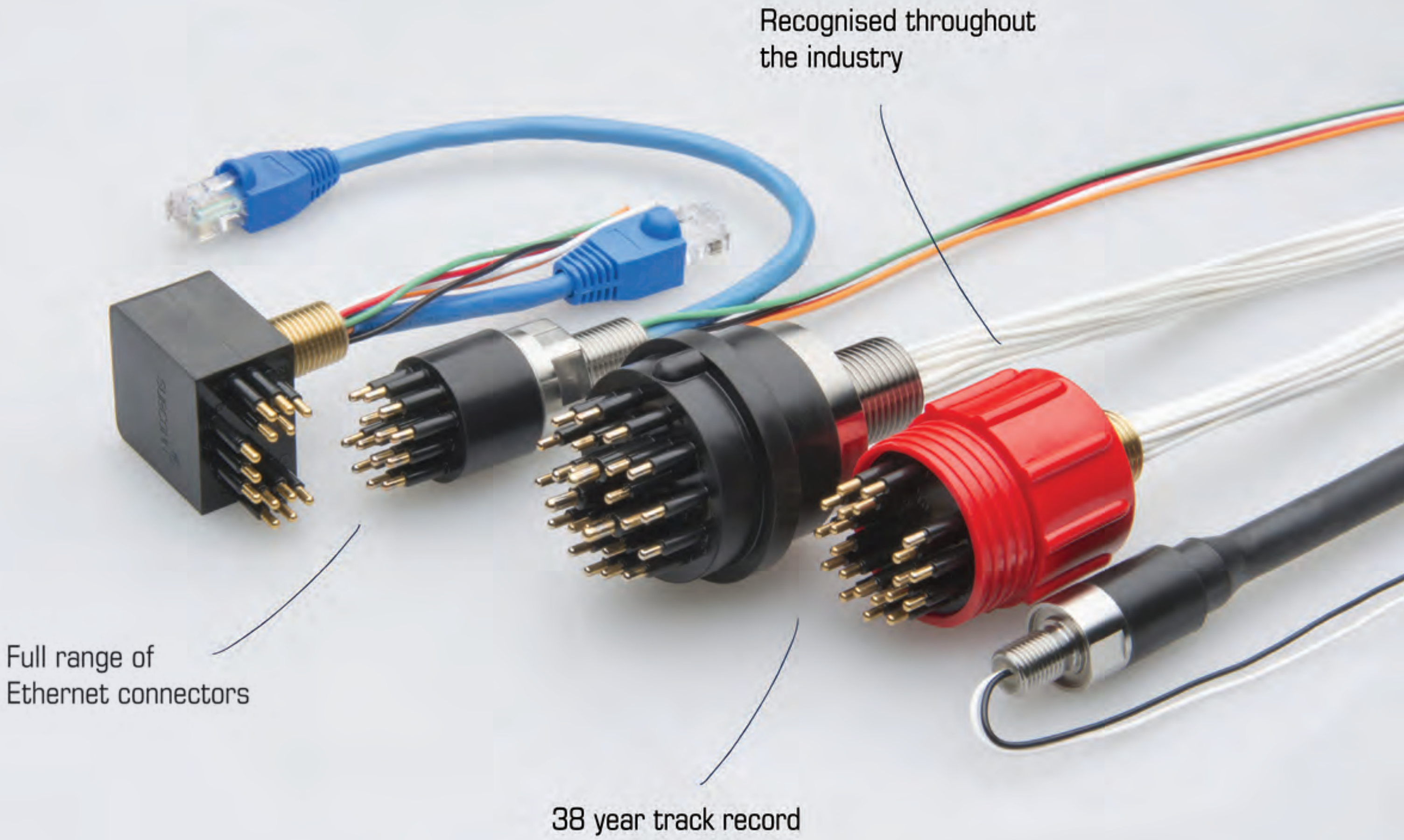

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(Credit: CAGE)

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(Credit: The Maritime Alliance)

Last month I once again was afforded the opportunity to moderate a few panels at the **8th Annual BlueTech & Blue Economy Summit** in San Diego, a high-value, high-level event put on by The Maritime Alliance. If you have not attended, I recommend looking into next year's event, scheduled for early November. It is modest in size but off-the-charts in quality of content and quality of participants, an event that I count on year in, year out, to help me set out editorial agenda. As we close 2016 and look forward to 2017, first and foremost I want to offer a sincere *'Thank You'* to our readers and our advertisers for your continued interest and support. The subsea sector is a dynamic and innovative, and despite the continued depressed price of oil and gas, long-term prospects are bright. From my seat, here are a few things to watch in 2017:

- **President-elect Trump:** The U.S. president-elect with the support of a Republican Senate and Congress could drive a transcendent period of military spending. While premature to conjure memories of the "600-Ship Navy," it is safe to assume that emphasis and funding for military assets on and under the seas should enjoy strong support.

- **Increased Amounts of Data:** The push to collect, disseminate, analyze and use increasingly massive amounts of data will work to not only make subsea operations more efficient and productive, it will literally open new world's of knowledge.

- **The Energy Markets:** Both fossil fuel and renewable, will continue to dominate conversations in 2017 and beyond. Oil prices are edging higher based on an agreed production capacity cut by OPEC, and on the renewable front, pockets of innovative projects in offshore wind and tidal power continue to drive innovative design and operation.

As always, we welcome your comments and contributions.

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Paschoa

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Unterweiser

Paul Unterweiser is a retired U.S. Navy officer, USCG licensed master, ROV pilot and, for the last 10 years, president of Marine Simulation, a software company located in NC specializing in developing training simulators for ROV pilot schools and other marine industry applications.

BG Group & the FlatFish AUV

The development of AUVs capable of being launched from FPSOs or actually being docked at the seafloor next to the subsea systems has been an industry goal for some years and offers a solution to two major problems: making deepwater subsea inspection become a simple task and decreasing the related costs. MTR's correspondent in Brazil spoke to Rosane Zagatti, BG Group's Subsea Technology Manager, about its FlatFish AUV project, which promises to bring solutions to deepwater infrastructure inspection challenges.

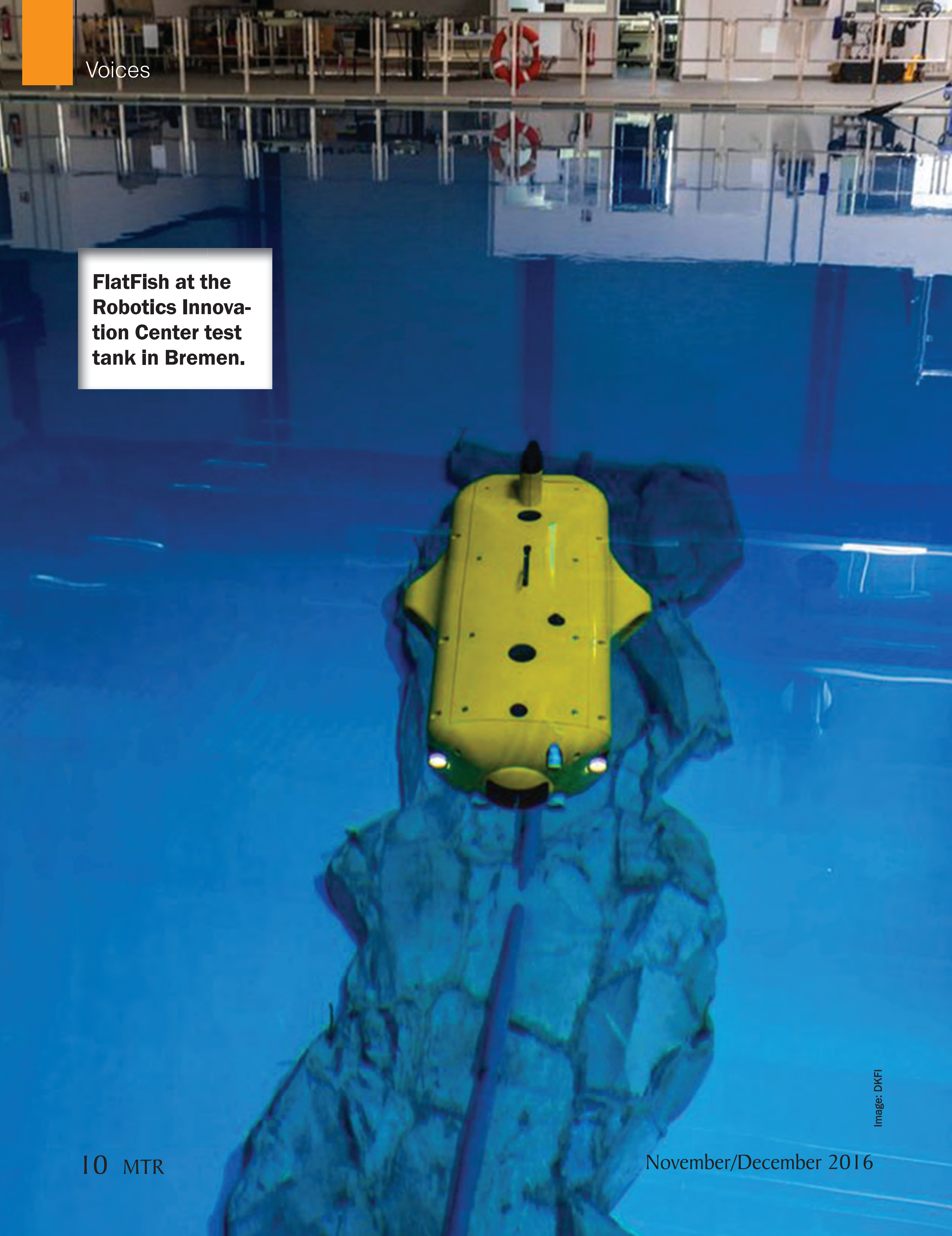
By Claudio Paschoa

Subsea systems are now an integral part of offshore oil production and vital to deepwater production. In deepwater developments, ROVs may be involved in both inspection and intervention services, with some operators using traditional AUVs for pipeline inspection, both requiring support vessels with day rates hovering between $100k and $200 k. Therefore, the cost of continuously inspecting subsea infrastructure can heavily impact an operator's OPEX. The FlatFish project concept was created by BG Brasil, a subsidiary of Shell, with DFKI, SENAI-Cimatec and EMBRAPII as partners in the project. The prototype, currently in sea trials, *The oil and gas industry is very conservative and new technologies need to be qualified following specific procedures and standards to demonstrate that all risks were mitigated and the reliability is according the specifications. The FlatFish is a result of a project of approximately 2 years, having started at the end of 2013. The first prototype demonstration was performed in June 2014, in the Maritime Exploration Hall at the German Research Center for Artificial Intelligence (DFKI) in Bremen.*

Rosane Zagatti

Subsea Technology Manager at BG Group

is being developed to carry out 3D visual inspections in high resolution of subsea pipelines and infrastructure. "Bremen, Germany based DFKI, our partner in the FlatFish project, had a key role in the development of the AUV. As a global reference for artificial intelligence and robotics, they were responsible for training and developing the technical capability for the Brazilian researches involved in the project. A partnership between SENAI-Cimatec and DFKI resulted in the creation of the Brazilian Institute of Robotics (BIR), which has FlatFish as its first project. The FlatFish researchers had, on average, one year training in DFKI. This is a great example of collaboration of public and private peers for technical and human resources



FlatFish at the Robotics Innovation Center test tank in Bremen.

Image: DKFI

training," said Zagatti.

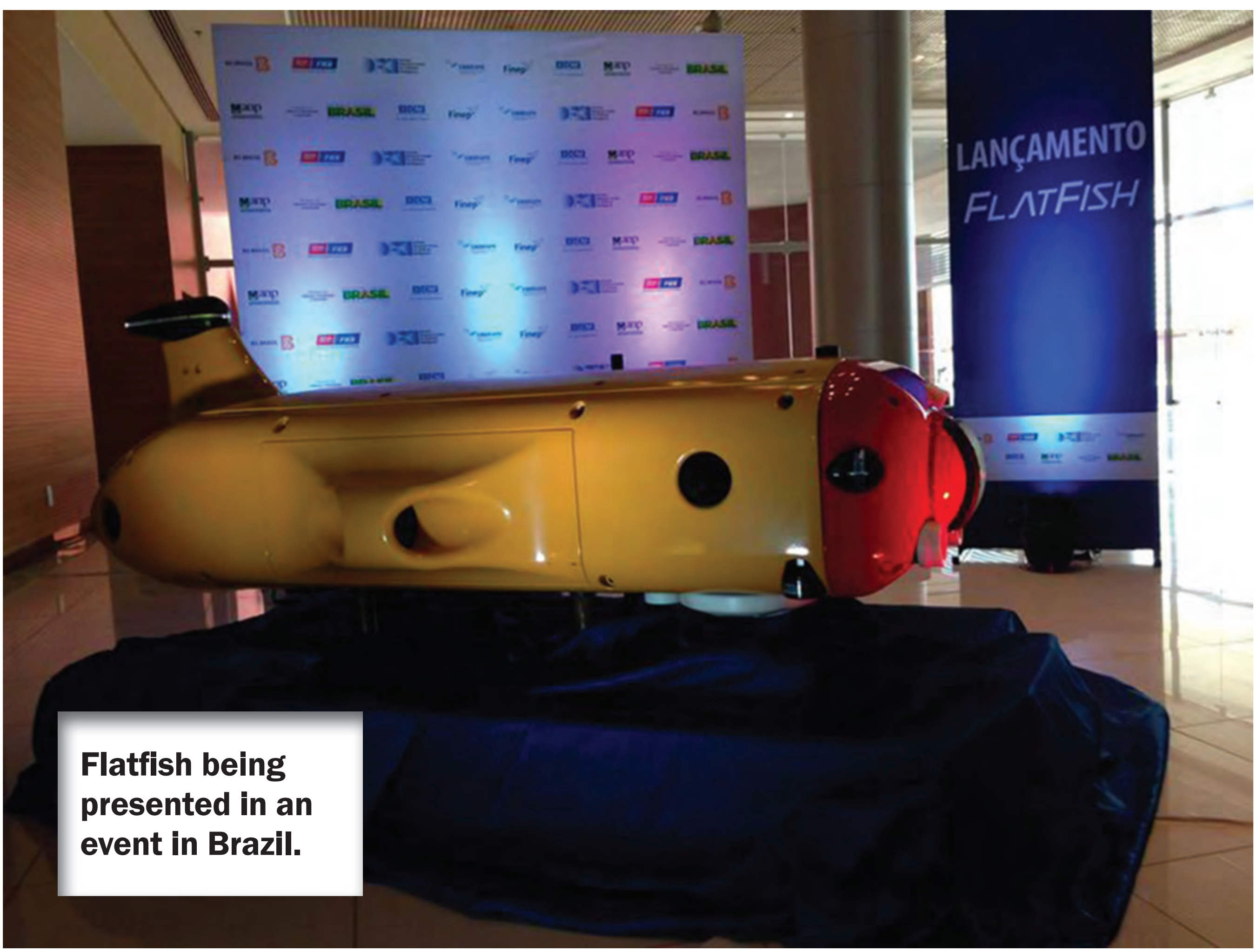
The prototype is under development by a team of 18 full time researchers from the robotics lab at SENAI-Cimatec in Salvador, Bahia, Brazil.

"The main system of the project comprises a hovering, observation class AUV capable of 'living' subsea for extended period of times," said Zagatti. "It includes data connection to a docking station for recharging the internal batteries of the vehicle in between inspection and data transmission to surface. Autonomy is assured by a software stack capable of controlling the vehicle, without human intervention, so that the vehicle can safely and reliably execute the task of navigating from docking station to a specified subsea structure, inspect the structure with the onboard sensor payload and return to the docking station. A web based user interface permits a non-specialist remote operator to define an inspection mission; visualize the inspection results through a structure-centred methodology; browse the inspection results section by section; carry out trend analysis; configure anomaly alarms and visualize image based 3D reconstruction of the inspected structure," said Zagatti. Flatfish can perform an up-close visual inspection of pipelines and structures, a critical skill to visualize and understand anomalies. High-resolution 3D and precision optics with natural colours allow the operator to see even a very small dent.

The FlatFish is being tested in an enclosed environment in Bremen and at sea in Bahia, with the Brazil model being used to inspect shipwrecks off the coast.

"The oil and gas industry is very conservative and new technologies need to be qualified following specific procedures and standards to demonstrate that all risks were mitigated and the reliability is according the specifications. The FlatFish is a result of a project of approximately 2 years, having started at the end of 2013. The first phase involved the development, testing and trial of two full-scale prototypes. The first prototype demonstration was performed in June 2014, in the Maritime Exploration Hall at the German Research Center for Artificial Intelligence (DFKI) in Bremen. The other prototype is currently performing sea trials in Brazil as it is very important to understand how different environments impact the responses." The prototype developed in this first phase weighs 275kg and is capable of working down to 300 meters, with sensors encased in a 220cm long by 105cm wide pressure hull. It can also operate from 16 to 24 hours and make a return trip of 20 km. It has six hubless ring thrusters and runs on Lithium-ion batteries.“The software development is the key aspect of the project and can easily be used in a deepwater vehicle. Now we are starting the second phase of the project and when concluded, we will be able to qualify the hardware and complete AUV system for deeper operations,” said Rosane.

The main challenge is to guarantee the AUVs reliability during long-term deployment, making a system with very low maintenance requirements. “Subsea is a dynamic environment and FlatFish is affected by uncontrollable and unforeseeable changes in water conditions, currents, sea life, fishing interaction and other ever-changing aspects. There is no surface vessel nearby to recover the vehicle if something goes wrong. No communication to a human expert while on a mission. And, the cost of a vessel mobilization and vehicle loss is significant. Therefore, FlatFish needs to be reliable in terms of hardware, software and autonomous decision-making. For example, if the FlatFish software would suffer a critical crash in every 200 hours of operations, our system has a 99% chance to recover from this crash. It would still mean an emergency vessel recovery every three years in average for a daily operated FlatFish,” said Zagatti. Artificial intelligence is extensively used in the FlatFish’s guidance systems, mission planning and in selecting inspection sensors, according to Zagatti; “Besides being cost-efficient – it can reduce inspection of subsea infrastructure from 30% to 50% – subsea inspection campaigns are subjected to limitations such as sea condition and market availability. Having artificial intelligence allow us to reduce the dependency on support vessels and to deliver faster response times. Also, it enables an increased frequency of subsea surveys and higher quality inspections, improving the understanding of system integrity and delivering improvements in reliability and performance of subsea infrastructure. Moreover, it will contribute to asset integrity assurance. As a result, it will enable improvements of all the operational capabilities (inspection, monitoring, intervention and repair).” Zagatti also pointed out that the FlatFish has a multiple guidance methods, some standard, some based on more advance software reasoning than a traditional AUV approach. The mission planner can adapt based on the sensor input, being more flexible in dealing with the environment changes. New software methods are used to process



Flatfish being presented in an event in Brazil.

Image: BG Group

the inspection sensors input in order to achieve an optimized inspection movement profile and mission. A special focus is also given on how to post-process and annotate the volume of data generated to optimize the time from data to information. The FlatFish also uses a laser line projection, depth sensor, inertial navigation system and Doppler velocity log combined with an optical-acoustic feature detection to navigate, along with ultra-short baseline acoustics for identification of flowlines, pipelines and other equipment, also employing multiple communications systems.

A functional replica of the docking station has been tested at the DFKI Bremen Robotics Innovation Center's 3.5 million liter seawater tank. The lessons learned from the mock-up tests have been used for the design of the new prototype of the docking station that will finish testing by the middle of next year as part of the second phase of the project. "We are starting the second phase of the project now. With Senai-Cimatec we are seeking a partner to bring FlatFish to the market. The new partner will be selected in 2016 and will work with us in the qualification of the technology through intensive offshore trials of the system, planned for 2017,"said Zagatti. FlatFish can also be launched and recovered directly from a FPSO or platform to perform subsea integrity inspections. An operator sitting remotely can program a queue of routine inspection and maintenance work for the AUV. "FlatFish plans the mission autonomously based on the requested work queue. The mission plan is then validated by simulation and send to the operator for approval. After this preparation the vehicle leaves the docking station, navigates to the target, inspects the target, and returns to the docking station," said Zagatti. "The resulting inspection data (photographs, 3D models etc.) is uploaded within the docking station and send to the operations center, where it can be automatically distributed to the most relevant recipients, post-processed and eventually raise relevant alarms. If an operator wishes to perform an unscheduled task, it is inserted into the work queue and scheduled to happen immediately or at a specified time. If high-rate communication equipment is installed within the field, it can be used to allow a remote operator to provide real-time commands on more complex tasks. FlatFish is the only AUV able to live on the seabed in a docking station and perform visual inspections and 3D reconstruction of subsea equipment and pipelines with high precision, a significant improvement over the existing autonomous vehicles," concludes Zagatti.

AUV Mission in the Great Lakes

By Eric Haun

A recent first-of-its-kind mission to the Great Lakes included the deployment of a long-range autonomous underwater vehicle (AUV) to help scientists better understand one of the world's largest and most complex freshwater environments.

The five Great Lakes (Erie, Huron, Michigan, Ontario and Superior) were carved out by glaciers thousands of years ago and today stretch across an expansive 246,000 square kilometers, holding an estimated 20 percent of the world's freshwater. The Lakes' vital role

MBARI engineer Brian Kieft with researchers from the U.S. Geological Survey (USGS) on board the USGS vessel with the Tethys LRAUV, in the southern portion of Lake Michigan

(Credit: Brett Hobson © 2016 MBARI)

within the surrounding environmental and economic landscape cannot be overstated. For scientists, however, studying this huge yet mysterious ecosystem has often been challenging.

In hopes of better understanding this complex freshwater system, the U.S. Geological Survey (USGS) Great Lakes Science Center – which studies the Lakes' living resources and their habitats – recently teamed up with the Monterey Bay Aquarium Research Institute (MBARI) to observe plankton communities in a project that seeks to improve upon traditional research methods by, for the first time in Lake Michigan, adding an AUV to the mix.

Conventional sampling technology for this type of study has typically involved some kind of vessel with nets, explained Dr. David Warner, a research fisheries biologist with the USGS Great Lakes Science Center, who said traditional methods are not only less effective, but slower and costlier than sampling with an AUV.

That's where MBARI's long-range AUV Tethys comes in. In August 2016 Tethys spent nearly a month traversing the entire body of Lake Michigan to gather data for the study of the lake's planktonic food webs and provide valuable insight for fisheries management and climate change research.

"The USGS is tasked with trying to understand the entire ecosystem of the Great Lakes, which is a big challenge," said MBARI mechanical engineer, Brett Hobson. "Because they needed to make basin-scale observations and were interested in employing adaptive sampling strategies to find hot spots of productivity, MBARI's long-range AUV [Tethys] was a good fit."

"Tethys is able to sample 24 hours a day, seven days a week, for as much as a couple of weeks at a time, and even longer if you minimize the kind of sampling you do," Warner said. "That kind of presence gives us a number of samples and amount of data that is orders of magnitude greater than what we can get from the ships. It can sample constantly. Combine the sampling speed of our ships and the expense to cover the kind of ground that the AUV can cover, and it becomes absolutely impossible to match what the AUV can do."

Tethys is designed first and foremost for travelling long distances. At 30.5 cm in diameter, 230 cm long and weighing 120 kg, the AUV can support an 8 W sensor payload for distances up to 2,000 km at 1 m/s; and this range can be extended to several thousand kilometers when operating at a speed of 0.5 m/s with minimal sensors. By way of a

Tethys LRAUV in Lake Michigan during the "sea" trials.

(Credit: Brian Kieft © 2016 MBARI)

MBARI engineers Ben Yair Raanan, Brian Kieft, and Brett Hobson prepare to deploy three long-range autonomous underwater vehicles from the Research Vessel Paragon in Monterey Bay.

(Credit: Todd Walsh © 2014 MBARI)

buoyancy engine, Tethys is also capable of trimming to neutral buoyancy and drifting in a low power mode.

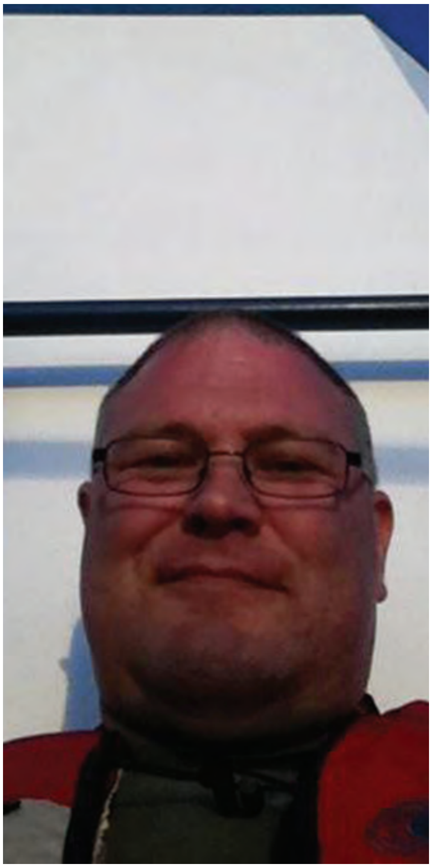
But, as the deployment was Tethys' first in freshwater, MBARI said the project presented several unique challenges to Hobson and principal investigator, Brian Kieft. The vehicle needed to be retrofitted for work in the less buoyant salt-free environment by adjusting ballast and adding extra flotation devises. Another challenge: Tethys had to be disassembled in order to be transported by more than 4,000 kilometers by land from California to Charlevoix, Mich.

Upon arrival to Lake Michigan, the AUV was reassembled and put through a series of sea trials before being packed up again and transported to Muskegon to begin the first leg – the southern portion – of its expedition. In its first week of deployment, Tetheys, outfitted with a suite of biogeochemical sensing equipment, travelled 400 kilometers between Muskegon, Chicago and Milwaukee. The team then transported the AUV over land to run a second and longer deployment through the north end of the lake.

"Our long-range AUV is unique because it is able to run 1,000 km long missions with a science payload to map the distribution of chlorophyll as a function of location and temperature as well as run adaptive missions to focus sampling along a front or vertical layer where hot spots of productivity usually occur," Hobson said. "The LRAUV we sent to Lake Michigan also measures optical backscatter, PAR and salinity, though that wasn't very useful in the fresh water lake. In the future we'd probably employ a bio-acoustics sonar for zooplankton imaging and/or our G3 ESP microbial sampler."

Warner said, "[The AUV] measured connectivity, temperature, depth . . . it measured salinity, it measured relative fluorescence – that's a way estimating how much chlorophyll is in the water, or more succinctly how much phytoplankton is in the water. It also used acoustic sampling in the form of acoustic Doppler profiler that we're going to try to use to estimate zooplankton biomass. We're going to try and do that by using comparative sampling data where we sampled side by side with our ship and the AUV. That comparative sampling should give us the ability to try and better understand some of the variables measured by Tethys actually are in the form of zooplankton abundances and chlorophyll distribution."

Tethys, used in conjunction with surface satellite imagery and vessel-based research, essentially expands the USGS datasets by providing a more accurate



David Warner

Brian Kieft and Brett Hobson

. (Courtesy US Geological Survey)

depiction of plankton from the surface down.

According to Warner, the primary difference between data gathered by the AUV and more conventional means is the spatial and temporal resolution and scope. "[With the AUV], we have samples every few meters horizontally and less than every meter vertically . . . The Tethys data we have ended up being somewhere in the order of 150,000 data points compared to what we collected using similar equipment from the ship that amounted to in the thousands of data points, not hundreds of thousands."

"We're trying to transform the way we go about sampling in the Great Lakes by utilizing these, what I would call, complimentary tools like the AUV to simply have capabilities well beyond what we already have," Warner said.

"What we hope to accomplish in the end is to be able to do surveys and research projects where we utilize ships to take advantage of their strengths where they exist – things like actually capturing fish with nets – as well as taking advantage of things like the Tethys AUV to utilize their strengths to do things ships can't do, like study lower trophic level organisms like phytoplankton and zooplankton. Combining these gears should give us the best set of tools we have for providing a good understanding for how the food webs in these lakes function, how they can support fish which are important for people, and how they store and process carbon, so that helps us understand the role of climate," Warner said. "Ultimately, this multi-tool approach to this kind of research is critically important and has been shown to be really effective in oceans, but hasn't been used to as much degree in the Great Lakes or other fresh water systems."

The research team is now in the early stages of data analysis which will ultimately lead to a number of papers in 2017.

As for future AUV deployments in the Great Lakes, "We don't have solid plans [at this point]," Warner said. "We would like to do this type of sampling in other lakes, and we especially want to bring Tethys back if fisheries acoustic gear is integrated into the AUV. That's one of the things the AUV was capable of deploying, and at this point in time the folks at MBARI are working on making that happen. And we would be very attracted to deploy [Tethys] again – potentially even somewhere else – if it can also measure fish abundance."

(Credit: Brian Kieft © 2016 MBARI)

MBARI engineer Brett Hobson loads the Tethys LRAUV into an SUV.

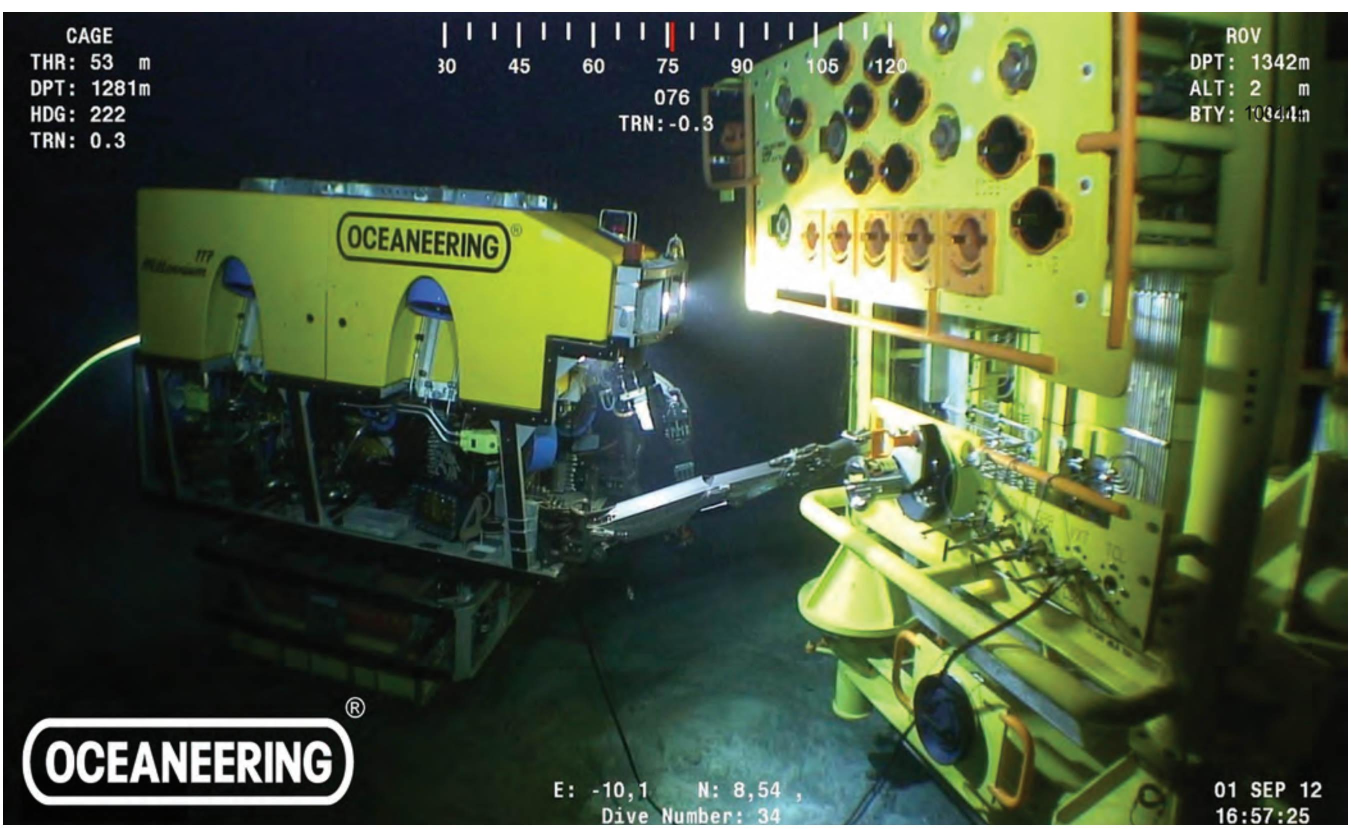
Uncontended Voice and Data Through TDMA Networks

How subsea applications are leveraging satellite technology for the "Internet of Things"

By Rolf Berge

The Internet of Things (IoT) has been a hot topic across many industries in recent years. Whether it's a fitness tracker, smart refrigerator, thermostat or apps within a car, most people are now connected to electronic devices in ways that they probably wouldn't have imagined 15 years ago. Experts are predicting that there will be more than 24 billion IoT devices installed and $6 trillion invested in IoT solutions by 2020. At this rate of growth, the IoT ecosystem extends beyond consumer electronics to other industries like healthcare, logistics, agriculture and oil and gas, to name a few.

For most of these applications, especially those located in remote areas, the IoT has only been made possible through satellite-based communication. For example, companies such as Harris CapRock* work with their customers to provide connectivity through satellite communications, with a specialization in transient environments. One way this



Credit: Harris Caprock/Oceaneering

Under this network model, an uncontended CIR is like a dedicated lane on the freeway that can only be used by a single company, allowing the company to send any mix of cars, vans and trucks as they like. The dedicated lane is unaffected by rush hour, or activity in other lanes. In other words, and for operators tracking multiple assets or remotely monitoring myriad metrics from a wide array of equipment, the perfect match.

is achieved is through Harris CapRock One. It provides a communication service that monitors for and adopts the best-fit satellite, wireless or terrestrial network as a rig or ship moves around the globe. The solution's multi-band antenna is capable of supporting C-, Ku- and Ka-band and is remotely configurable, saving on the costs associated with an on-site service technician.

With this setup, customers are allowed to freely roam wherever they want worldwide and the equipment self-configures to the most appropriate connection in the given conditions – making

IoT applications a reality, even in the middle of the ocean. This type of reliability opens a window to what customers can achieve through communications technology and connectivity, allowing them to derive benefits from the IoT that weren't previously available.

Uncontended TDMA Networks

Another way Harris CapRock achieves connectivity is through uncontended Time Divisional Multiple Access (TDMA) networks. TDMA networks are very flexible in supporting highly mobile assets that need to move from one region of the world to the next. What many customers don't realize is that service providers have the ability to offer uncontended TDMA networks with a dedicated committed information rate (CIR). This architecture allows access to committed bandwidth levels at all times – an advancement over traditional TDMA networks. Under this network model, an uncontended CIR is like a dedicated lane on the freeway that can only be used by a single company, allowing the company to send any mix of cars, vans and trucks as they like. The dedicated lane is unaffected by rush hour, or activity in other lanes. In other words, and for operators tracking multiple assets or remotely monitoring myriad metrics from a wide array of equipment, the perfect match. TDMA networks are able to react to changing traffic requirements from the VSAT to the hub much faster than a single channel per carrier (SCPC) network. This makes TDMA networks much more appealing when dealing with bursts of traffic or IoT applications.

Oceaneering

In one such application, the results are noteworthy. Harris CapRock deploys voice and data services through an uncontended TDMA network with its customer, Oceaneering, to support live video services which are currently utilized for subsea and topside activities offshore. By nature of the work, Oceaneering's fleet is almost always located in hard to reach areas making satellite communications a must.

As a global oilfield provider of engineered services and products, primarily to the offshore oil and gas industry, Oceaneering has a focus on deep-water applications. Oceaneering's business offerings include remotely operated vehicles (ROVs), built-to-order specialty subsea hardware, deep-water intervention and manned diving services, non-destructive testing and inspection, as well as engineering and project management. The company provides the hardware, networking and all communications services to install and backhaul video from even the most remote locations.

For Oceaneering, the IoT is enabled by the use of cameras and sensors on vessels to create feedback to users onboard and onshore. Traditionally, operations personnel were required to monitor gauges and sensors. With the availability of the Harris CapRock satellite communications link, sensors are interconnected and monitored via various gauges and dashboards instead of through manual intervention.

Through the IoT, companies are given great visibility into their subsea operations. Predictive maintenance has become a more common method to reduce costs, and video is a key tool in validating the wear and use of equipment. Subsea video is used to monitor Oceaneering's ROV operations and to inspect subsea hardware for any damage or erosion and corrosion issues. Video management is provided through an integrated web-based portal for viewing and management of real-time streaming and historical archiving and review. The user has the ability to tag interest areas for subsequent analysis and view multiple streams in a unified display. The analytics around the video enable clients to measure the amount of surface coasting or rust occurring on assemblies and calculate when to replace them.

Harris CapRock in Action

Recently, an operation was initiated to verify a leak in one of Oceaneering's subsea risers which was used to transfer product from the subsea floor to the offshore production platform. With these types of operations, there is quite a bit of ROV work and support around the installation, maintenance and operation of the riser (including frequent inspections) – all requiring subsea video.

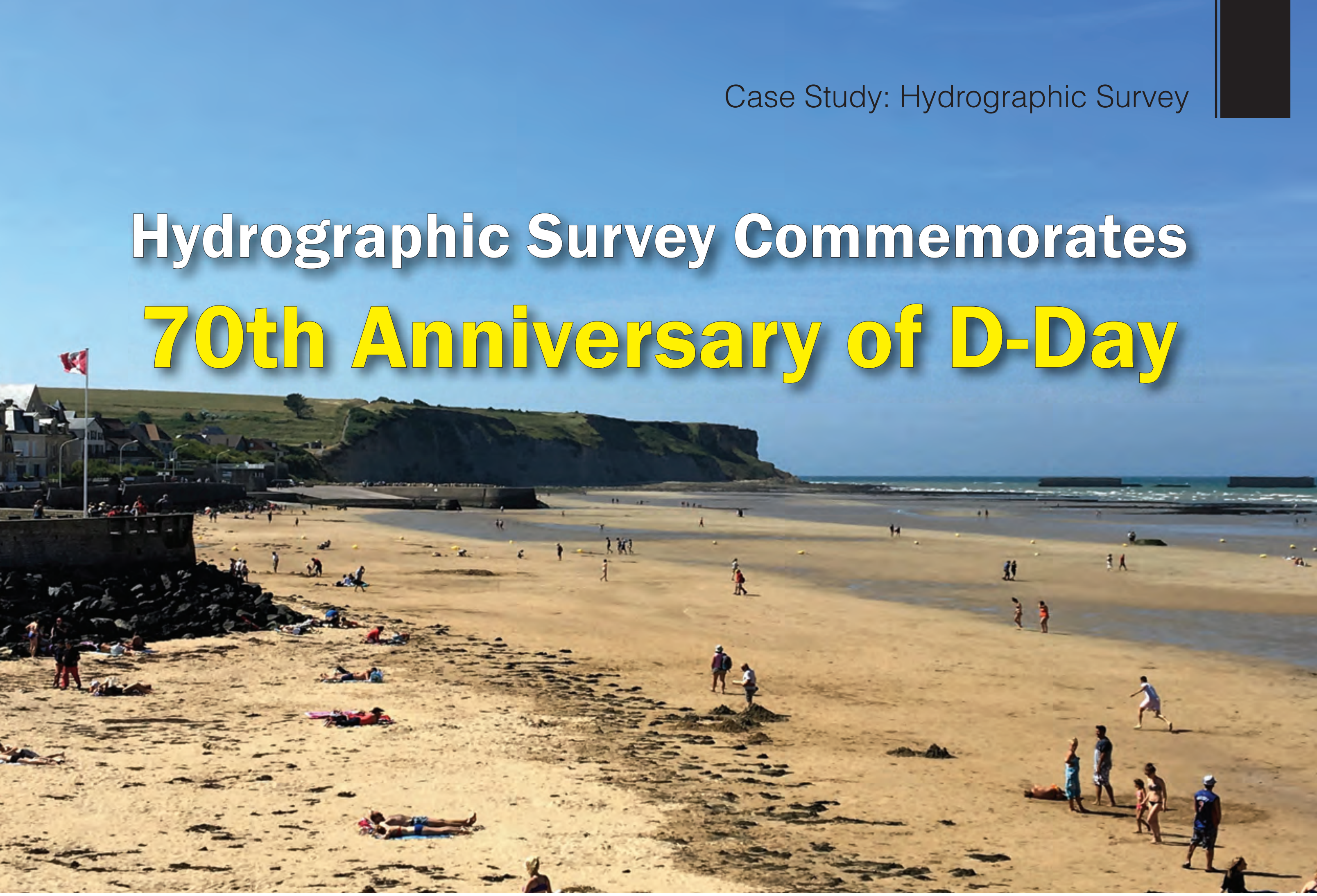
To fix the issue, live video was streamed to multiple users in order to design a repair kit for the damaged pipe joint. Measurements were made directly off the video using photogrammetry, which allows precise measurement when two cameras are used in coordination. The cameras on the surface and live streaming were used to conduct operations monitoring and surveillance of activities to provide direct feedback and assistance to crews offshore. Oceaneering was able to successfully conduct a repair of the riser while providing operational visibility to the client – all while the operation was underway through satellite-enabled live streaming video.

Today, several of Oceaneering's clients now conduct operations through an onshore command center and maintain active communications with the crews offshore operating the equipment. As vessels become more automated, the need for connectivity only increases. The visibility that's made possible through Harris CapRock's satellite link has become a necessity for the subsea operations, and through it, Oceaneering has been able to provide more sophisticated solutions because of reliable communications across its fleet of vessels.

**** Editor's Note:***

On November 1, 2016, Harris' CapRock Communications commercial business was acquired by satellite communications and network service provider SpeedCast International Limited in a cash transaction valued at $425 million.

Hydrographic Survey Commemorates 70th Anniversary of D-Day



A team of international scientists has surveyed the Normandy coast to reveal how the greatest naval invasion in history unfolded. Utilizing the latest technologies and advanced software, the team surveyed 511 km2 of seafloor, producing an enormous 11 TB of data. Employing HYPACK hydrographic surveying software, the team was able to assimilate over 4 billion soundings from multi-beam sonar to produce very high resolution color three-dimensional images of the seabed, including many remaining artifacts from the D-Day landings.

"The Normandy seabed is effectively a massive archaeological site," explained Harold Orlinsky, HYPACK, "However, the sunken items left behind by this momentous event are starting to disappear, and the D-Day landings took place on an enormous scale, resulting in the deaths of thousands of troops, so the surveying project was undertaken to honor those that passed, and to explore the wrecks before they disappear forever."

Background

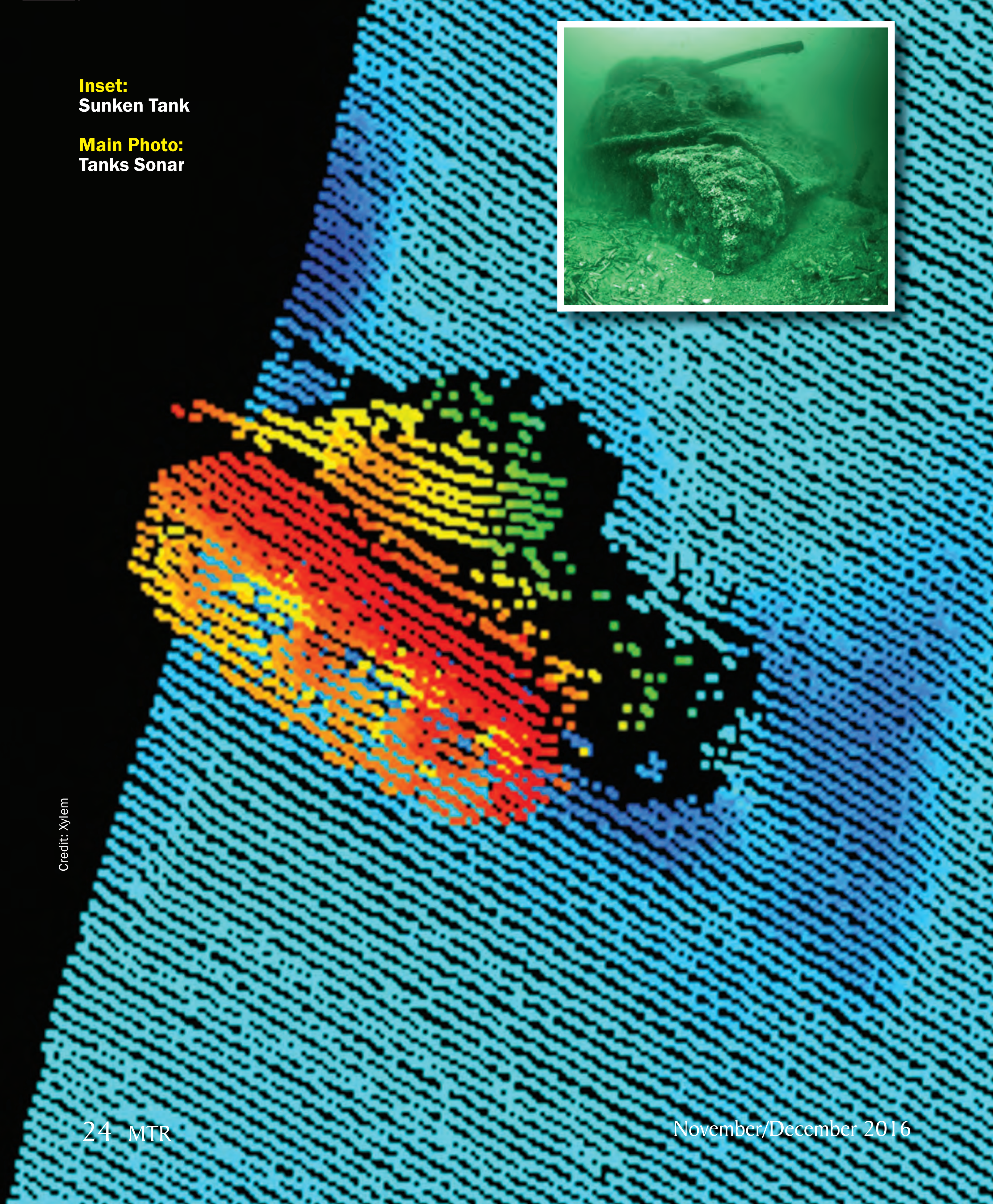
On June 6, 1944 the largest, most complex amphibious landing in history took place on the beaches of Normandy, France. The military operation began the liberation of German-occupied northwestern Europe and contributed to the Allied victory in World War II. Operation Overlord was the codename for the Allied invasion and the assault phase of Operation Overlord was known as Operation Neptune.

The term 'D-Day' is a military designation used to indicate the start date for specific operations; but the Allied invasion of Northern France is by far the most famous D-Day. Operation Overlord took three years to plan and involved military tacticians, scientists and engineers; working together to develop equipment and methods capable of transferring an army across the English Channel. Many of the innovations that were employed were previously untested in warfare, and the Normandy seabed offers an insight into the ingenuity of those involved.

The invasion fleet of almost 7,000 vessels was comprised of warships, minesweepers, landing craft, ancillary craft, and merchant vessels. Aerial support was provided by nearly 11,000 planes and by the end of June 11 more than 300,000 troops, more than 54,000 vehicles and more than 100,000 tons of supplies had been landed on the Normandy beaches.

In anticipation of the invasion, the Germans had heavily fortified the Atlantic coast over a number of years and the Allies suffered heavy losses. As a result, the seabed is littered with an enormous number of wrecks and other military assets including those that were developed in the three-year operation that led to D-Day.

The Germans believed that Calais would be the most likely



Inset: **Sunken Tank**

Main Photo: **Tanks Sonar**

Credit: Xylem

invasion point because it has a port and is the closest point in continental Europe to Britain. Calais was therefore the most heavily fortified region. Nevertheless, Field Marshal Rommel believed that the Normandy coast could be a possible landing point, so he built concrete gun emplacements at strategic points along the coast, and to counteract landing craft and impede tanks, he placed wooden stakes, metal tripods known as hedgehogs, mines and large anti-tank obstacles on the beaches. Five beaches were targeted by Operation Neptune: UTAH and OMAHA were the code names for the most westerly beaches which were the location for an amphibious assault by American troops. British troops formed the assault at GOLD and SWORD beaches, and Canadian troops stormed JUNO beach.

As Supreme Allied Commander of the Allied Expeditionary Force, General Eisenhower was under enormous pressure to launch the invasion, with vast numbers of troops ready for action and every day that passed further risking German discovery of the plan, but weather conditions were very poor and the invasion was delayed. Lower tides were also a factor in the determination of the invasion date because a lower tide extends the period in which landings are possible. Eventually a 'col' (interval of calm weather) was identified and a final and irrevocable decision was made: D-Day would be June 6, 1944.

Allied ingenuity

Despite the col, sea conditions were extremely difficult during the landings and resulted in a significant loss of military assets. For example, the hydrographic survey revealed sunken tanks in otherwise 'good' condition that had sunk before reaching the shore. These Duplex Drive (DD) tanks, nicknamed 'Donald Duck tanks' had been fitted with folding floatation screens that were supposed to make them buoyant, and they had a propeller powered by the tank's engine to drive them in the water. The survey showed that many had sunk and this has been attributed to the rough sea conditions and because some were launched too far out to sea. It has been noted that some of the tanks which successfully made it to shore were manned by troops with peacetime sailing experience which meant that they were able to navigate effectively while minimizing the effects of the waves and water ingress.

The DD tanks were just one of a group of tanks that became known as 'Hobart's Funnies' after Major General Percy Hobart. A wide range of tanks were developed from existing models to undertake specific functions. For example, the ‘Crocodile’ was a Churchill tank modified by fitting a flame-thrower in place of the hull machine gun and another was adapted to be able to launch 40 pound mortars known as ‘flying dustbins.’

A number of other innovations were still evident on the Normandy seabed. Evidence of wooden boats no longer exists, but a wide variety of metal vessels were identified in the survey. For example, the Allies were aware of the need to reduce the time for troops to disembark and Jackson Higgins, a boat manufacturer from New Orleans, designed a range of boats that were employed extensively on D-Day. Higgins’ boats were able to deliver large quantities of men and equipment quickly from ship to shore, without the need for established harbors. His various boats included the LCVPs (Land Craft, Vehicle, Personnel), special craft designed to carry infantry platoons and jeeps to shore. With a front ramp, Higgins’ boats were able to reduce unloading time which saved many lives. Consequently, years later, General Eisenhower said “Higgins won the war for us.”

Churchill believed that Operation Overlord would be unable to deliver large quantities of heavy equipment without access to a port, so he instigated the development of two artificial harbors that became known as Mulberry Harbors. Following trials with initial designs, the components of the harbors were manufactured in the U.K., towed across the English Channel and assembled off the coast of Normandy. Mulberry A, was constructed at Omaha Beach and Mulberry B (nicknamed Port Winston), was constructed off Arromanches at Gold Beach.

The Mulberry harbors consisted of a floating outer breakwater, a static breakwater consisting of scuttled ships and reinforced concrete caissons, floating piers, roadways and pier heads.

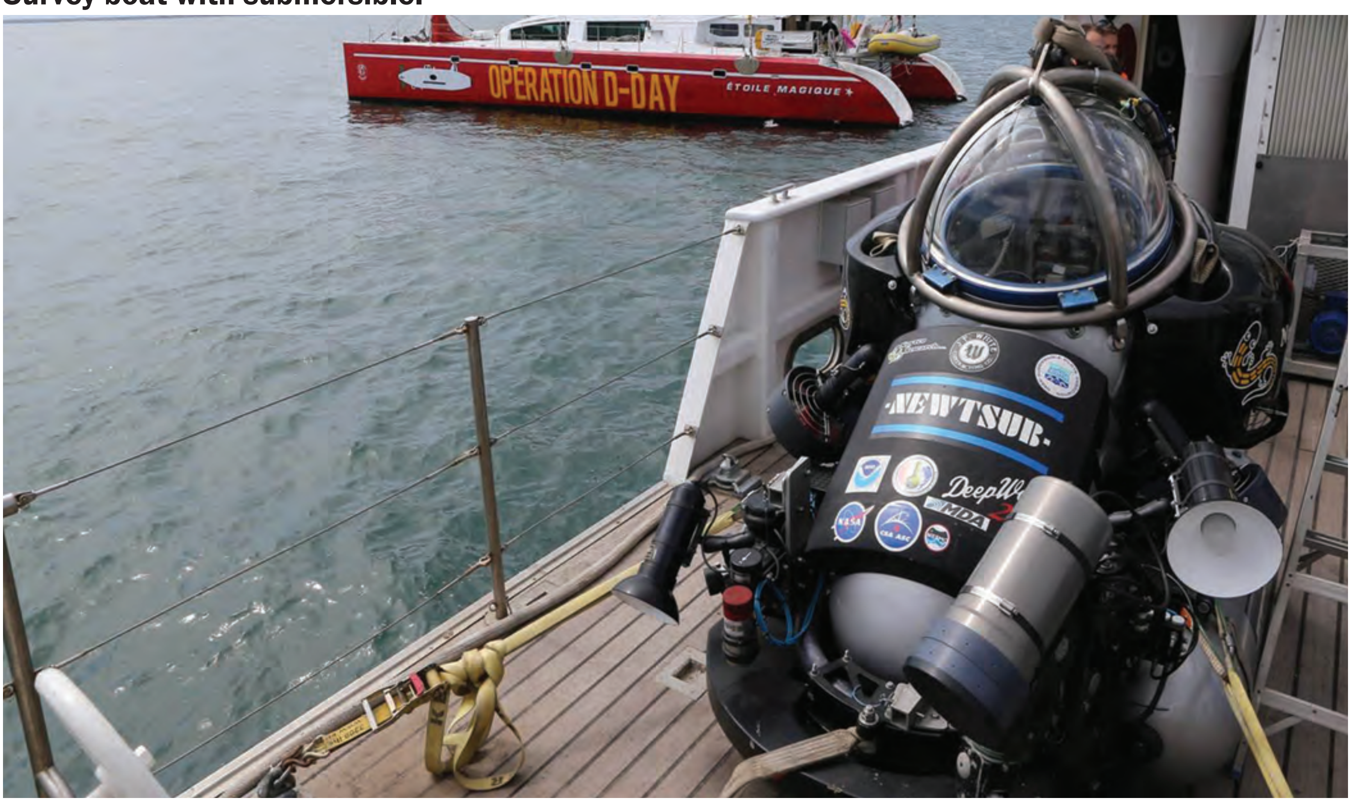
Unfortunately, a severe storm began on June 19 and after three days Mulberry A, which served the Americans at Omaha, had been wrecked. Parts of it were salvaged to repair the British harbor at Gold which worked for 10 months. Over that period, the harbor landed 2.5 million men, 500,000 vehicles and 4 million tons of goods.

2013 Hydrographic Survey

The survey was conducted using Trimble RTK with a CODA F-175 motion reference unit and advanced multi-beam, pole-mounted sonar (EdgeTech 4600) fitted to the underside of Etoile Marine’s Catamaran, the Magic Star. At 25 x 12 meters, the catamaran was large enough to enable 24/7 operation over a survey period that ran over six weeks. Water depth varied up to 100 meters and the catamaran sailed back and forth, scanning ‘swaths’ 40 miles in length.

In contrast with conditions during the D-Day landings, the weather conditions during the survey were relatively calm and the onboard team even managed to turn the engines off and survey under sail at one point. In the first phase of the work, 350 separate wrecks and debris were marked, and in the second phase 50 specific targets were scanned to create highly detailed 3D images. For example, the wreck of the USS Susan B. Anthony was scanned. This was a 483ft. troop transport

Survey boat with submersible.



Credit: Xylem

ship that sunk when it struck a mine in a swept channel on June 7, 1944. However, in this case, all 2,689 people aboard were saved.

The survey team did not find any unexploded devices, but did scan many items that had been the victims of such explosions. In addition to British and American equipment, the survey also found the German U390 submarine, which was sunk on July 5, 1944 by depth charges.

The HYPACK software combines tools for planning the survey lines to be run, collating all the data from the multi-beam system, motion reference unit and GPS, plus a powerful post-processing and display package. The end result is the 3D images, such as those collected during this survey, that make it possible to see underwater. It is even possible to create animations to give the viewer an impression of being able to fly above the seabed.

Describing the work to handle the enormous quantities of data produced by the 4 billion soundings gathered by the survey, HYPACK's Jerry Knisley said, "The Log Backup Time was set to 15 minutes to limit the size of the recorded files – this started a new file every 15 minutes in HYSWEEP. However, each HSX file was still around 260 Mbytes, which meant that we were handling 1 Gbyte of data per hour."

Summary

HYPACK provided a number of key tools to complete the survey, providing full support and onsite assistance. Their Orlinsky said, "We were immensely proud to be involved in this project; not only because it demonstrated the enormous power of HYPACK software to manage vast amounts of data, but also because there are very few eye-witnesses left from D-Day, and the project provided a unique opportunity to reveal the detail of this underwater graveyard."

Today, 27 war cemeteries hold the remains of more than 110,000 dead from both sides: 77,866 German, 9,386 American, 17,769 British, 5,002 Canadian and 650 Poles.

Emphasizing the importance of remembering D-Day, Orlinsky said, "Operation Overlord represents a vital moment in the history of the free world, and it was an honor to be part of the team that commemorated the 70th anniversary by documenting the remaining artifacts of this epic event."

"Brexit"
What's in store for the subsea sector?

By Kira Coley

The UK subsea industry has grown by 40% over the past three years and now holds almost half of the global market. The EU referendum has plunged the industry into uncertainty and the UK must now wait to see how June's historic vote shapes the future of one of its fastest growing sectors. The interconnected nature of subsea, renewables and offshore activities makes predicting impacts even more difficult as the market attempts to understand the challenges, and possible opportunities, ahead.

At the forefront of innovative technologies, the UK's subsea sector drives advancement in offshore developments through the provision of equipment, experience and skills to the global markets. According to NOF Energy's Subsea Northeast group, the UK subsea sector supports more than 66,000 jobs in more than 750 companies, supplying goods and services valued in excess of $11.2 billion.

George Rafferty, Chief Executive of NOF Energy, comments, "The UK subsea sector is enormously important. Firstly, the value of the sector to the UK economy is around $1.9 abd $2.5 billion annually. Lots of companies in the UK have a global footprint and we're recognized as a leading sector, not only in oil and gas but increasingly in offshore wind as well. We lead the way in subsea technology and these technologies will continue to be used and developed for the entire subsea sector globally. The UK is also the largest market in offshore wind and our subsea sector will play a very large role in its development, not only in the UK but also in Europe and elsewhere."

The UK's commitment to supporting low carbon energy, North Sea activities and promoting UK content assumes, post-Brexit, the government will continue to push for growth in its subsea, offshore and marine energy sectors. As these activities are linked, the growth of the subsea sector relies on the continued support of offshore renewables, oil and gas and large EU directives such as the new high voltage subsea connecters linking the UK and Europe.

It is likely that, for the foreseeable future, the European market will remain uncertain as we wait to see if industrial links between the UK and Europe remain connected. For now, mixed responses throughout the sectors create further uncertainties as companies on all levels attempt to carry on with business as usual.

Brexit and UK Content

Over recent years the UK Government has adopted a strong agenda to promoting UK supply chain content for offshore wind farm developments. The decision to leave the EU may unsettle important original equipment manufacturers (OEMs) and other major supply chain firms who were considering investing in the UK, and delay or deter this investment. If so, this could negatively impact the ability to maximize UK content and the long-term development of the supply chain.

Proximity to a good stream of offshore wind developments is an important factor for OEMs considering investing in the UK. Further factors include perceived long-term stability of national renewable energy policy and support, and general investment factors such as a favorable business environment, access to skilled people and costs of land and premises. However, it is the overall uncertainty about how Brexit might play out and how that affects the pipeline of new offshore wind developments that is likely to be the main concern to the industry.

Regeneris Consulting is a specialist economic development and regeneration company that has worked with many clients in the offshore and marine energy sectors. Associate Director, Stuart Younger, explains, "At the moment, any major growth of the UK offshore wind supply chain is most likely to be driven by investment from large OEMs or other major supply chain firms from overseas – particularly from elsewhere in Europe. If you look at how the supply chain works, lower tier suppliers often cluster in close proximity to these OEMs

(Photo: Regeneris)

"Like I said during the Scottish independence referendum in 2014, businesses will work with whatever political structures form after any vote. **Businesses will adapt and get on with it.** *They're global players, and while Europe is important, there are other markets elsewhere."*

George Rafferty
Chief Executive, NOF Energy

and major supply chain firms. So, if they settle in the UK they will often attract other companies in their supply chain who will want to be based nearby, as well as support the growth of existing lower tier UK supply chain firms. For the UK supply chain to grow substantially and UK content in the offshore wind supply chain to increase, we need to attract more investment from these large firms. And, the more uncertainty there is, the more risk that this could put these firms off investing in the UK." While there are concerns as to what extent UK investment is perceived a risk, there has been a lot of progress in developing the UK's offshore wind supply chain in recent years. After the EU referendum, one of the potential positives from a UK supply chain perspective is the relative cost of UK sourced goods and services. As the cost of importing increases due to a weaker pound, goods and services from the UK will look more attractive by comparison, which could help to increase the UK supply chain sourcing.

Pierre Boyde, Commercial Director at DeepOcean, expresses concerns. "One significant issue we have right now is that when we tender for future projects, which involve the supply and engineering of UK based goods and services, we have considerable uncertainty as to what tariffs will apply past 2018. This is critically important for big contracts because they're two to three years ahead, minimum. It's very different for people who are planning months ahead. I know what will happen with tariffs and duties in three months' time, but what's going to happen in three years' time? If you choose to qualify the risk it could make our offer unattractive to the end customer. In order to minimize this risk, we may be forced to use EU-based subcontractors rather than UK-based subcontractors."

Losing Connections

A critical point of interest for the subsea industry going forward are the new generation of subsea high voltage connectors between the UK and other European countries.

Boyde explains, "These are designated as European Projects of Common Interest (PCI) and not only benefit from accelerated planning and permitting procedures but are eligible to receive EU funding via the $5.7 'Connecting Europe Facility'. There are currently 16 subsea power cable projects across Europe that have applied for this status; eight of these projects connect to the UK with a total capacity of approximately 8 GW, or approximately 20% of the UK's total current electricity supply. DeepOcean and many other UK subsea players play a significant role in the planning and execution of these projects. Clarity is therefore needed as to whether subsea power cable projects connecting to the UK will qualify in the future for this funding. In five to 10 years' time, on a cold winter's night, these interconnectors may be keeping the lights on in the UK."

Furthermore, one of the fundamental business cases for these interconnectors was cheaper electricity prices. The wholesale price of UK electricity is currently around double that on the continent. Therefore, for each connector installed the market price of electricity in the UK goes down by 1%. This raises the question that, post-Brexit, would there be a stable regulatory and funding regime to put these projects in place if the UK leaves?

Cost for Future Developments

With a weaker pound, imports are more expensive, and following Brexit, if trade agreements become less favorable,

DeepOcean's T3200
underwater trenching system.

(Photo: DeepOcean)

this could further add to the cost of construction and ongoing operations and maintenance, pushing up the overall cost of producing offshore wind energy and creating a less attractive market.

Younger comments, "With regards to UK offshore wind and marine energy sectors, there are possible impacts on both the cost of construction and of annual operations and maintenance of energy infrastructure. However, the longer term impact on the offshore wind and marine energy sectors will be affected not just by the specific impact on the cost of producing energy from these sectors, but more importantly by the comparative impact versus other energy sources, which are competitors."

"Again, it is difficult to assess what this overall effect will be," Younger continues. "In the construction phase of offshore wind developments around 50-80% of spending is typically on imported goods and services which could be significantly affected by a rising cost of imports. However, once constructed, offshore wind represents a UK-based power source, so a rising cost of imports would have limited impact on annual power generation costs."

On the marine energy side, the loss of EU funding is a particular concern. The EU provides valuable European Regional Development Fund monies for low carbon and renewable energy development, which parts of the UK have used to support the development of early stage wave and tidal energy generation technology, including substantial investment in Wales. This money is seeking to help these technologies reach a stage at which they can compete commercially with other energy technologies as well as embed their supply chains in the UK. By leaving the EU, this funding will be lost, and it is currently unknown whether or how this might be replaced by the UK government. Even if this funding is replaced, it may not come with the same requirement for investment in low carbon sectors, and so could get diverted to other economic priorities.

Further Political Instability

The prospect of further instability by another Scottish referendum causes additional concerns for the offshore sectors, especially subsea and oil and gas. The recent slump in oil prices due to high costs and dwindling resources, less spending by

Maersk Connector: DeepOcean's state of the art cable lay vessel.

(Photo: DeepOcean)

producers and the threat of further jobs cuts demands political instability to be minimized and a more attractive investment climate to be created.

Boyde stresses, "The other really big one for the UK subsea industry is that Brexit could potentially lead to a breakup of the UK. Then a big hit, which happened at the last referendum, is that people will put a North Sea oil and gas development spending on hold for a while until they know the nature of the settlement. Particularly, given oil and gas prices, a lot of investments are now even more marginal. I think having the double whammy of a low oil price and further financial uncertainty around projects, whilst the UK is haggling with the EU and Scotland haggling with the UK, there is a risk that responding could be put on the back burner."

Whatever the case, the decision to leave the EU signals a challenging time ahead. The interconnecting nature of these offshore and subsea sectors means that impacts must be viewed together and not in isolation. The UK government also needs to make it clear to all sectors what will be their level of commitment and support going forward to help reduce uncertainty and minimize political instability in the shadow of another referendum.

The common response is that it is still too early to tell what the longer-term impacts will be. Some organizations are hoping to find new opportunities within the newfangled market. The indications are that at least for now companies will attempt, but may struggle, to continue with business as usual until the future of the industry is clearer.

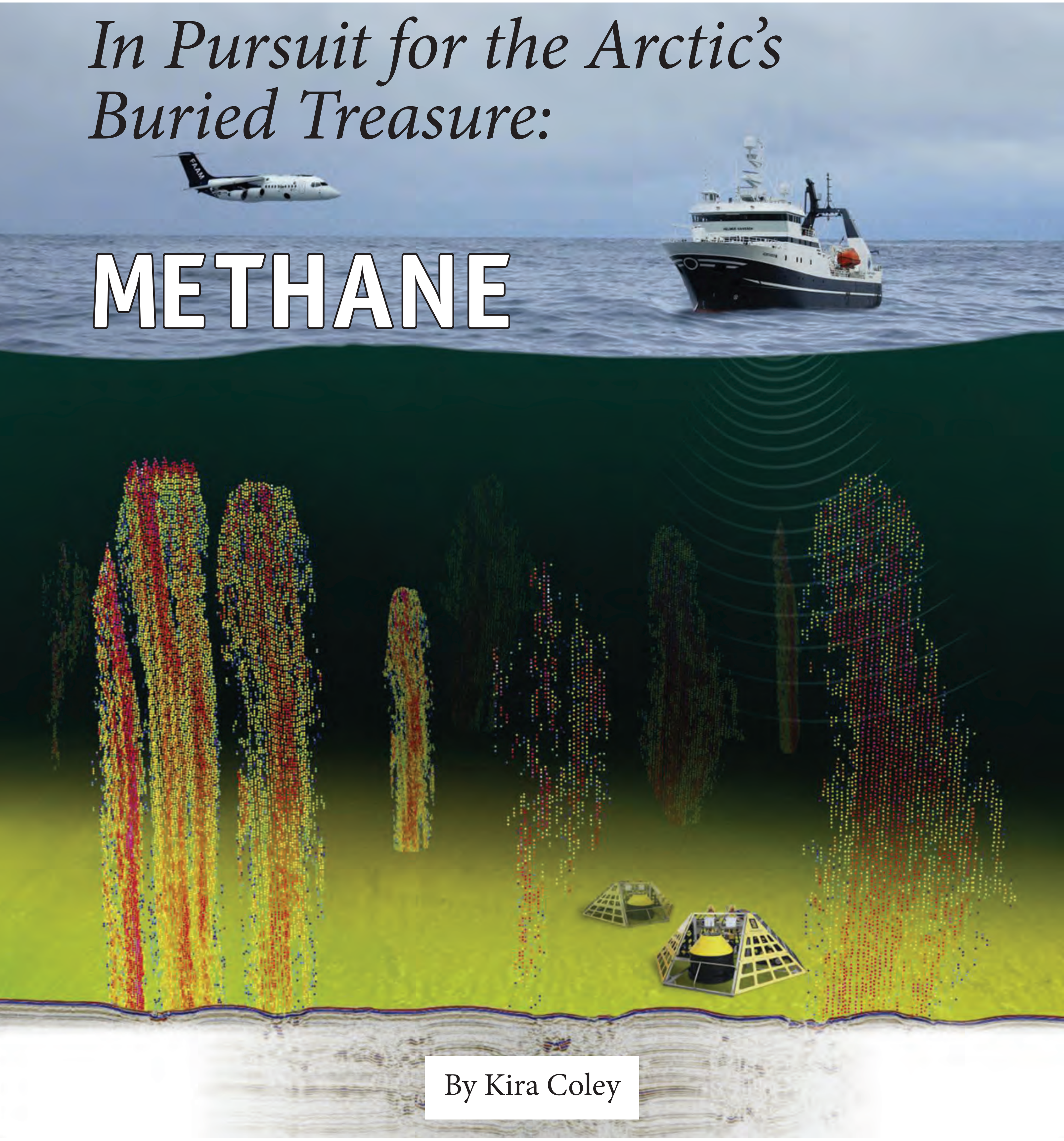
"The businesses that can offer new technology and are in niche positions within the market will always survive. Those offering off-the-shelf products, however, will struggle. Many of the subsea businesses in the UK, and here in the Northeast of England, offer niche specialist technology and they're developing, so they will always be in demand. Like I said during the Scottish independence referendum in 2014, businesses will work with whatever political structures form after any vote. Businesses will adapt and get on with it. They're global players, and while Europe is important, there are other markets elsewhere," Rafferty says.

Acknowledgements

George Rafferty, Chief Executive of NOF Energy.
Pierre Boyde, Commercial Director at DeepOcean.
Stuart Younger, Associate Director at Regeneris Consulting

In Pursuit for the Arctic's Buried Treasure:

METHANE



By Kira Coley

CAGE conducts cross-disciplinary research in the Arctic Ocean deploying observatories as well as conducting expeditions by sea and air to collect data on methane release from the ocean floor.

Illustration: Torger Grytå/CAGE

Trapped beneath permafrost and ocean sediments, the release of the world's largest natural gas resource, methane, has become a hot topic for international research. As rising temperatures continue to warm the Arctic region, the vast frozen fields of gas, known as gas hydrates, grow unstable beneath the retreating ice. The Centre for Arctic Gas Hydrate, Environment, and Climate (CAGE) strives to address one of the greatest scientific uncertainties: how much greenhouse gas threatens to escape the sub-seabed sediments and what will this mean for (1) the global climate gas budget, and (2) the Arctic marine ecosystem?

Located at the gateway to the Arctic, the Arctic University of Norway in Tromsø (UiT) is the northernmost university in the world. With an innovative research group and a suite of advanced technology, CAGE scientists study methane release from gas hydrates beneath the Arctic Ocean to unveil potential impacts on marine environments and global climate systems.

CAGE director, Jürgen Mienert, explains, "We have several connected themes so that we can understand the complete carbon recycling system related to gas hydrates from the subseabed to the atmosphere. First, we accomplish 4D time-lapse seismic studies to visualize potential sub-seabed gas hydrate accumulation and gas migration pathway areas. Second, we work in the water column taking both ocean spatial and methane gas concentration measurements using different types of laser spectrometers but also test new technologies in collaboration with the Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE) in Grenoble, France. Oxygen isotope measurements identify where the methane sources are coming from, and whether they are shallow biogenic or deep thermogenic sources."

"When the methane reaches the upper water column where you have light, an interesting scenario develops, particularly for the Arctic, you have a higher biological productivity. In the future, if increases of methane release in a more ice-free Arctic Ocean occur, one could hypothesize that there will be an increase in biological productivity and thus, ocean life. Once methane reaches the air, we use airplanes in cooperation with National Centre for Atmospheric Science, Department of Chemistry; the University of Cambridge and the Facility for Airborne Atmospheric Measurements (FAAM); Cranfield University; and Norwegian Institute for Air Research (NILU). Together we investigate the gas compositions and the concentration of methane above those gas hydrate fields – this is a typical cross-disciplinary research scenario for us."

CAGE uses and develops long-term multi-sensor ocean observatories, cabled and non-cabled, together with Kongsberg Maritime and Norway's Institute of Marine Research (IMR). The cabled observatories allow scientists to utilize these stations for a decade on the seabed. The non-cabled observatories remain in key locations for one year and provide the site flexibility required by researchers working in demanding and complex environments.

Developing new high-resolution geophysical technology within acquisition, processing and interpretation, CAGE wants to directly detect and image ma-

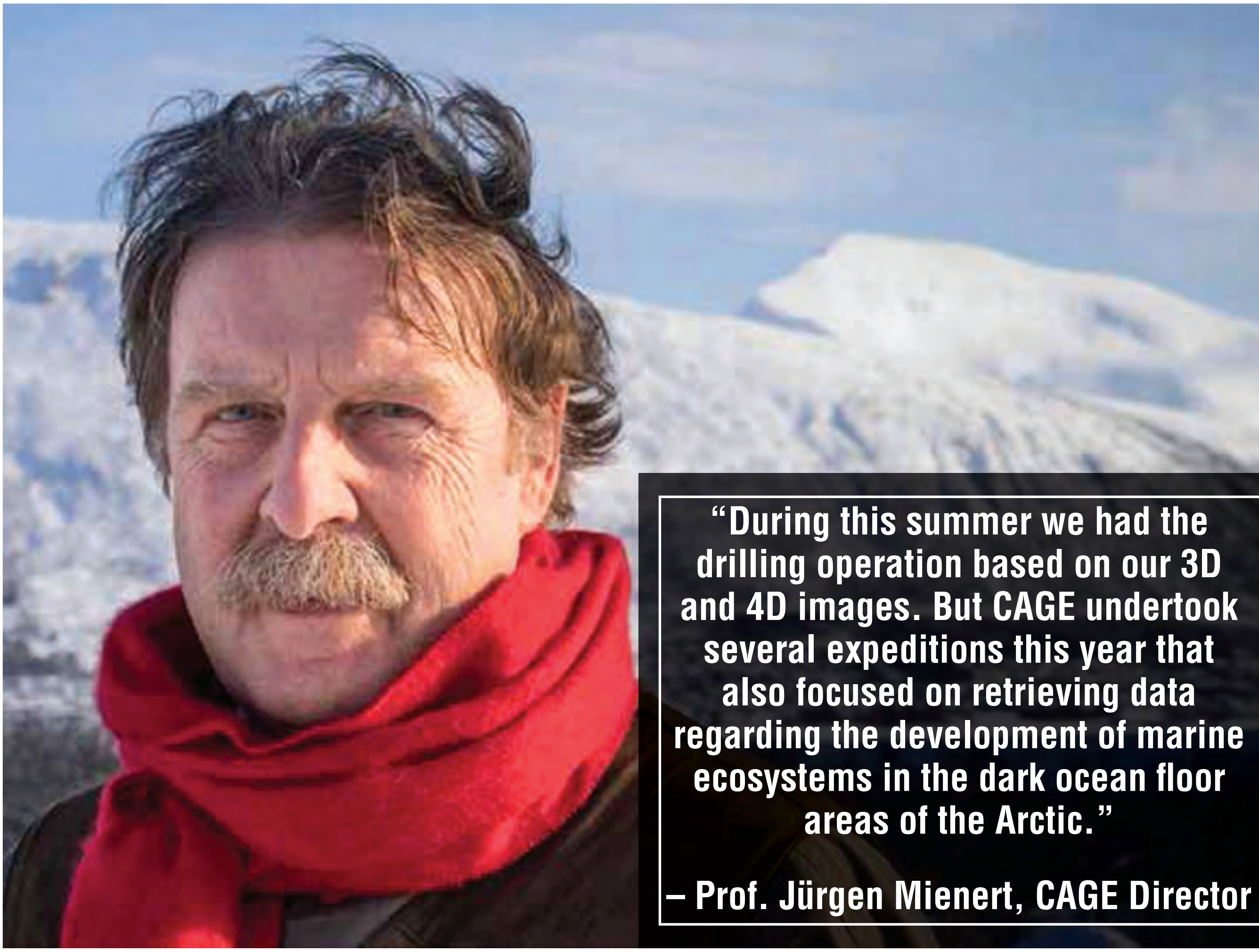


Photo: CAGE

"During this summer we had the drilling operation based on our 3D and 4D images. But CAGE undertook several expeditions this year that also focused on retrieving data regarding the development of marine ecosystems in the dark ocean floor areas of the Arctic."

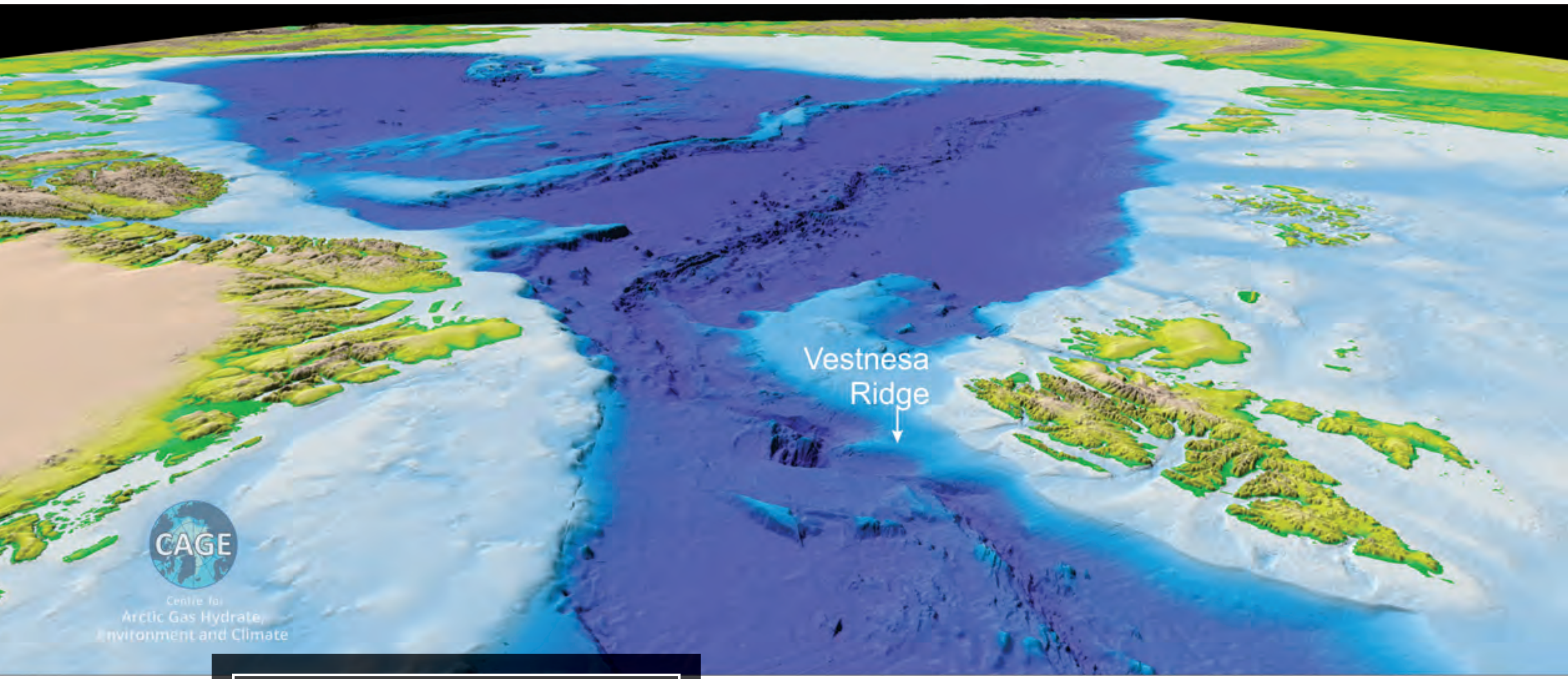
– Prof. Jürgen Mienert, CAGE Director

rine methane hydrate reservoir dynamics in the Arctic, based on acoustic and electromagnetic data and inverse modeling. To date, calculations of the methane and its ice form, gas hydrate, differ substantially across studies. While the most cited global estimate is 10,000 gigatonnes (or one billion tons), a recent calculation suggests this was hugely misjudged and global estimates of 74,000 Gt of methane stored as hydrates is more likely.

How much is beneath the seabed is dependent on the supply of biogenic and/or thermogenic methane, and the sedimentology – how much pore space is available to build up the gas hydrate. In addition to these, the pressure and sub-seabed temperature determine the zone where hydrates can exist. The gas hydrate stability zone – the area in which the hydrates are still stable – sometimes several hundred meters deep in the Arctic, together with the type of sediment, methane supply and heat flow rates, provides a basic quantification of how much methane hydrate may be available.

The other parameter that may be substantial is the variability of the geothermal gradient or the heat flow within the sediment. The heat flow determines how stable the fields are over an extended period as well as the ocean warming from above the sea floor, contributing to the melting of hydrates.

"Heat flow measurements in the Arctic are very rare, and that means you have a high uncertainty in your calculations. The other uncertainty relates to permafrost. We are still in what I would call the 'post-glacial' time, meaning we still see the effects of the ice ages today. Particularly in the Arctic, areas as far as the Barents Sea and north of Norway were covered by massive ice sheets several kilometers in thickness, which caused high pressure and low temperature on the sub-seabed. So, the methane hydrates stability zone was much more extensive than it is today. They covered an enormous area of the Arctic – another reason why we have such a high uncertainty in our calculation of a very dynamic system on geological time scales. To be more robust, we use observations together with modeling exercises using ice sheet conditions, pressure, low temperature, and retreat of the ice sheet to see where we may still have both permafrost and hydrates in those Arctic gas hydrate fields."

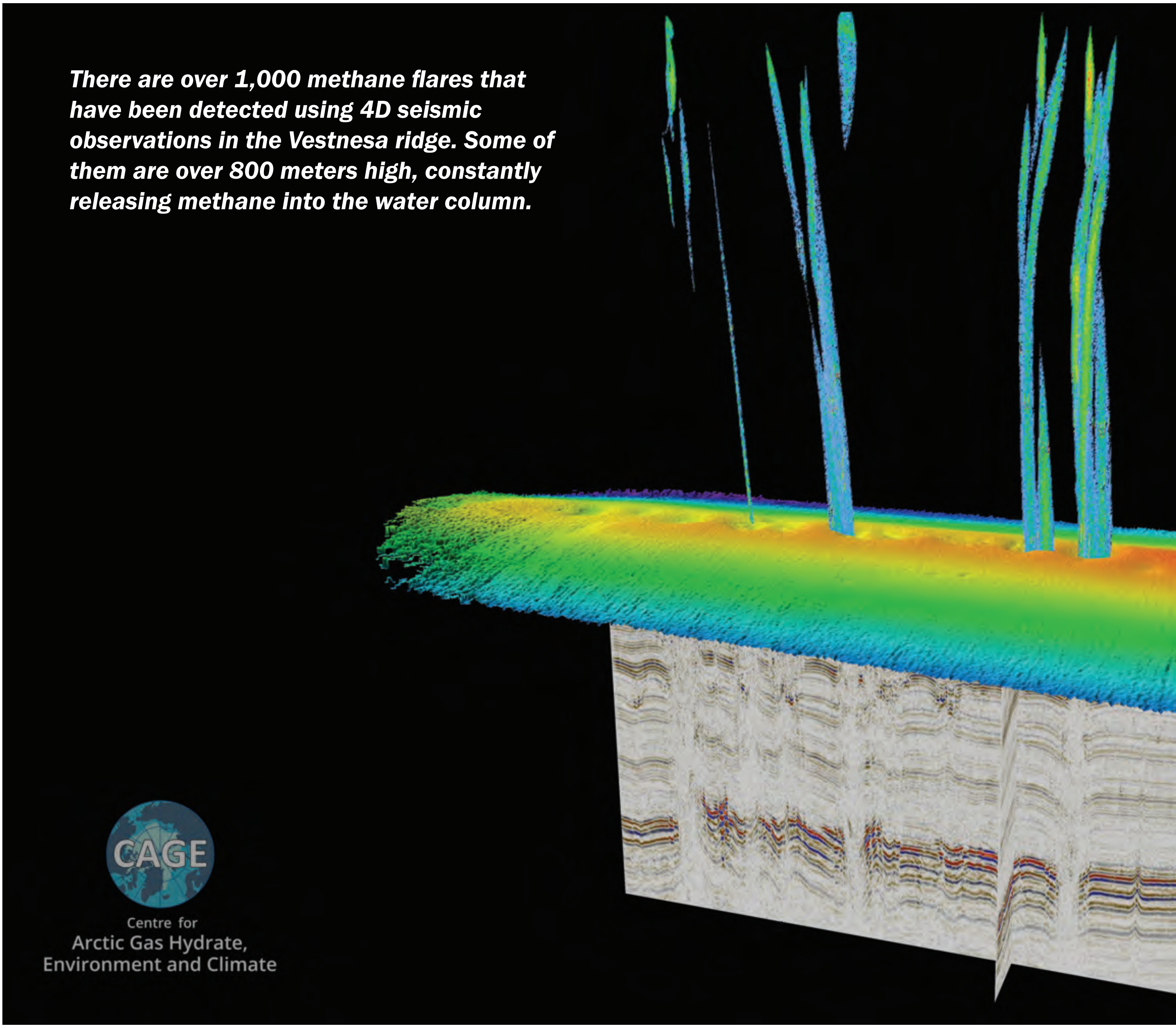


Vestnesa Ridge in the Fram Strait in the Arctic Ocean is one of the key sites for CAGE research.

Illustration: Torger Grytå/CAGE

In July, CAGE undertook an expedition to the sedimented and gas-hydrate charged Vestnesa Ridge, offshore Svalbard. Vestnesa lies on the active ridge system of the oceans, which are undersea mountain chains formed by tectonic movement and stretching around the globe. Utilizing advanced technology, an expert team of engineers, operators and researchers battled the elements, drilling at 1,200 meters of water depths down into the gas-hydrated sediments in an attempt to determine how much methane is captured beneath the Arctic subseabed and, when released, how it will impact the regional Arctic marine ecosystems. The expedition was in collaboration with MARUM in Germany and their mobile drilling rig, MeBo, which was used to acquire gas-hydrate core samples from the sediments.

Mienert describes, "During this summer we had the drilling operation based on our 3D and 4D images. But CAGE undertook several expeditions this year that also focused on retrieving data regarding the development of marine ecosystems in the dark ocean floor areas of the Arctic. We also investigated the impact of methane release on benthic fauna as

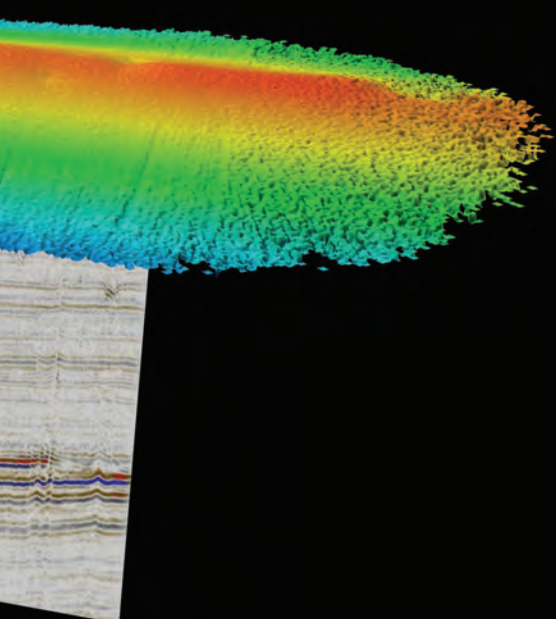


There are over 1,000 methane flares that have been detected using 4D seismic observations in the Vestnesa ridge. Some of them are over 800 meters high, constantly releasing methane into the water column.

we expect an expansion in those benthic fauna regions based on the increase methane release from the seabed. The third operation was in deep water, where we operated a deep-sea ROV at 2,000m. This activity was also related to investigating biofauna in the dark, chemosynthetic communities, the conditions they live in and the search for new species – these highly specialized species may produce chemical compounds that can be of interest for pharmacy and medical purposes in the future."

CAGE's goal is to provide new information and improve our understanding of the variability of methane release, which can be related to retreating glaciers from the last glacial until today. Using a suite of specialized technology and modeling data, the scientists will reconstruct changes in the Arctic region over million, millennial and decadal time scales.

"In the Arctic, we wish to drill deeper reaching beyond the base of the gas hydrate stability zone. So, the next phase for us is to work with industry to get a commercial vessel to one of the gas hydrate fields, which will allow us to recover more of the gas hydrated sediment formations. We can then understand the geological system that is giving you the boundaries, so that we can calculate total amount of methane hydrate that may be stored in the Arctic marine sub-seabed environment. That, of course, may relate to unconventional energy resources, an interest for industry. So we are looking at where the gas hydrate fields are; how much methane is stored there,



"When the methane reaches the upper water column where you have light, an interesting scenario develops, particularly for the Arctic, you have a higher biological productivity. In the future, if increases of methane release in a more ice-free Arctic Ocean occur, one could hypothesize that there will be an increase in biological productivity and thus, ocean life…"

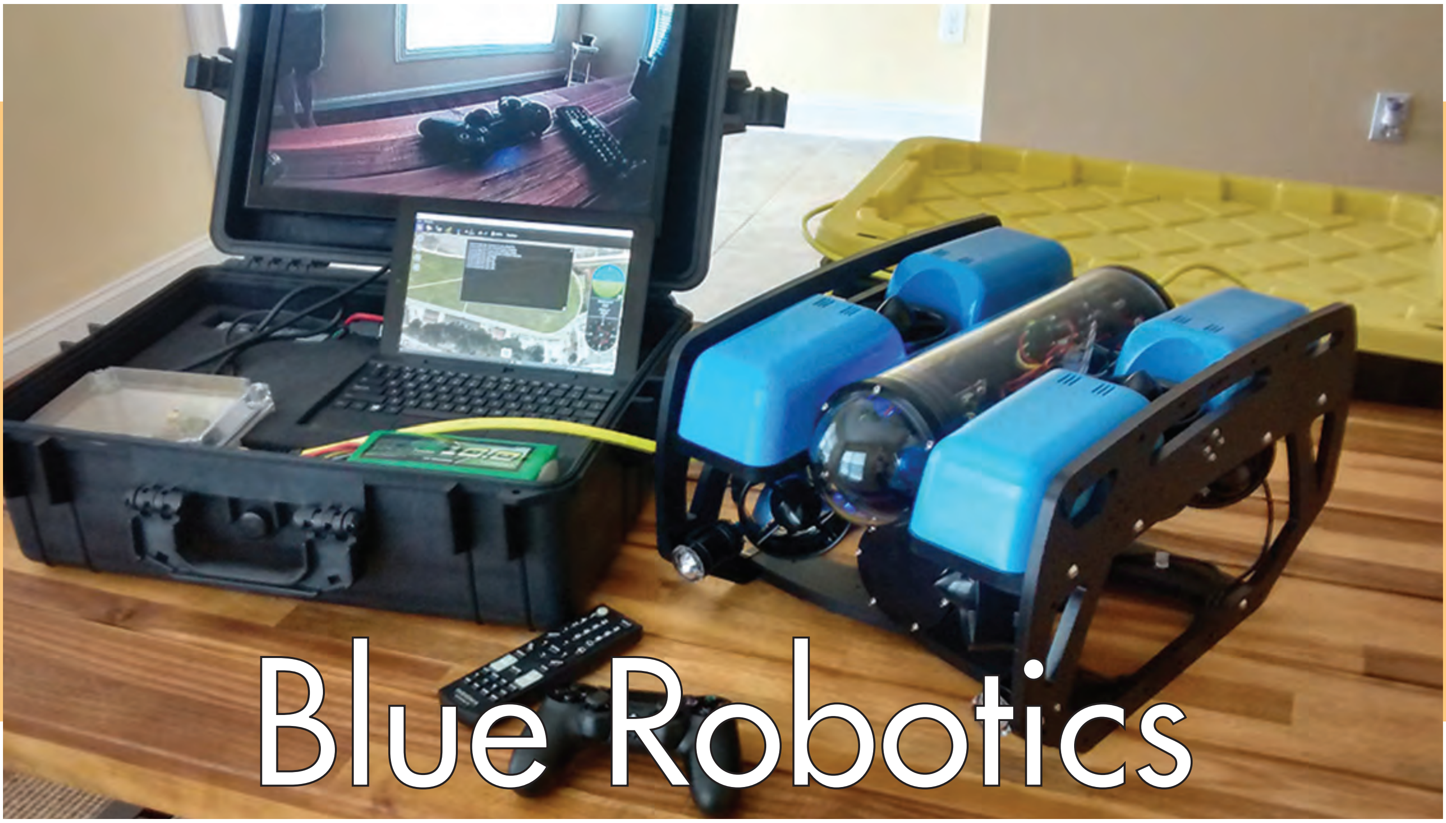
Illustration: Torger Grytå/CAGE

what type of sediment exists; how it will impact the environment and global climate; whether the technology is ready to drill the gas hydrate fields, and if not ready, what is needed to extract the gas hydrates in the future."

Currently, the Arctic region produces about one-tenth of the world's oil and a quarter of its natural gas. New estimates suggest that a significant fraction of the world's petroleum reserves still lie undiscovered within the Arctic.

"The most exciting places for those in the industry are conventional hydrocarbon fields, where you have oil and gas directly beneath a gas hydrate field as it will allow you to extract gas from two reservoirs. But there are some challenges both in terms of technology and environmental impact, that need to be better understood. In the long term, we hope to get a team of international geoscientific experts with an Integrated Ocean Discovery Program (IODP) to the Arctic. The hope is to use the Japanese ship Chikyu, which recently drilled gas hydrates offshore Japan and India. They carried out the largest expedition for drilling and mapping of gas hydrates ever, with great success."

"In the future we will use more observational data and modeling scenarios to identify target areas and increase success. We have more observations now in the Arctic than ever before, so the integration of observations and modeling is the key to identifying the areas in the Arctic that are of highest interest for environmental and climate research," concludes Mienert.



Blue Robotics BlueROV2

By Paul Unterweiser

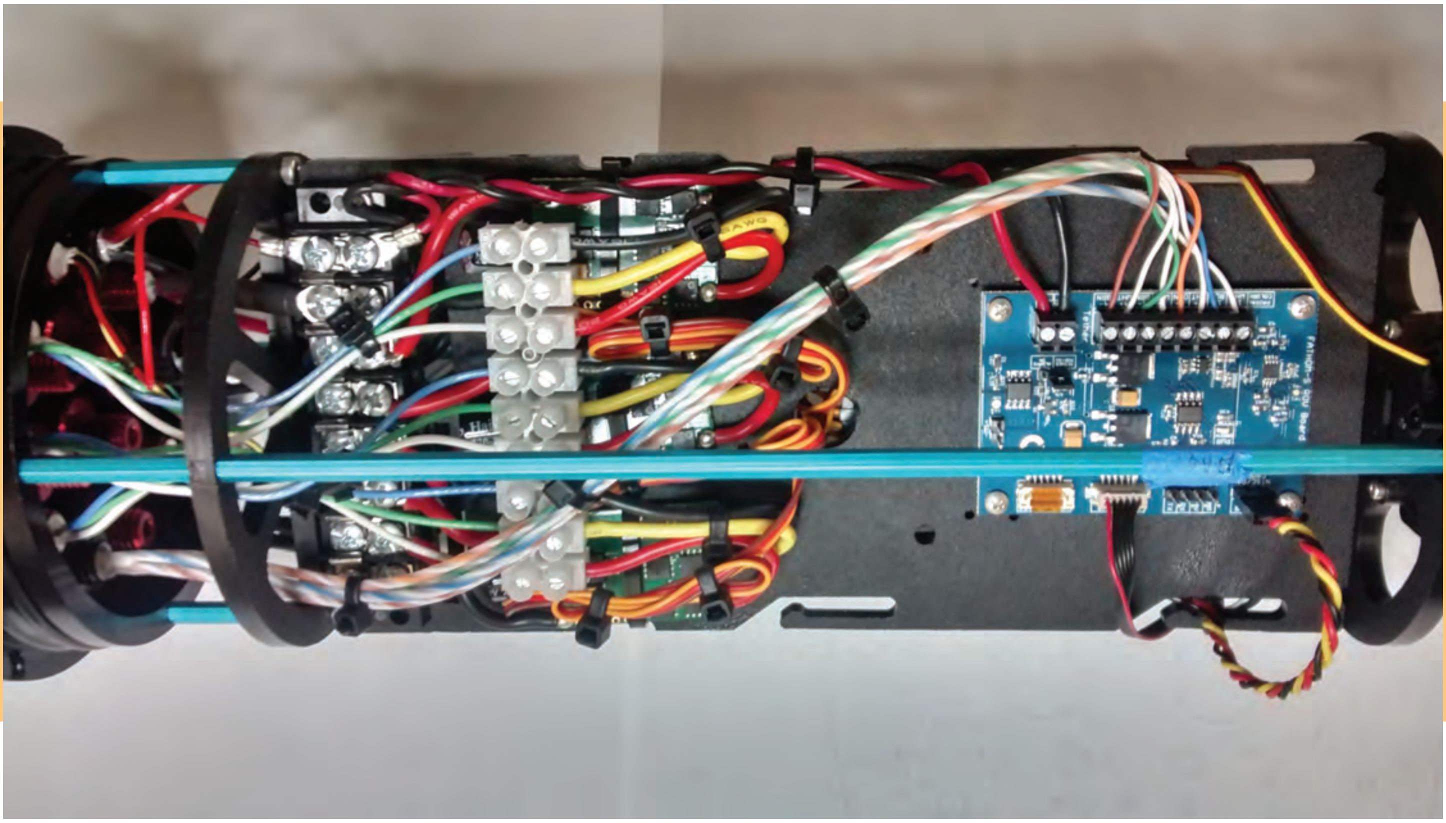
The popularity and availability of aerial quad-copter drones have grown exponentially over the past few years. But, in large part because of the complexities that water penetration poses for electronics, underwater remotely operated vehicles (ROVs) have not experienced that same level of popularity. The technology required to fabricate the components for an ROV to explore beyond a few meters depth has been beyond the capabilities of all but a handful of companies who have mastered the skills. In many cases, those skills have been kept proprietary and the products have demanded high prices. Not long ago you needed well over $10,000 to consider buying even the smallest observation ROV. As mini ROVs have grown in capabilities, so have the prices to the point where a fully-capable mini ROV now costs in excess of $40,000. All that may soon change thanks to companies like Blue Robotics and its newly released BlueROV2.

At first glance, the BlueROV2 is a vectored six thruster ROV, capable of depths of 100 meters in a kit form. But because every bit of the design, from the housings to thrusters to the firmware that controls it, is open to the public, the future and upgrade-ability of the design is virtually unlimited. This not only means that people with technical skills will be able to adapt the BlueROV2 to perform whatever new tasks they might be clever enough to design, but it also means that even the average user is free to source parts and enhancements (such as sonars) from whomever they want. This is an entirely new and potentially powerful approach to ROV design and marketing.

What comes with the kit

The kit includes all the thrusters, electronics, housings, frame, flotation, nuts and bolts that you will need to fully assemble a complete ROV. It also includes a tether (of your

**All images courtesy of Paul Unterweiser*



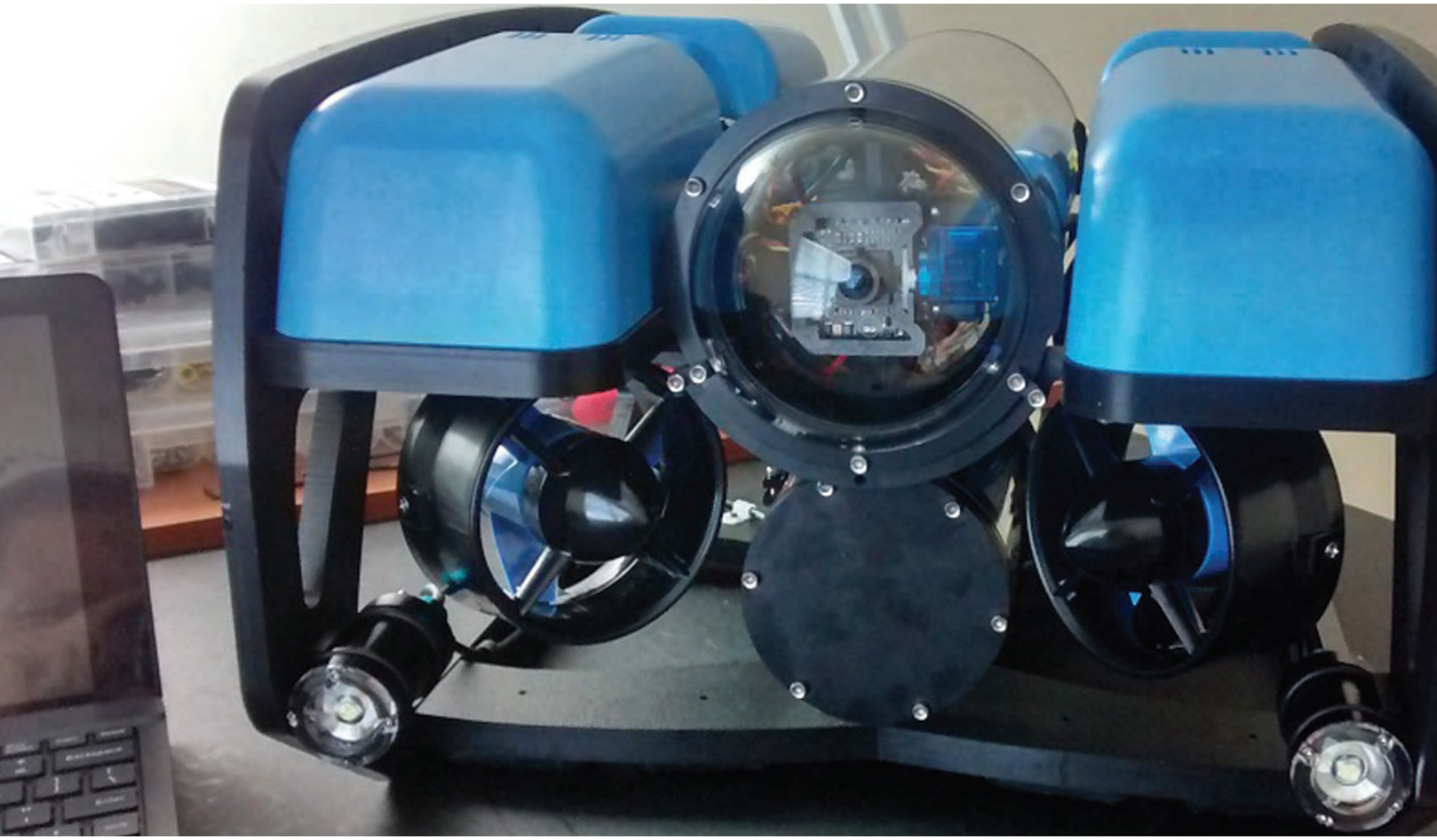
choice of length) and a topside electronics board. What it does not include are a few basic tools you will need (such as screwdrivers and wire snips), batteries (14.8 VDC LiPo batteries are recommended), a laptop/ tablet to control the ROV, or a monitor to display the video. These are left to the builder to buy and assemble as they wish. Some steps of the construction, such as the waterproof housing penetrators, have already been potted to the cables, while other steps, such assembling the frame and connecting the wires to the various electronics, have been left for the builder to complete.

BlueROV2 kit components

Besides Blue Robotics' novel approach to delivering this new product, some of the components which make up the kit are themselves equally novel. The motors in the thrusters, for example, are not sealed from water intrusion but instead are open so water can pass freely. The thruster's construction is mostly from plastics and other inert materials, and what components that are not inert are potted. Surprisingly, even though these thrusters are constantly exposed to salt and debris, long term testing has proven them to be pretty reliable. And considering the cost savings these thrusters afford, it would appear to be a viable approach.

Kit options

Besides various tether length options, you can also choose between the "stan-

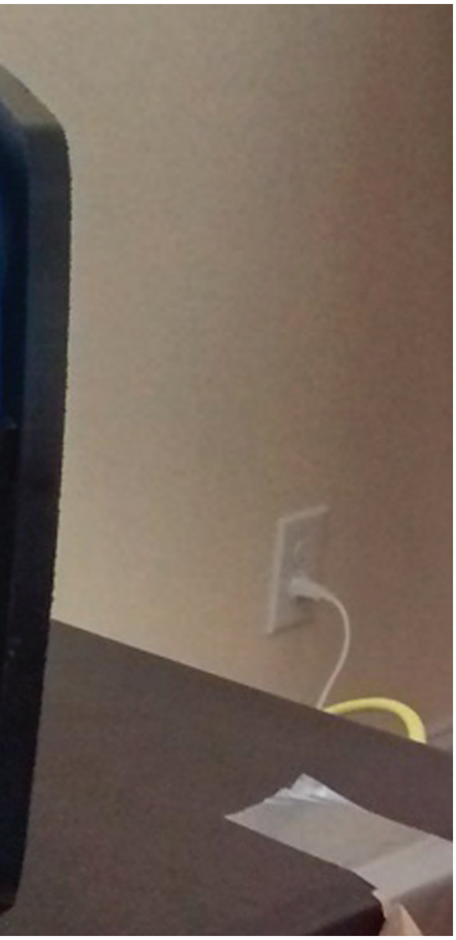


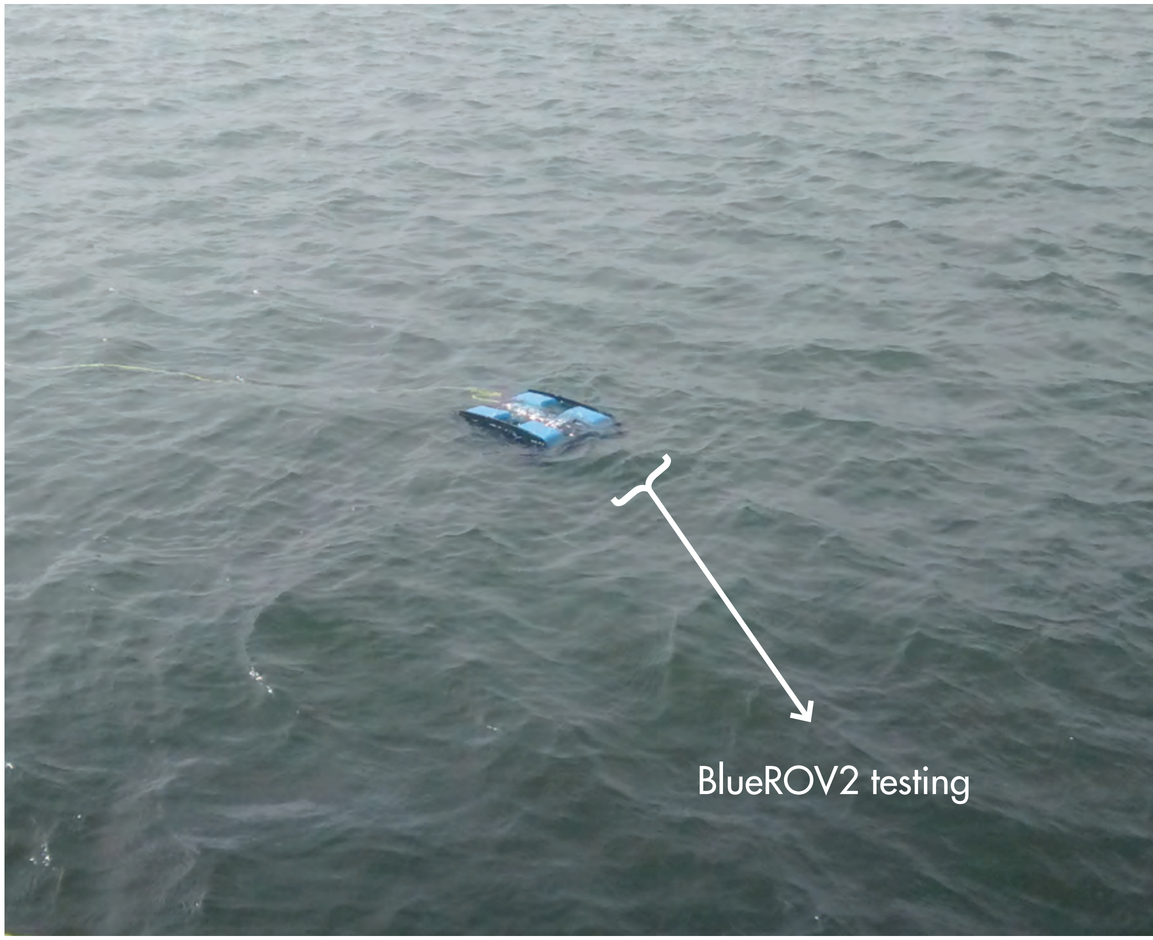
dard" and "advanced" electronics packages. The standard package uses RS-422 serial communications for control and composite (NTSC / PAL) video. The advanced package uses a tiny, on-board computer (Raspberry Pi), and other electronics to send both HD video and ROV control via Ethernet and a single twisted pair. The standard electronics is similar to how most commercial ROVs are configured. The advanced electronics is something new, offering some exciting new capabilities along with a few additional risks. For this evaluation I built two kits, one with standard electronics and one with the advanced electronics.

Building the kits

The first kit I built was a "beta" version of the "Standard Electronics" kit and so my build was only slightly more complex than what a customer who receives a kit can expect. Assembling the kit primarily involved:

1. ***Wiring the ROV side electronics*** - This step involved mounting two electronics boards to the panel and then connecting them, via screw terminal strips, to the electronic speed controllers (ESC) and thrusters; and then connecting the tether leads to the electronics in the same manner. If you have absolutely no electronics or small tool experience at all, this might take you a bit longer, but it took me about an hour altogether. Most of that time was deciding how to best route the wires so everything would appear neat and easy to repair in the future.
2. ***Assembling the frame -*** This was one of the easiest parts of the build. The frame is made of HDPE, anodized aluminum and connected with stainless screws. This took less than 30 minutes to complete.
3. ***Change props and mount the thrusters -*** This was as easy as step 2. The only bit that was more time consuming was swapping the right-hand props in three thrusters to left-hand props. The thruster needs to be disassembled in order to do this, which is not an ideal situation, but performing this task offers two advantages: first, you end up with enough spare props so you have replacement for all six of them, and second, you are taught how to dis- and reassemble the thrusters, a skill worth having with any ROV.
4. ***Mount the housings and route the external wires -*** This next to last step was very straightforward and did not take long at all to accomplish. The most difficult part (until Blue Robotics sent me a photo for guidance)





was deciding how to route the external wires. With a few photos for guidance (which are now included in the kit's instructions) I finished the ROV end of the build.

5. ***Design and assemble a topside control box -*** This last step is likely the most challenging part of building the kit, and your options range from simply mounting the topside electronics in a plastic box (which is what I did) to mounting it along with monitor, tablet and other electronics in a proper, waterproof pelican style case (what I plan on doing in the future). In my case, I spent roughly $400 on all the parts and batteries I needed to finish the build to the state seen in the photos.

I built the second kit (with the "Advanced Electronics") several months after the first. In that time I picked up several kit building tips from other builders and came up with a few of my own. Because this electronics package includes an additional component (the Raspberry Pi computer) building it was a little bit more involved and routing the wires neatly was a bit more challenging than the first kit. As for the software side, I ran into a few minor glitches but thanks to some help on Blue Robotics' support forums I was able to get things up and running relatively quickly.

Building a topside box

One of the bigger challenges to assembling this kit is designing a box to house the topside electronics. This is one area where it is completely up to you as to how complex or how simple you want to be. I wanted to use "off the shelf" components as much as possible and decided to use a simple, waterproof plastic (NEMA) electronics box and splash resistant bulkhead connectors. While I was at it, I also installed a USB to RS485 converter in the box for use with a sonar I will be installing later.

Bench testing

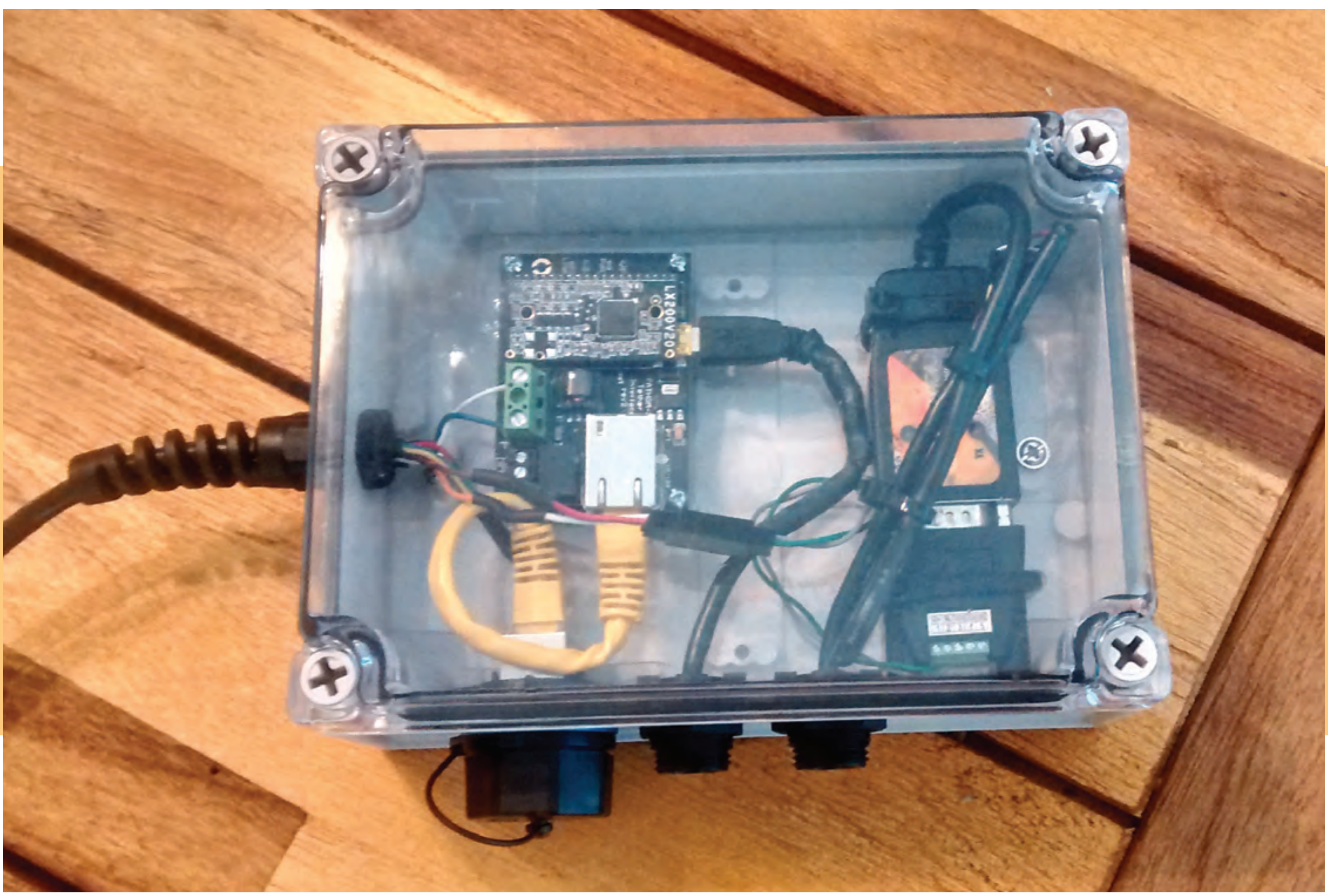
After assembling the ROV and building a simple topside control unit it was time to install the software and give everything a test. The software that the BlueROV2 uses topside, "QGround Control" is an adaptation of aerial drone software. Likewise, the ROV end hardware it uses is also an adaptation called "ArduSub". Although initially designed for flying craft, I later learned Blue Robotics modified version worked pretty well, plus because most of the software's momentum is driven by the aerial drone community, it is constantly being improved. Another benefit of open source software is that I can use it with a wide variety of hardware platforms. The topside controller, for example, can be a Windows, Mac, Linux or even Android computer/tablet. I used a Windows tablet topside and updated the ArduSub firmware via a USB cable connected to the control electronics in the ROV. A few minutes following the instructions and the electronics were ready to operate. I closed up the housing, attached a battery and fired up the ROV and topside controls. Almost immediately, the ROV signaled a few chirps and beeps, telling me it had initialized and was ready to run.

When the ROV is first powered up, the compass sensor and topside joysticks needed to be configured. Following the instructions was relatively straightforward. The next step, taken straight from the aerial drone world, was to "arm" the ROV by sliding an icon on the tablet's screen. By arming the ROV, it was now ready to operate and the thrusters would respond to joystick commands. I tested the thrusters, lights and camera tilt, and all worked as expected. I picked up the ROV and turned it left and right, then tilted it in various directions while watching the attitude and compass displays on the topside tablet computer. Everything seemed to work.

Before taking the ROV in the field, I also wanted to give it a test in freshwater. So I gave the water-tight housings a vacuum test, just to make sure they were sealed properly, then put the ROV in a water filled tub. Although the ROV appeared to be functioning correctly on the bench, it was not until I put it in the water that I learned that there were a few settings in the software that I had missed during set up. Some helpful guidance from Blue Robotics and I resolved the issues in short order. I repeated these tests several times until I felt confident that the housings were sealed and I had configured the software properly.

In the field testing

The conditions here in coastal North Carolina can be challenging for operating a ROV. Visibility is typically poor, the area has an abundance of snags and obstacles, and is notorious for strong currents. Not the worst conditions a ROV pilot will experience, but certainly not the best either. The day of the test was typical for here, 12 to 15 knots of side shore wind and about 1 knot of current from an outgoing tide.



PROS

- Unrivaled value
- Very good durability
- Good ease of use
- Excellent expand-ability
- Good serviceability
- Excellent thruster power
- Includes features typically found in higher end ROVs, such as vectored thrust and “fly by wire” mode
- Streaming HD video (with the “Advanced Electronics Package”)

CONS

- It comes in kit form and requires assembly
- The topside controls are up to the builder to design and fabricate
- Some service procedures (such as replacing a prop) are more involved to complete than I would like
- Runs on batteries, so time on station is not unlimited
- Slight (200-250 ms) lag in HD video stream (with the “Advanced Electronics Package”)

With an assistant to manage the tether, I powered up the ROV and topside controller, checked that everything was sealed properly, then put the ROV in the water. I could immediately see that the BlueROV2 was considerably more buoyant than I would prefer. Although the kit comes with enough additional weight to make it neutrally buoyant, we decided to continue with the test as is. I gave the joysticks some quick commands, the thrusters shot water in the expected directions and the ROV lunged as directed. This ROV has power! I flew the BlueROV2 on the surface with full power, dove to the bottom, watched the instrument displays, flew it sideways against the current and familiarized myself with the controls. At full power the ROV had no problem overcoming the current and responding to my directions. Once back on track, I reduced the thruster gain to 25% and repeated the exercise. Although it was not able to speed against the current, it had no trouble maintaining station.

I should note that the BlueROV2 I was testing was running on a version of software that used “fly by wire” (what Blue Robotics calls “Stabilized mode”) by default. Although newer versions of the software includes other flight “modes”, I only tested fly by wire.

I continued to test the BlueROV2 at depths of zero to 5 meters and was thoroughly impressed with its performance. The ROV had more power than I was expecting, the fly-by-wire mode worked very well, the heading, attitude and depth sensors all worked as expected and overall the test was completely successful. What few issues I did run into were related to how I had configured my topside equipment. For example, I neglected to set the Windows tablet’s power mode to “always on” so it would go to sleep after 10 minutes of inactivity and disconnect from the ROV. Although a bit of a nuisance, it was no fault of the BlueROV2 and minor issues such as these are to be expected as part of the learning curve when testing a newly completed kit.

Conclusions

Looking back at my experiences with the BlueROV2 I have to say it is an amazing piece of equipment. For under $4,000 you have nearly everything needed to assemble a very worthy ROV capable of a wide range of observation class tasks, from water tank to ship hull to fish farm inspections. The BlueROV2 can do it. This is no toy, the components are very well made and the ROV’s capabilities rival more well-known products which cost many times more. It is a kit and some skills are required to complete it. But if you are able to use a few simple hand tools, follow written instructions and install and configure computer software, you have all the skills required to build this kit. I would say the greatest challenges for the builder are the topside controller and dealing with the software/firmware, but even these tasks are not very difficult. And building the kit yields an additional benefit, that when it comes time to repair or maintain the ROV, you will already have all the skills and experience necessary to perform the tasks. I cannot think of a better way for students and budding ROV pilots to become familiar with the technology.

About Blue Robotics

Motivated by a desire to build a better underwater thruster and armed with a degree in engineering, Rustom “Rusty” Jehangir came up with a novel design that turned into a very successful Kickstarter campaign. Now, just two years later, Blue Robotics has grown to a staff of nearly a dozen engineers and technicians working full time designing fresh new approaches to the challenges of ocean exploration.

http://www.bluerobotics.com

The Author

Paul Unterweiser is a retired U.S. Navy officer, USCG licensed master, ROV pilot and, for the last 10 years, president of Marine Simulation, a software company located in North Carolina specializing in developing training simulators for ROV pilot schools and other marine industry applications.

http://www.marinesimulation.com

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Oceanology International North America

OI 2017 set to cover the full extent of marine science and ocean technology

The first edition of Oceanology International North America (OINA), established from the well-known OI event in London, will make an impact within the ocean science and technology industries in San Diego, Calif. in February 2017.

OINA is set to capture the full extent of the marine and ocean technology industries in North America. The event is the newest addition to the Oceanology International portfolio, with the flagship Oceanology International event in London now in its 47th year, and OI China now in its fifth year. Oceanology International North America has already attracted a number of well-known speakers and exhibitors from industry, academia and government, including James Birch, Director-SURF Center, Monterey Bay Aquarium Research Institute (MBARI); Jules Jaffe, Research Oceanographer, Scripps Institute of Oceanography; Igor Prislin, Vice President – Chief Analytics Officer, BMT Scientific Marine Services; Michael Flynn, Chief Technology Officer, Cathx Ocean and Jake Sobin, Manager Sciences (Americas), Kongsberg Underwater Technology.

More than 2,500 visitors and delegates are expected to partake in the three-day event at the San Diego Convention Center from February 14-16, 2017. Visitors to the event will have access to a myriad of marine and ocean science technology organizations from an array of sectors, including academia, fisheries and aquaculture, government, marine environmental protection, marine renewables, marine science, ocean mining, offshore construction, offshore oil and gas, ports, harbors and terminals, ships and shipping and telecoms.

With the attendance of so many industry experts, OINA provides the opportunity to network, make new contacts, share knowledge and conduct business all under one roof.

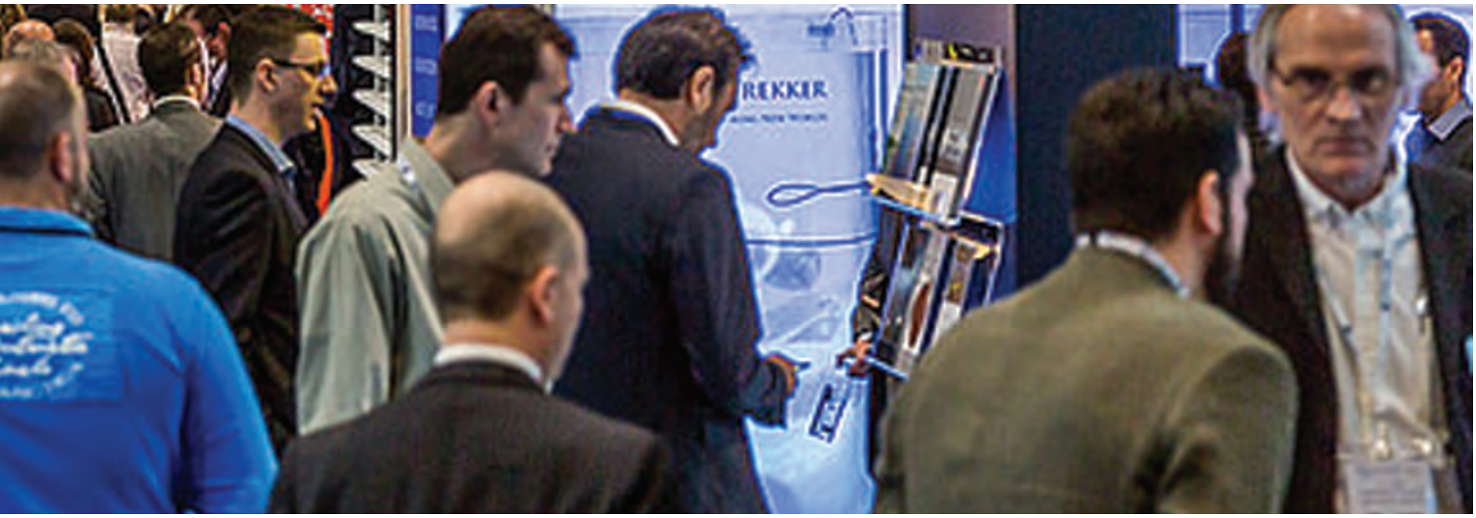
The North American exhibition is organized by Reed Exhibitions in partnership with The Maritime Alliance (TMA). OINA is also supported by a range of leading industry associations including The Society for Underwater Technology (SUT), National Oceanic and Atmospheric Administration (NOAA), The Institute of Marine Engineering, Science and Technology (IMarEST), National Ocean Industries Association (NOIA) and Integrated Ocean Observing System (IOOS).

Event Director, Jonathan Heastie of Reed Exhibitions, said, "Oceanology International is committed to providing what the industry wants, which is why we are launching the event in the world's largest marine technology market, North America. OINA will bring together all elements and communities within the North American ocean science and marine technology market. This includes ensuring we bring together multiple buyers from differing industries, all united by the use of technology, but in a myriad of different ways."

In addition to the OINA exhibition, the conference program will provide a better understanding of present and future technological requirements and opportunities of the Blue Economy over multiple conference sessions including; keynote panels, technical tracks, breakout panel sessions and the Catch The Next Wave conference. The conference programs will focus on key issues for North America and globally, establishing OINA as a must-attend forum for thousands of industry, academia and government professionals interested in sharing knowledge to improve their strategies for measuring, advancing, protecting and operating in the world's oceans.

Conference committee member, Justin Manley, Founder of Just Innovation, explained, "OINA is designed to cut across several maritime disciplines. While it will include traditional content similar to prior OI events, its new location and organizing team will bring views from a very broad ocean science and technology community. This distinctive and global perspective will be a special offering in North America."

The multi-track conference will showcase keynote sessions, taking place February 14-15, 2017. These will explore the requirements for ocean science and technology in support of delivering a sustainable Blue Economy. Leaders from science, industry and government will define the characteristics that allow the ocean activities for the protection of the marine envi-



Scenes from OI 2016 in London.

ronment. The sessions will highlight the exploration of ocean resources, transportation and security and climate and environment. Ellen Burgess of Reed Exhibitions said, "The keynote focused panel discussions at OINA will be an insight into the emerging topics for ocean science and technology and how this is delivering an environmentally sound blue economy."

The keynote sessions and other conference program have all been established by a highly experienced conference committee, consisting of 12 industry and academic experts, dedicated to supporting the industry. Ralph Rayner, chair of the OINA17 conference committee, is a U.S. IOOS Industry Liaison at NOAA and Co-Chair of the Partnership for Observation of the Global Oceans Industry Liaison Council.

"Oceanology International is unique in its focus on demonstrating the benefits of ocean science and technology to the many users of the ocean," Rayner said. "I am particularly looking forward to the keynote panel sessions as these will set the scene for future ocean science and technology needs associated with working in, on and under the oceans to deliver economic benefits and protect the ocean environment."

In addition, a series of topical technical tracks will run across the three days exploring the current developments in ocean science and technology. These will assess the emerging markets and geographical opportunities, and feature technology advancements, case studies and best practice, presented by industry and marine science experts.

Key technical topics include 'Big Data, Visualization and Modeling' which will cover subjects such as offshore operations, accuracy of weather forecasting, transforming ocean data into accessible information and analysis tools and approaches.

The 'Sensors and Instrumentation' session will include approaches to marine sensor technology, principally chemical and biological and pilot/demonstration level talks that illustrate the size-limitation and operational independence challenges of deploying new sensors on autonomous platforms.

Other technical tracks will cover 'Unmanned Vehicles and Vessels' which will involve the broad outlook of the UUV and USV markets and emerging technology, 'Hydrography, Geophysics and Geotechnics' discussing the supporting new solutions, sensors, integration and automation.

The final day of the program will look to the future with the Catch the Next Wave (CTNW), which is organized in association with Scripps Institution of Oceanography. CTNW will take a long-term view of the science and technology that will shape future development and protection of the oceans and what the marine industry can learn from disruptive technologies emerging across other industry sectors.

Committee member Leo Roodhart said, "I am very much looking forward to a new 'Catch the Next Wave' session at OI North America. The two previous editions in London were spectacularly good in discussing future technology and innovation pathways towards possible oceanological breakthroughs. This time the theme of the session is to honor the work of the famous oceanographer Walter Munk which may provide completely new insights into future directions of ocean science."

The CTNW will also credit the achievements of Scripps oceanographer Walter Munk as he approaches his 100th birthday. The focus will be on the many aspects of ocean science that Munk has worked on in his long and distinguished career are heading, and how technological innovations might contribute to progress.

In line with the established OI London event, the North America conference will be supported by an extensive industry exhibition. Booths from some of the biggest names in ocean science and marine technology from the U.S. and across the world will present a glimpse into the next generation of products and solutions designed to support both research and industry.

Other features at to the conference will include the Investment, Trade and Innovation Theater and a number of "Ocean Social" networking events. During OINA there will also be opportunities dedicated to meeting education and career needs of the Blue Economy.

The three-day program takes place at the San Diego Convention Center from February 14-16, 2017. Visit the OINA website for more information or to register.

Anderson

(Photo: EdgeTech)

Arnold

(Photo: M^2 Subsea)

ASME

(Photo: MacArtney)

Simon Gillet & Stewart Graves

(Photo: Mainstay Marine Solutions)

Anderson Joins EdgeTech

Erik Anderson joined EdgeTech as hydrographic product engineer based in the company's Boca Raton, Fla. office. Previously with NOAA's Office of Coast Survey, he has a Bachelor of Science in Ocean Engineering from Florida Atlantic University, Master of Science in Hydrography and Category "A" International Hydrographic Certification.

New ROV Market Player: M^2 Subsea

A recently formed subsea services business based in Aberdeen and Houston has secured a private equity investment to acquire a fleet of 32 remotely operated vehicles (ROVs). The recently-established M^2 Subsea Limited is now set to become one of the largest independent providers of ROV services globally and offer its customers solutions for inspection, repair, maintenance, decommissioning and light construction.

Heading up the business is president and CEO **Mike Arnold**, who brings 35 years' experience in the subsea industry as original founder of Rovtech as well as Hallin Marine UK and Bibby Offshore's ROV services unit. He is joined by a management team of other subsea veterans including operations directo Mark Wood and business development director Mike Winstanley.

Bayliff New Aqua Comms CEO

Aqua Comms DAC, the operator of Ireland's first dedicated subsea fiber-optic network interconnecting New York, Dublin and London, has appointed Nigel Bayliff as its new CEO.

Smith Joins WHG

Rob Smith joined Woods Hole Group as business development manager/senior oceanographer based in the group's Texas office.

MacArtney Acquires ASME

MacArtney Underwater Technology Group has acquired the majority holding in Denmark based ASME A/S, a designer and manufacturer of complete systems to the marine offshore, ocean science and renewable energy markets. ASME specializes in PLC and PC based active heave compensated solutions, launch and recovery systems, automated electric and hydraulic turntables and tensioners, electronic control systems and many more specialized systems. The company's ASME Hydra A/S subsidiary designs and manufactures hydraulic cylinders. More than 125 employees work in ASME's manufacturing and office facilities. The company's founder, Arne Schmidt, will resign by the end of 2016.

New Wave Energy Converter Under Development

Pembroke Dock-based Mainstay Marine Solutions won a contract to build a new energy device for $7.4 million. The firm will complete the first major stage of an innovative wave energy converter development project on behalf of client Wave-Tricity, who was recently granted a $5.1 million investment from the European Regional Development Fund via the Welsh Government. It will develop and test a new device called the Ocean Wave Rower, which will convert the natural motion of the waves into clean energy. The device will be deployed in the Pembrokeshire Demonstration Zones, a wave energy site off the Pembrokeshire coastline, for two years. T

MetOcean, JouBeh Merge to Form metOcean telematics

MetOcean Data Systems has merged with JouBeh Technologies, resulting in the formation of new company metOcean telematics, effective January 1, 2017. The company's corporate headquarters, including the research and development and production facility will be located in Dartmouth, Nova Scotia, Canada. MetOcean Data Systems is a developer and manufacturer of data acquisition and telemetry systems, and

metOcean™ telematics

JouBeh is a Iridium satellite reseller. metOcean telematics will provide end-to-end telematics services, with a focus on niche MetOcean solutions and custom defense and security products.

Hydroid Opens New HQ

Hydroid Inc., a subsidiary of Kongsberg Maritime and manufacturer of marine robotics, has opened a new headquarters building in Pocasset, Mass. to house its corporate and administrative offices. The new facility, Hydroid's third major building opening in two years, is on the same campus as the company's existing manufacturing and research facility.

Engineering Rep Named for Icebreaker Wind Project

The Lake Erie Energy Development Corporation (LEEDCo) in Cleveland, Ohio has appointed engineering and operations support services contractor Offshore Design Engineering Limited (ODE) as the engineering representative for Icebreaker Wind, a 20.7 megawatt offshore wind project in Lake Erie, and the first freshwater offshore wind project in North America. Icebreaker Wind will provide the electricity needs for 7,000 homes. It is the first freshwater project of its kind in North America, the first to withstand significant foundation icing conditions (surface ice and keel ice loads on the structure) and the first to acquire a submerged lands lease option in the Great Lakes.

Kongsberg Opens South African Facility

Kongsberg Maritime has opened a facility in Cape Town, its first location in the Republic of South Africa. The new Kongsberg Maritime South Africa facility combines office and warehouse space in addition to a testing lab, with plans in place to open training facilities that will help local offshore operators to meet local content requirements.

A UK First for Decommissioning Market

A specialist team of companies have come together to deliver a decommissioning program under one collaborative offering. Integrated DECOM will offer independent frontend engineering and environmental solutions providing integrated support for oil and gas operators looking to retire redundant facilities without the burden of an in-house overhead. With over 20 years' knowledge delivering the major UKCS decommissioning projects to date, Costain, Axis Well Technology, BMT Cordah and DNV GL have the capability and capacity to deliver the entire decommissioning work scope up to the approval of the project's decommissioning program, from subsurface to structure, through a single point solution.

New Task Force for California Offshore Renewables

The U.S. Bureau of Ocean Energy Management (BOEM) and the State of California held the inaugural meeting of the California Intergovernmental Renewable Energy Task Force to begin planning for future renewable wind and wave energy development opportunities in federal offshore waters along the Golden State. The team will facilitate coordination and communication between BOEM and state, local and tribal governments and other federal agencies concerning potential renewable energy leasing for research activities and commercial development on federal submerged lands on the Outer Continental Shelf (OCS), offshore California. California is the 14th U.S. coastal state to form a renewable energy task force.

Bourne Tidal Test Site Receives Preliminary Permit from FERC

The Bourne Tidal Test Site is now a bit closer to reality: the Marine Renewable Energy Collaborative (MRECo) received approval from the Federal Energy Regulatory Commission (FERC) for a preliminary permit to set up a test site for tidal energy in the Cape Cod Canal, marking the first step toward gaining the requisite regulatory permits. The Bourne Tidal Test Site is intended to facilitate the growth of a tidal energy.

Hydroid

Image: Hydroid

Icebreaker Wind

(Photo: ODE)

Kongsberg

(Photo: Kongsberg Maritime)

DECOM

(Photo: DECOM)

Kraken

(Photo: Kraken)

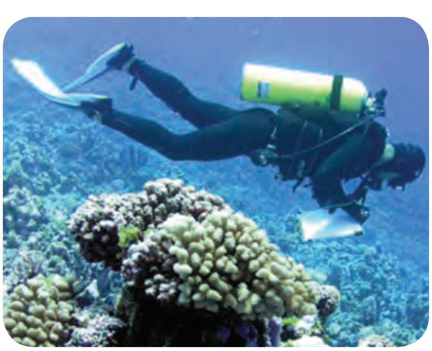
Sea Machines

(Photo: Sea Machines Robotics)

Lambaré (center)

(Photo: SEG)

NOAA



(Photo: NOAA)

Government Backs Kraken

Kraken Sonar Systems Inc., a wholly-owned subsidiary of Kraken Sonar Inc., will receive up to $485,000 from the National Research Council of Canada Industrial Research Assistance Program (NRC-IRAP). In addition to technical and business advisory services provided by NRC-IRAP, the funding will be used to develop Autonomous Launch and Recovery Systems (A-LARS) for unmanned maritime vehicles and expand Kraken's Handling Systems Division.

Sea Machines Gets a Boost

Boston based autonomous control and navigation systems developer Sea Machines Robotics was named a $50,000 GOLD-level Boston winner at the annual MassChallenge Awards. Sea Machines was one of 128 early-stage companies accepted into the 2016 MassChallenge Boston program, from more than 1,700 applicants. Over the past four months, the startup has leveraged the organization's global network of mentors, experts, and corporate and nonprofit partner organizations to launch and grow their business at zero-cost and for zero-equity.

Lambaré Wins SEG Reginald Fessenden Award

Gilles Lambaré, Research Director, EAME, Subsurface Imaging, CGG, has been distinguished with the Society of Exploration Geophysicists' (SEG) Reginald Fessenden Award in recognition of his initiation of the concept of common-angle migration and demonstration of the potential of that approach to seismic imaging. Lambaré was honored jointly with Sheng Xu of Statoil, one of his former PhD students when he was associate professor at the Geophysical Research Center of the Paris School of Mines.

NOAA Awards $9.3 Mln for Coral Reef Conservation

The NOAA Coral Reef Conservation program is awarding more than $9.3 million in grants and cooperative agreements to support conservation projects and studies to benefit coral reef ecosystem management in seven U.S. states and territories, the Caribbean and Micronesia. All projects focus on the three primary threats to coral reefs: global climate change, land-based sources of pollution and unsustainable fishing practices, and highly threatened coral regions and watersheds.

Course for Cable Lay Operators

Makai Ocean Engineering is now offering an advanced cable laying course for operators who have managed real cable installations at-sea using MakaiLay. Participants will learn how to manage real-world scenarios such as handling as-built cable lengths from the factory that are different than the originally planned cable assembly lengths, identifying and managing roto count errors, managing emergency ship stops and cable engine stops and more.

Silicon Sensing Supports Autonomous Ship Project

To mark the 400th anniversary the Mayflower's first sailing to America, a team led by U.S.-owned but Plymouth-based firm MSubs, and including Plymouth University and charitable research foundation ProMare, has initiated a plan to design and build a fully autonomous ship to make the same Atlantic crossing, completely unmanned, in 2020. Silicon Sensing will provide a package of support to help turn the MAS400 concept into reality. Silicon Sensing will supply its latest precision MEMS IMU (Micro Electro-Mechanical Systems - Inertial Measurement Unit), the DMU30, to provide the inertial sensing data within the electronic autopilot to help guide MAS400 during its ocean adventures. MSubs and Silicon Sensing have been collaborating on the evaluation of DMU30 for future INS-based surface and subsea navigation solutions for a variety of projects at MSubs.

ASV: 1,000 Days of USV Ops

ASV Global conducted 1,000 days of unmanned operations, reaching the landmark during Unmanned Warrior 2016. The 1,000 days of unmanned operations only accounts for time that ASV Global has spent operating its own vehicles over the past six years and covers a wide variety of applications, including hydrography, oceanography, subsea positioning, mine countermeasures, ISTAR and naval gunnery training.

Boskalis Wins Work for Hornsea Offshore Wind Farm

Royal Boskalis Westminster N.V. has secured a contract from DONG Energy Wind Power A/S for the transport and installation of the foundations for a part of the Hornsea Offshore Wind Farm Project One. The transport and installation of the foundations will be executed by Boskalis' new offshore transport and installation crane vessel for which an existing F-class heavy transport vessel is currently being converted. The vessel will be equipped with a 3,000-ton mast crane, dynamic positioning (DP2) and additional accommodation for up to 150 people.

U.S. Shore Landing for Monet Submarine Cable

TE SubCom has completed the U.S. shore landing for the Monet Submarine Cable, a 10,556km cable that will connect Boca Raton, Fla. to Fortaleza and Praia Grande, Brazil, where shore landings were completed earlier this year. Monet is owned by Google, Algar Telecom, Angola Cables and ANTEL. The 100G-capable cable system will provide a low latency route from Brazil to North America with a minimum bandwidth of 60 Tbps.

Hawaiki Cable on Schedule for Mid-2018 Completion

Hawaiki Submarine Cable LP and TE SubCom announced that system manufacturing has commenced for the 14,000 km Hawaiki transpacific cable system scheduled for completion in mid-2018. Hawaiki will link Australia and New Zealand to the mainland United States, as well as Hawaii, with options to expand to several South Pacific islands. Co-developed by New Zealand-based entrepreneurs Sir Eion Edgar, Malcolm Dick and Remi Galasso, the carrier-neutral cable system will be the highest cross-sectional capacity link between the U.S. and Australia and New Zealand.

N-Sea Charters Siem Barracuda

Subsea IMR provider N-Sea has increased its fleet through the long term charter of Siem Offshore's offshore subsea construction vessel, the Siem Barracuda. The vessel is equipped specifically for subsea IMR, Survey and construction operations, featuring twin WROVs, moonpool deployed, a 250T AHC crane and accommodation for 110 personnel.

MacArtney Supplies EMO Mux Systems to Unique System

The newly established MacArtney Canada office has delivered two EMO DOMINO-7 Mk-2 fiber optic multiplexer systems designed to offer up to 2,000 watts of DC power distribution for Unique System LLC (USA), a Unique Maritime Group company and integrator of turnkey subsea and offshore solution providers based in New Iberia, La. and Houston.

Keel Laid for New UK Polar Research Ship

Sir David Attenborough joined more than 1,000 people for the keel laying of the new $189 million polar research vessel. Construction was officially started by the world-renowned naturalist and broadcaster, after whom the ship is named, at the ceremonial event at U.K. shipbuilder Cammell Laird's Birkenhead site in Liverpool City Region. The ship is scheduled to set sail in 2019. Universities and Science Minister Jo Johnson said, "The RRS Sir David Attenborough, with Boaty McBoatface operated from her as a robotic underwater vehicle, will be one of the most advanced research ships in the world. It will help inspire the next generation of scientists in the U.K. and build on our status as one of the world's leading nations in polar science, engineering and technology."

(Photo: Cammell Laird)

Sir David Attenborough and John Syvret

Images & Information from Oceans 2016

Deep Ocean Engineering’s Phantom T5 Defender ROV was on display.

A flurry of robots, including Ocean Lab’s Data Diver swarm AUVS.

GSOS – Japan pavilion.

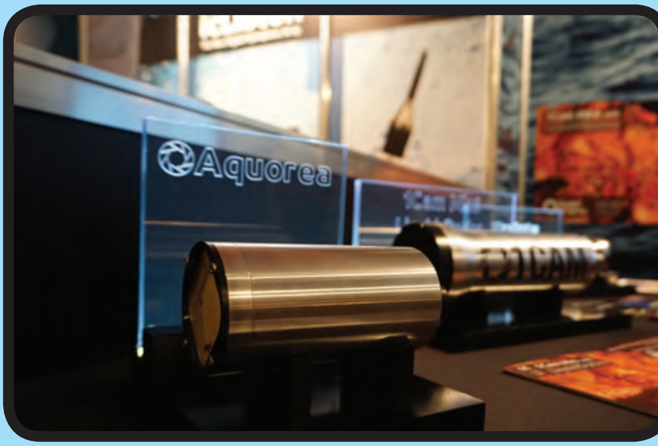
Teledyne Marine’s Echotrac II.

OceanGate Clyclops 1.

The wind and solar powered Saildrone autonomous surface vehicles are built in Alameda, CA.

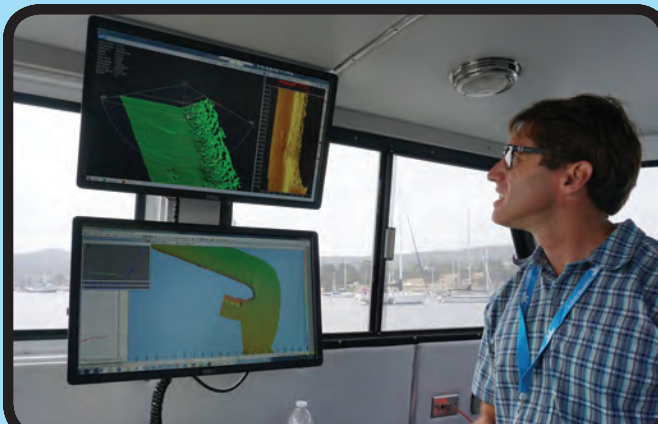
The Oceans 2016 conference and exhibition, co-sponsored by the Marine Technology Society and the IEEE Oceanic Engineering Society, was held September 19-23, 2016 in Monterey, Calif. The event drew more than 100 exhibitors showcasing some of the latest products, services and technological advancements. (All Photos: Eric Haun)

Lars Hansen, President of MacArtney Inc., celebrated his birthday at Oceans.



SubC Imaging had several products on display, including its Aquorea LED (L) and 1Cam Mk6 (R).

DeepSea Power & Light's new LED SeaLite.



Patrick Nissen, Sr. Hydrographic Surveyor, Teledyne Reson, during live, on-water demos.

Thomas J. Knox, General Manager, MacArntey Canada Ltd.

Seafloor Systems' Josh Grava, vice president sales; Cody Carlson, hydrographer; and John Tamplin, president; with the EchoBoat ASV.

New Low-light Camera

DeepSea Power & Light expanded its camera offerings to include the Low-Light SeaCam (LLSC). With a minimum faceplate illumination of 4.5 x 10-4 lux, the LLSC provides performance competitive with SIT technology for a fraction of the price. The compact form factor measures 124mm long and 56 mm in diameter. The standard titanium housing is rated to 6,000 meters with a glass dome port that enables an 85° horizontal field of view.

www.deepsea.com

Image: DeepSea Power & Light

Image: Outland Technology

UWL-810

Outland Technology's new underwater LED laser, model UWL-810, gives the operator the opportunity to scale its subject on a 2D screen using underwater video for uses ranging from ROVs, dive cameras, fixed installations and more. The UWL-810 runs on any power source from 5-30 Volts, AC or DC. It features a 50,000 hour life and an LED spread of 100MM. Just 1-in. diameter x 6.8-in. long, it has a depth rating of 800 meters with an optional 2000 meters available. Materials include anodized aluminum and acrylic.

www.outlandtech.com

Underwater Video Camera

A new lightweight underwater color video camera from Danish manufacturer LH Camera offers fisheye optics, four-pin Subconn micro connector, high sensitivity and extreme wide-angle lens (0.1 lux, 92 degrees) for use by professional divers, offshore divers and underwater surveyors, often with ROV equipment. It is pressure tight up to 100 meters.

www.lh-camera.dk

Image: LH Camera

Image: ROS

ROS Positioner Technology

Remote Ocean Systems (ROS) developed a new lightweight pan and tilt positioner that can be computer controlled and programmed. The new P15 positioner includes a heavy-duty connector that enables RS485 communication protocol for precise positioning and allows for field firmware upgrades. The P15 is a smaller, lightweight rugged design that is ideal for small ROV's and bridge and dam inspections. It can handle payloads to 15 lbs. with an accuracy level of 0.1-in. +/- 0.1-in. The P15 is available air filled (70 meters) or oil filled for depths to 6,000 meters.

www.rosys.com

New L3C-HD and L3C-HDX Cameras

Teledyne Bowtech introduced the updated L3C-HD and the new L3C-HDX underwater cameras to add to its diverse range of high definition and compact tooling cameras.

The updated release of the L3C-HD camera now features full HD 1080p up to 60fps to add the full list of HD-SDI outputs available (720p 50, 720p 60, 1080i 50, 1080i 60 and 1080p 50). The camera also features simultaneous SD and HD-SDI output capability and is fitted with a fixed focus wide angle lens that provides a 67° diagonal angle of view in water. It is housed in 1000m, 4000m or 6000m depth rated Titanium, and is capped by a highly scratch resistant and 99.8% optically pure Sapphire window. Additionally, the new L3C-HD camera is approximately 40% smaller and lighter than its predecessor. The key feature of the new L3C-HDX camera is that the digital signal from the camera is a visually lossless compressed signal that will travel up to 250m on a Teledyne Bowtech coax. This visually lossless compression adds zero latency to the signal and the video is viewed on an HD-SDI capable monitor after going through a small converter box. Built with the same depth rating options, inside the same Titanium housing and behind the same Sapphire window as the L3C-HD, the L3C-HDX only enhances the capabilities of Teledyne Bowtech's underwater camera products.

Both the L3C-HD and the L3C-HDX cameras are designed to be lightweight and compact, and are ideally suited to tooling, diving and ROV/AUV operations.

Teledyne Bowtech has been designing, manufacturing and supplying harsh environment vision systems to the subsea ROV, AUV, defense, nuclear, and leisure and marine science markets for more than 25 years. The range of underwater cameras includes Compact Tooling and Diving Cameras, High Definition Cameras, Standard Zoom Cameras and Low-Light Cameras, all with specialist features and benefits suitable for a wide range of applications.

In addition to underwater cameras, Teledyne Bowtech's harsh environment vision systems include LED lights, Video Inspection Systems, Xenon Underwater Strobes, Pan and Tilts, custom-molded cable assemblies, underwater electrical connectors, fiber-optic multiplexers and slip rings for use in hazardous areas or subsea, at any ocean depth.

www.bowtech.co.uk

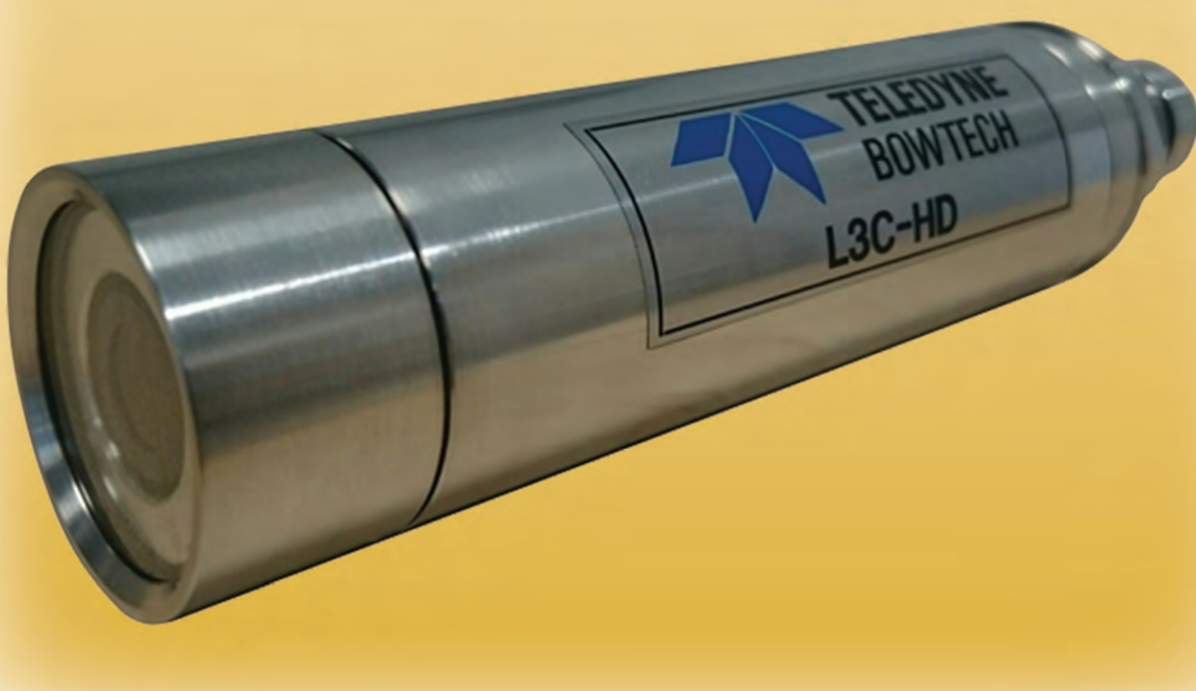


Image: Teledyne Marine

Kongsberg Upgrades Multibeam Echo Sounder

Kongsberg Maritime

Kongsberg Maritime launched GeoSwath 4, the fourth generation of its GeoSwath shallow water multibeam echo sounder, featuring a new look deck unit, which is smaller and lighter, with sufficient Ethernet, USB and serial interfaces to suit any combination of peripheral sensors. Inside, the new hardware enables the GS4 to transmit on both port and starboard transducers simultaneously, doubling the previous along track data density and increasing the performance and resolution.

km.kongsberg.com

New Batteries Help Vehicles Dive Deeper

Steatite

Steatite has completed the first phase of a 24-month project to develop a pressure-tolerant lithium sulphur (Li-S) battery pack that can improve the endurance and speed of 'deep-dive' autonomous underwater vehicles (AUVs). Having demonstrated that Li-S cells can operate at depths up to 6,000m, the project can now move on to the battery development phase involving continued development of Steatite's pressure-tolerant multi-chemistry Battery Management System (BMS). The first phase of the project was completed at the National Oceanography Center (NOC) in Southampton and involved repeatedly testing Li-S cells at pressures and temperatures equivalent to undersea depths of 6,000m.

www.steatite.co.uk

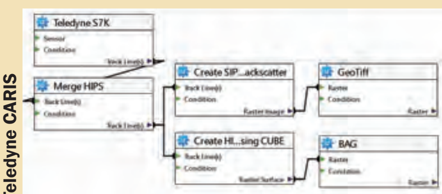
Motion Control Version 2.5 Release

Coda Octopus

Coda Octopus has released Version 2.5 of its Motion Control Software Package: its latest MOTION control application provides complete setup, management, monitoring and replay for all four products in the MOTION range: the F190, F180, F180R and F175 series.

www.codaoctopus.com

Teledyne CARIS Unveils HIPS and SIPS 10



Teledyne CARIS

Teledyne CARIS has updated its bathymetric, seafloor imagery and water column data processing software HIPS and SIPS 10, introducing new capabilities for automation, efficiency and usability through the integration of the Process Designer and the simultaneous introduction to the first commercially available solution for generating Variable Resolution (VR) Surfaces from source data.

www.teledynecaris.com

New Docking Head for Schmidt's ROV SuBastian

MacArtney

Schmidt Ocean Institute has chosen a MacArtney docking head to ensure optimum handling of its remotely operated vehicle (ROV) SuBastian on board the R/V Falkor. The MacArtney MERMAC D docking head for ROV SuBastian has been designed featuring a special property, single suspension point.

www.macartney.com

OSIL Satellite Modem

OSIL

Ocean Scientific International Ltd. (OSIL) added a new low-cost, low-power satellite modem to its range of telemetry equipment. The system will publish data, including traditionally high-cost/volume currents and waves, from any location globally using the Iridium satellite network.

Monthly line rental costs are minimal, and data costs are kept low by using SBD messaging with big bundle deals available for multiple or long term deployments.

www.osil.co.uk

Cyanobacteria-Sensitive Optics for Fluorometer

Turner Design

Turner Designs' Enviro-T2 is an in-line fluorometer suited for drinking water or wastewater facilities that want to detect cyanobacteria and algae in their water flow. It is an accurate, single-channel fluorometer which easily integrates with data collection systems providing a 4 – 20 mA output proportional to the fluorescence from chlorophyll in water. The Enviro-T2 Red Excitation Fluorometer has maximum sensitivity for better detection of cyanobacteria; the Enviro-T2 Blue Excitation Fluorometer is configured with maximum sensitivity to all other algal groups.

www.turnerdesigns.com

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	(4) Requested Copies Distributed by Other Mail Classes Through the USPS (e.g. First-Class Mail®)	1,032	958
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PS Form 3526-R, September 2007 (Page 2 of 3)

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

Now in its 25th year, Underwater Intervention is jointly owned by the Association of Diving Contractors International (ADCI) and the ROV Committee of the Marine Technology Society. The show attracts thousands of commercial divers, contractors, engineers and safety professionals who converge on New Orleans for a few days of exchanging ideas, demonstrating new technology and supplies, and generating attention for a highly precise and sought-after line of work that is integral to many different industries.

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- Network with leaders in the underwater industry from around the world.
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You don't want to miss this!

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

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