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FEATURE STORY

A Clash of Green & Blue

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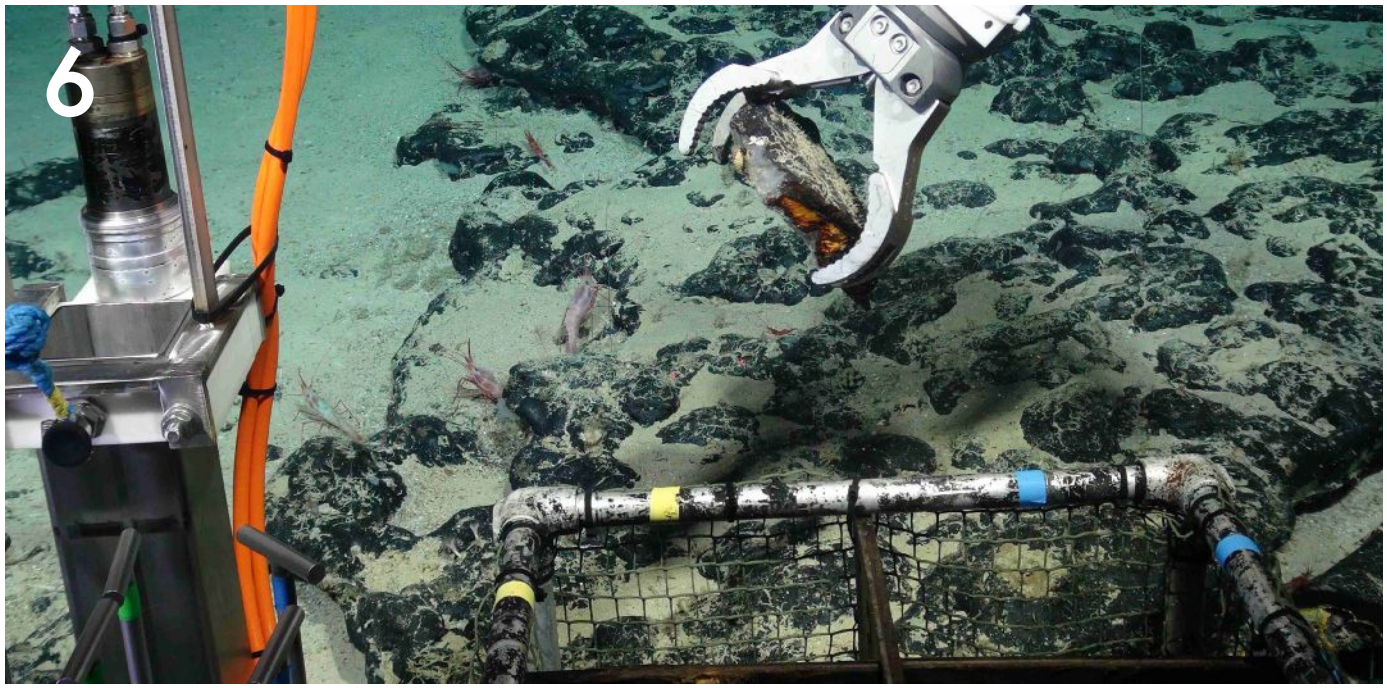

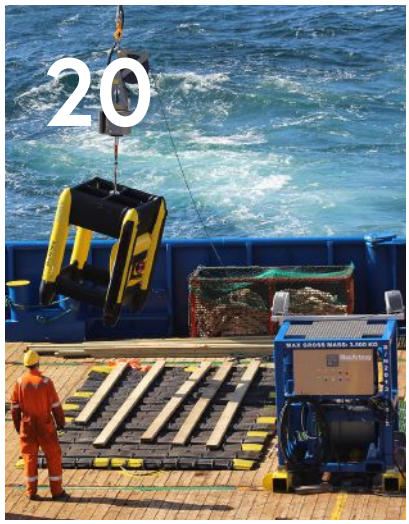

DEPARTMENTS

IN EVERY ISSUE

ON THE COVER:
Ampelmann's enhanced E1000 motion compensated access system can transform from a gangway into a crane boom.

Managing the environmental impact of marine activities around the world.

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RICHARD LAWSON
CEO of the International Ocean Science and Technology Industry Association (IOSTIA.org)

IOSTIA:
A New Organization in the Science & Technology Industry

Two years ago after serving nearly a decade with a prestigious ocean technology association, I pursued an opportunity to consult with a number of different types of non-profit organizations. However, because of my strong personal connection with the ocean, I never lost touch with my colleagues in the ocean industry.

From them, I continued to hear a familiar refrain: The offshore energy sector was well-represented by a number of outstanding non-profits and substantial industry events. However, companies focused on other Blue Tech sectors were struggling to find the same kind of home.

To explore this "gap" in the industry, I reached out to a wide spectrum of professionals and pulled together a small team of colleagues experienced with ocean-related non-profits. Together, we began to identify a clear gap in the ocean science and technology industry sectors that was not being filled by traditional non-profits.

This void centered mostly on the lack of a traditional "trade associations" providing services and benefits such as a robust and proactive lobbying and government affairs program, common-sense business savings, federal contracts and grants resources, access to venture capital, and other business-enhancing benefits—put another way, an organization that focuses on practical bottom-line enhancing programs that save members time and money.

While there are many outstanding ocean-related non-profit organizations, think tanks, scientific societies, and centers of learning serving the industry, almost without exception they are all organized as IRS Section 501(c)(3) public charities and private foundations with an education and scientific-focused mission and primarily serving individual members.

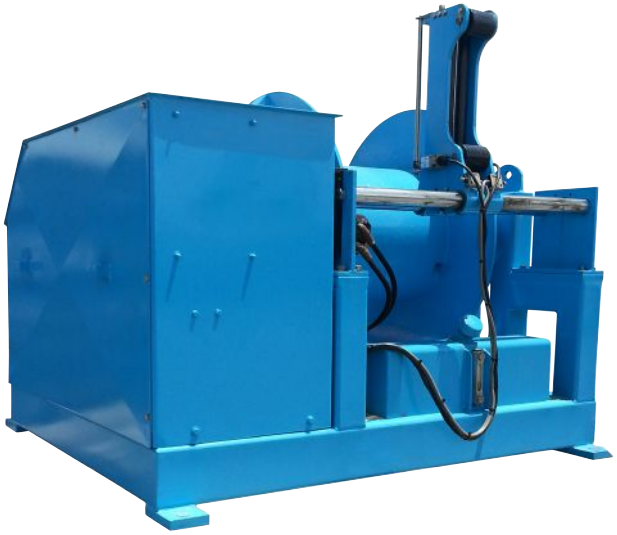
So, in September 2017, we instead launched a 501(c)(6) trade association, the International Ocean Science & Technology Industry Association (IOSTIA) to fill the existing gap and complement the 501(c)(3) organizations. While it may appear nuanced, the differences between the two types of non-profits are important. Trade associations are solely organized to support overall industry needs and to promote the business interests of their members.

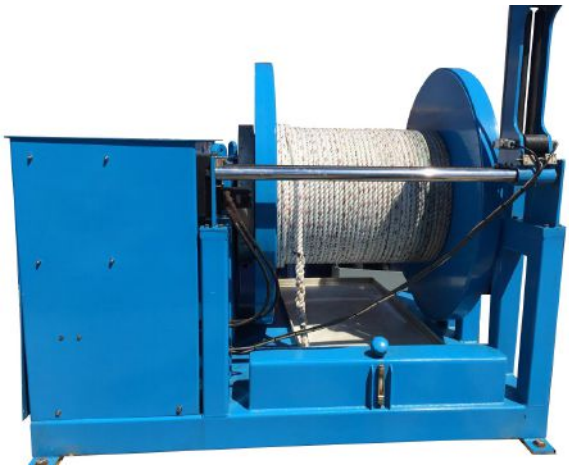
With as many as two-thirds of IOSTIA-related companies headquartered overseas, this industry association will also be international in scope and substance. That means we'll be engaging foreign Embassies and relevant agencies located in Washington to assist international companies interested in entering the U.S. and other foreign economic and regulatory markets. IOSTIA is the only organization that provides international ocean technology companies a true voice in Washington, DC and an opportunity to have influence on matters of spending, regulation, and trade.

IOSTIA is the result of a serious and involved two-year effort to determine exactly what benefits and services would be of greatest value to member companies, and we think we've nailed it. IOSTIA is focused only on strengthening the industry and serving our member companies.

As our member companies add their unique thumbprints to IOSTIA's priorities, we look forward to being that essential industry voice in Washington, DC.

We hope you'll consider joining us at IOSTIA. You can find more information at www.IOSTIA.org





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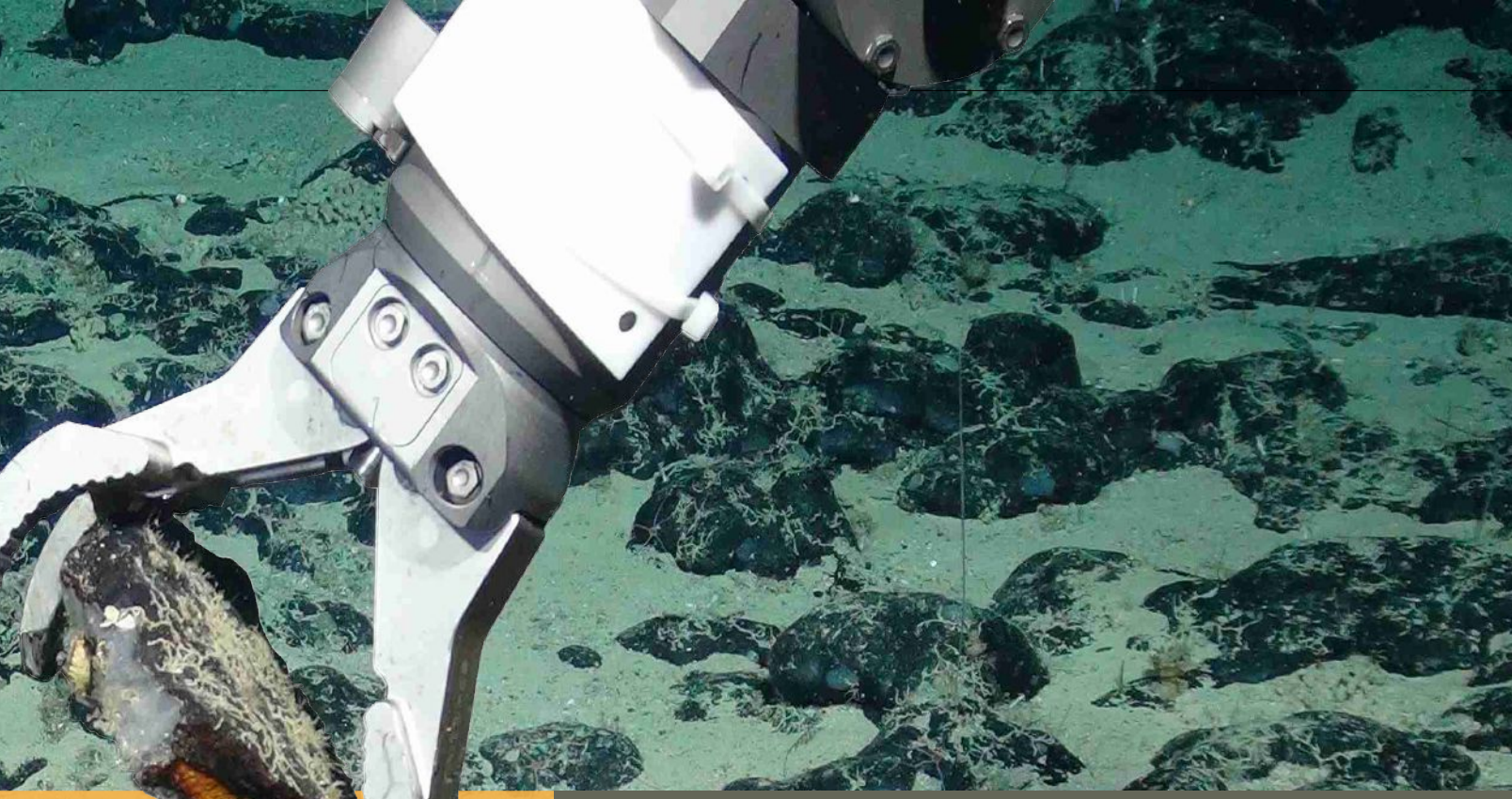
A Clash *of* Green and

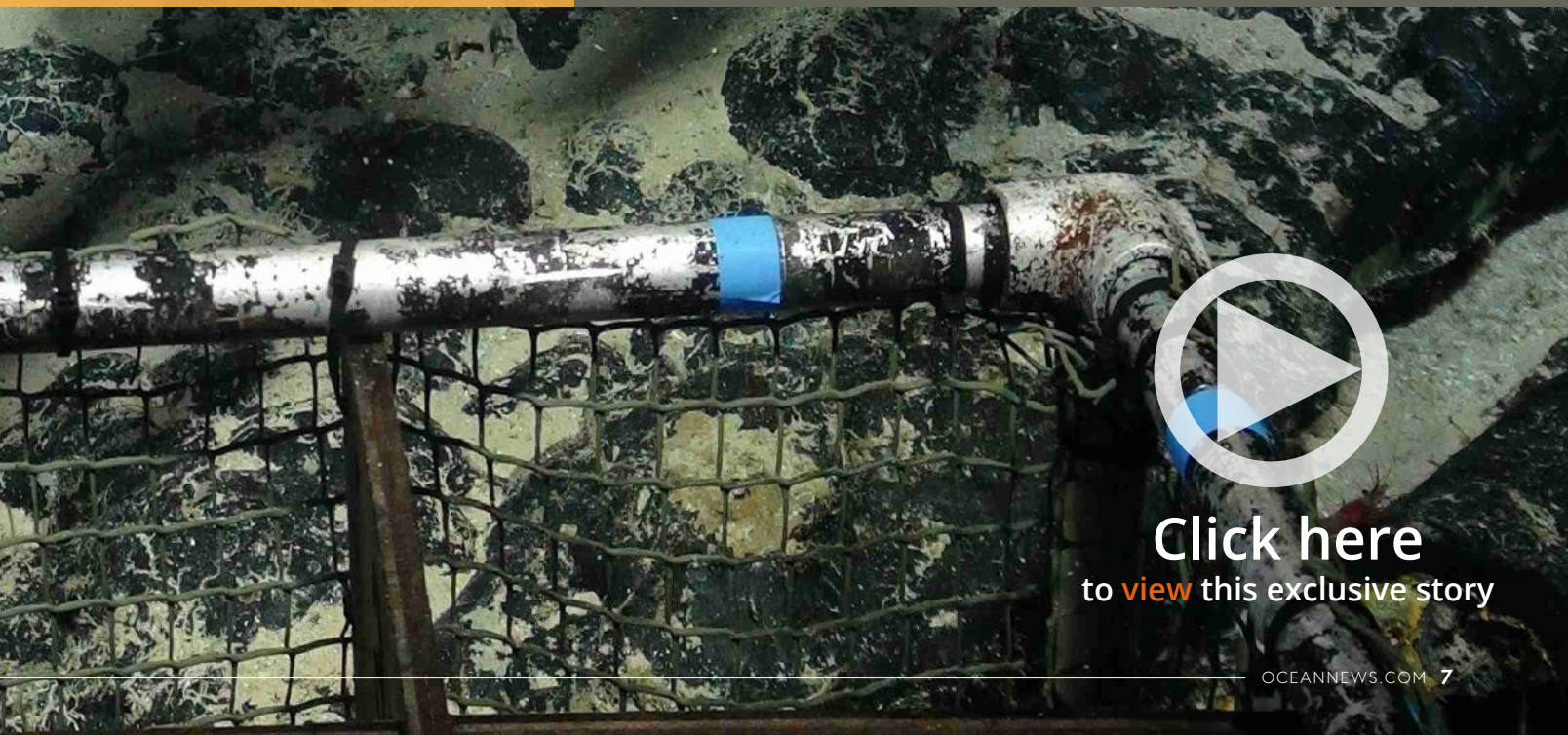
By Kira Co



Blue

ley, UK Correspondent

In the UK, solar is a significant component of the renewable energy mix. What makes this technology so unique over other energy sources is that solar has the capability of meeting the energy needs of the entire planet, but at what cost?



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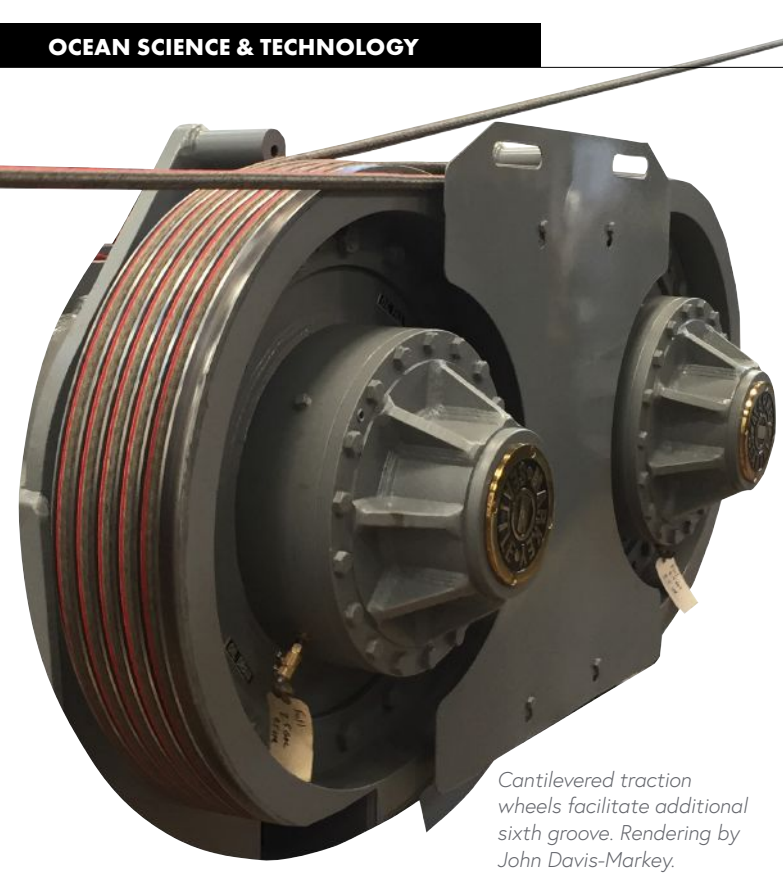


Cantilevered traction wheels facilitate additional sixth groove. Rendering by John Davis-Markey.

New Developments in RESEARCH TRACTION WINCH SYSTEMS

Markey Machinery's development of Deep Sea Traction Winches closely parallels the evolution of UNOLS (University National Oceanographic Laboratory System) requirements for deep sea research winches.

In 2014, China's Shallow Sea Technology Company approached Markey Machinery about an opportunity to represent the company's research winch machinery in the bid process for the Ocean University of China's planned Research and Training Vessel *DONG FANG HONG #3*. A key requirement of that opportunity would be providing traction winches capable of working with synthetic fiber lines at significant line loads and speeds.

Globally, there is increasing interest in the potential use of synthetic fiber cables in oceanographic systems. Ropes constructed of synthetic fiber exhibit the breaking strength of steel wire, yet are buoyant in water. Steel wire rope sinks due to the weight of the wire. Operations deploying steel wire at sea accumulate wire weight as more wire is deployed. This parasitic load deducts from the winch's pull capabilities, whereas synthetic rope only minimally has an impact. This makes synthetic ropes superior for handling sizable loads while exploring ocean basins.

Still, there are drawbacks to working synthetic lines. Markey engineers know this given the company's long history of providing tug-mounted, high-response hawser winches utilizing synthetic line for ship assist and escort operation in high seas. For those unfamiliar with tug applications, one example of this technology is Markey's Render-Recover® automatic line control. It is an automatic motion compensation technology developed to eliminate shock loading of synthetic hawser lines, a leading cause of early failure of synthetic ropes. Integrating this proven technology into traction winch systems utilizing synthetic rope ensures long rope life, and also improves depth position stability of deployed science packages.

Another advancement is in the area of line spooling. It addresses the slipperiness of synthetic rope, and the tendency of 12-strand braided ropes to knife into lower layers at line pulls of 20 ton and more. Markey engineers resolved this issue by increasing level wind speed so that successive layers cross over the preceding one at a relatively acute angle. This Markey innovation prevents upper layers pulling down between lower layers when under tension, which is unsuitable in any winch application.

Following receipt of the order for the five-winch package for the *DONG FANG HONG #3* the Director of Shallow Seas Technology, Jimmy Wang, introduced Markey project engineers to a new type of line designed to be a direct replacement for steel trawl wires used in fishing applications. It helped to resolve some traditional technical issues encompassed in systems of this type. One involves the issue of traditional helical ropes and cables responding to increasing line tension by spinning. The new synthetic line, having both the rope and a durable cover made of braided synthetic fiber, is also torque-balanced due to the braided construction, making it ideally suited for bottom sampling at depth.

The traction winch performance requirements are substantially greater compared to research traction winches Markey has supplied in the domestic U.S. market. Chinese operators required machines with load / speed parameters demanding 200% more power. To take full advantage of the traction head dual 150 HP electric motors (delivering 225-kW total) the Ocean University of China required 22mm synthetic rope with 400kN minimum breaking strength. To meet the regulatory strength standards for pulling long cores imbedded in the sea bottom, Markey's engineering team of Peter Petrov and Ross Murray designed a dual storage drum and single

storage drum traction winch system with a number of new features. Among them are the addition of a sixth groove to the traction winch drums which ensures all 225-kW of motor power is transferred to the 12,000-meter rope to extract core samples and retrieve these to the research ship.

The combination of this new synthetic line with Markey's latest high-performance traction winch design has resulted in a very powerful, high-performance machine. Some of the performance points include:

- Oceanographic deck machinery designed to handle cables with breaking strengths to 44,000kg (96,800lbf);
- Traction winch control systems using hawser winch-derived Markey Render/Recover® active tension compensation to protect synthetic line;
- Markey traction winches with 20,000kg rated line pulls and light line speeds up to 120 meters per minute; and
- Traction winch machines designed specifically to work and effectively spool the newest high performance UHMP ropes.

Even during pre-shipment tension spooling of synthetic rope onto the new storage winch this system exceeded the expectations of Markey's engineers. Under controlled factory conditions with the air gap characteristic of 'round' cable, the wraps accumulate and layers build as if spooling a double-armored cable. Coupled with the storage winch controls that include adjustable back tension while level winding the drums, confidence is high regarding level wind operation during actual operating conditions when the *DONG FANG HONG 3* is at sea in 2019. Importantly, the observed results of tension spooling reinforces the value of applying Markey's precision spooling principles of engineering level winds to select, synthetic ropes whose manufacturer's guidance stipulates avoiding grooved drums.

For more information, visit www.markeymachinery.com.

View of system spooling. Rendering by John Davis-Markey.

AWI's Underwater Robot Tramper Successfully Recovered

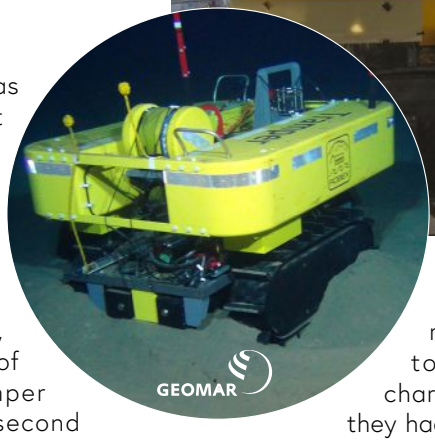
Pre-investigation with the ROV. Photo courtesy of Kiel 6000 ROV-Team GEOMAR.

On 27 August 2017, deep-sea researchers from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) recovered the underwater robot Tramper, which had been taking measurements at a depth of 2435 meters for nearly 60 weeks—the first long-term mission involving a crawler under the Arctic sea ice.

For the first 24 weeks, the robot took biogeochemical readings at various sites, just as it was intended to. Unfortunately, because of a broken tread, Tramper got stuck in the same place in January, though it continued to record the oxygen content in the sediment.

It was an exciting weekend on board the research icebreaker *Polarstern*: the deep-sea and aerospace researchers from the Helmholtz Alliance ROBEX entered the Fram Strait on a nearly direct course from the Norwegian port of Tromsø. On Friday, 25 August they then launched the remote-controlled underwater vehicle ROV Kiel 6000, supplied by the GEOMAR Helmholtz Centre for Ocean Research in Kiel, at the same location they had deployed Tramper on 11 July 2016.

"We started by dropping down to Tramper's starting point, and found the exact place where we launched it," reports the scientific leader of the expedition, Dr. Frank Wenzhöfer, from on board the Polarstern. A live feed from the ROV's cameras was set up in the ship's winch control room. "The ROBEX team followed the search for Tramper with baited breath from the winch control room," recalls ROBEX coordinator Martina Wilde, whose background is in aerospace research. The expedition team was able to watch in real-time how the ROV followed Tramper's tracks. "We could see where it had driven, and that it still seemed to be in good condition," says AWI biogeochemist Wenzhöfer, before adding: "As it then filled the camera screen, we were a bit puzzled as to why it was standing at right angles to its path." The answer: one of its caterpillar treads had broken down, as a result of which Tramper spent the second half of its mission.



Once Tramper had been found, the researchers and engineers had to have a bit of patience before it could be brought to the surface. The robot can only be retrieved with the help of an inflatable boat—but, given the high winds (five to six on the Beaufort scale) and two-meter waves, this was only feasible two days after initial contact. Once the seas had calmed, the recovery could finally begin. The researchers transmitted a signal to Tramper, which released its ballast as planned and began rising to the surface, taking two hours to ascend the 2435 meters. The expedition team then retrieved it with an inflatable boat and hauled it on deck with a crane.

An assessment of the data and a closer visual inspection confirmed that the measuring and recording systems (camera and sensors) had worked perfectly. "All of the programmed cycles worked as they were meant to—unfortunately, for the second half of the mission, only in one spot over and over," explains Wenzhöfer. Because of the broken tread, for weeks Tramper dug itself deeper and deeper into the seafloor. As a result, the robot covered a total distance of roughly 360 meters. "The first 24 weeks show some exciting data that we'll now begin carefully analyzing. And that means we now know more about variations in oxygen consumption on the Arctic seafloor over half a year (July to December)," summarizes Wenzhöfer. What's more, the robot's designers were amazed to see how much battery charge it still had – an aspect they had been somewhat concerned about. Since Tramper used up only half its charge, it could have kept going for almost another full year. Battery performance at 0.8 degrees below zero is difficult to predict, making this a welcome surprise.

Needless to say, it's a pity that the mission didn't yield data on oxygen-consumption variation for the second six-month period (January to August): the sensors kept recording, but always at the same spot where Tramper had become mired. The expedition team will now attempt to repair the caterpillar tread. If they succeed, they'll replace the crawler's batteries and sensors and redeploy it, so it can gather data for an entire year-long cycle as planned.

The next highlights of the expedition will include tests of the GEOMAR underwater crawler VIATOR and an underwater glider developed at the University of Bremen's MARUM (Centre for Marine Environmental Sciences) in the context of the Helmholtz Alliance ROBEX. To read news on the recovery mission and further highlights from the expedition from ROBEX coordinator Martina Wilde, visit the Helmholtz-Polarstern-Blog (German language only).

For more information, visit www.robex-allianz.de/en.

Inset Photo: AWI underwater robot on deck RV Polarstern. Photo courtesy of Alfred-Wegener-Institut.

NOAA, Paul G. Allen Philanthropies to Expand Deep Ocean Observations

In a groundbreaking public-private partnership, Microsoft co-founder and philanthropist Paul G. Allen and NOAA's Pacific Marine Environmental Laboratory will deploy a large array of new deep ocean floats to expand ocean observations in a key area of the western South Atlantic Ocean.

These instruments, called Deep Argo floats, can collect data down to nearly four miles deep, and promise to lead scientists to a better understanding of how the bottom half of the ocean may influence long term weather, climate, and sea level rise.

Paul G. Allen Philanthropies has committed more than $4 million for the multi-year project, Jump-Starting Deep Argo. Allen's research vessel R/V Petrel will deploy an array of these floats in the deep international waters east of Brazil.

"This is NOAA's first formal public-private partnership for sustained ocean observations," said acting NOAA Chief Scientist Craig McLean. "We applaud Paul Allen for his visionary investment in long term knowledge to help answer some of Earth's most challenging questions."

NOAA chose the western South Atlantic for the array because it provides a window into the global thermohaline circulation, called the great ocean conveyor belt, which is linked to global climate variations. At the bottom of the basin, very cold, dense Antarctic water flows northward while just above, slightly warmer, lighter North Atlantic deep water flows southward. Limited data have shown that the Antarctic water has been warming over the last three decades.

The project expands on the success of Argo, an international array of almost 4,000 freely drifting floats that measure temperature and salinity in the upper 2,000 meters or 1¼ miles of the global ocean. Since 2000, Argo has revolutionized oceanography, providing data publicly in near real-time that are vital for understanding the roles of ocean temperature, salinity, and current variations on weather, climate and ecosystems.

While Argo provides data on the upper half of the ocean volume, Deep Argo floats, which dive to 6,000 meters or 3.7 miles, will probe the less-understood bottom half.

"We're proud to launch the Deep Argo technology," said Spencer Reeder, director of climate and energy initiatives for Paul G. Allen Philanthropies. "Paul Allen believes that gathering high-quality oceanographic data is vital to understanding our Earth's changing climate."

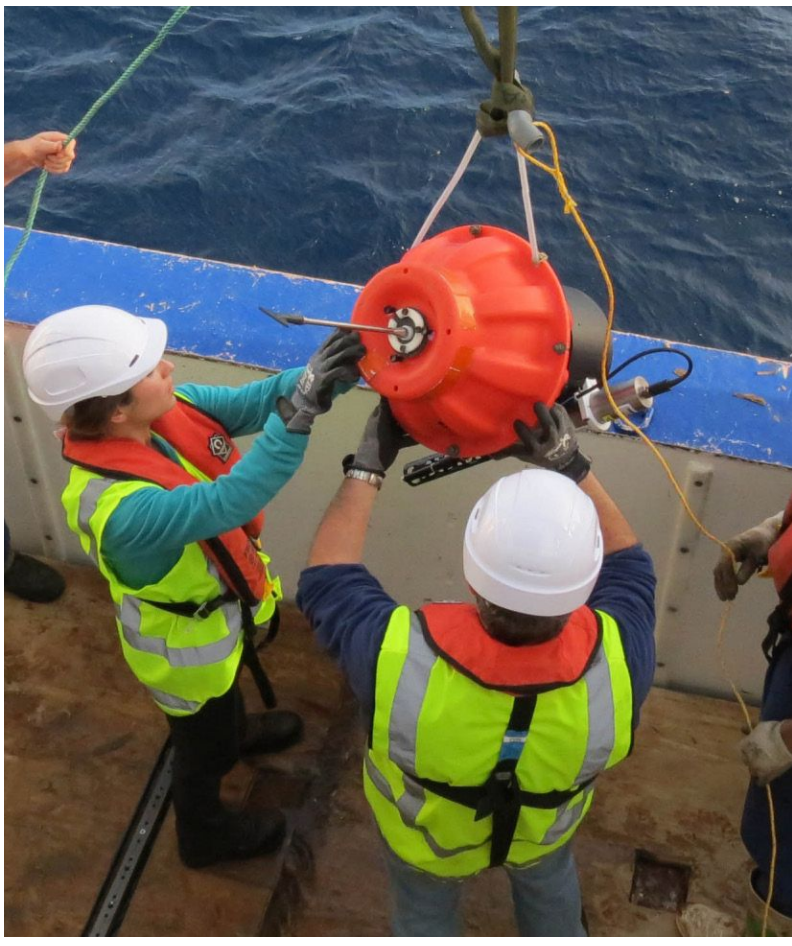
This new project will be the first comprehensive sampling of an entire deep ocean basin by this technology, which has been previously tested only in small pilot deployments.

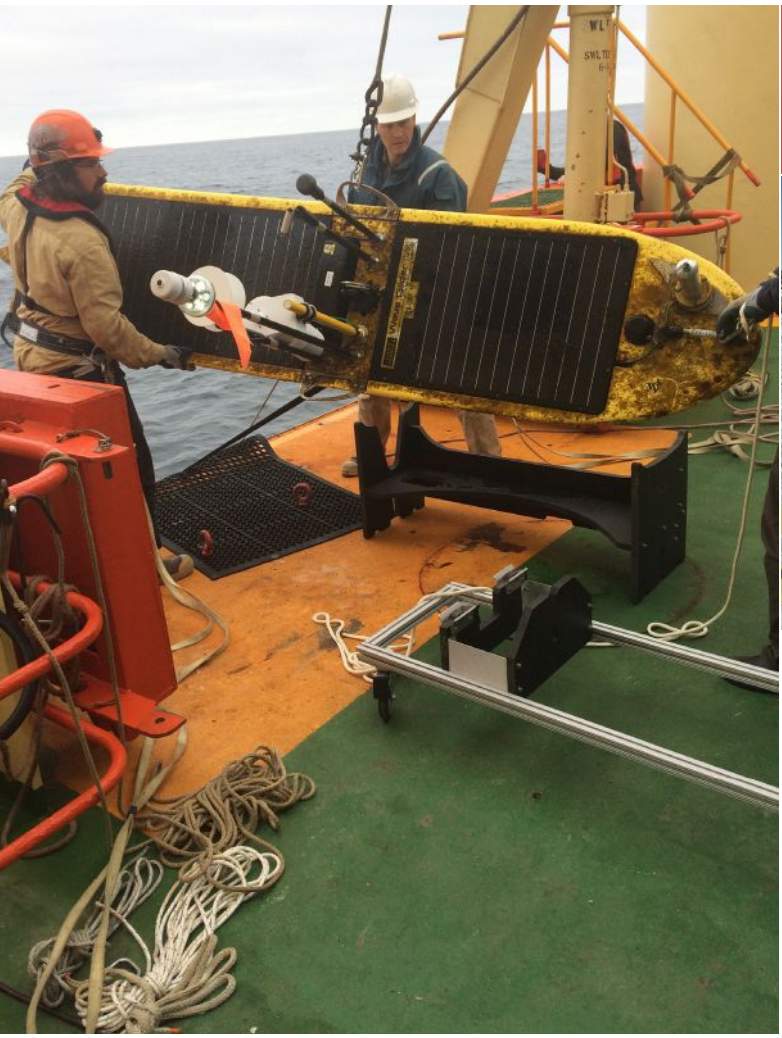
"Putting Deep Argo floats in the western South Atlantic is another step toward a global Deep Argo array, which will illuminate key portions of our changing oceans," said Gregory C. Johnson, an oceanographer at NOAA's Pacific Marine Environmental Laboratory who will lead the project. "It's like we've had a candle in a dark room and now we're going to flip on the lamp. We'll see all the details."

Researchers from NOAA's cooperative institutes at the University of Hawaii and University of Washington will contribute to the project.

For more information, visit
www.noaa.gov or www.paulallen.com.

Deploying Deep Argo.





Left: Matt Boyer (left) and Jim Thomson retrieve the Wave Glider in March from off the coast of Argentina. Photo courtesy of University of Washington. Below: The Wave Glider near Antarctica's Palmer Station in December before starting its epic voyage on the Southern Ocean. Photo courtesy of Avery Snyder/University of Washington.

Wave Glider Surfs Across Stormy Drake Passage in Antarctica

The UW oceanographers used a commercial Wave Glider made by Liquid Robotics, a California-based subsidiary of the Boeing Co., to surf along the water's surface gathering observations. The researchers added extra sensors for temperature, salinity, air pressure, humidity and wind to the commercial model.

After a test run in summer 2016 off Washington's coast, the instrument was deployed off the Antarctic Peninsula in December. It spent about three months zigzagging its way across the fabled Drake Passage, while the researchers occasionally piloted the instrument remotely from shore.

As the study's authors wrote, this is where the strong Antarctic current becomes "a mess of swirling eddies" and meanders around its central path. "The zig-zag pattern in the middle of Drake Passage was designed to survey the strong fronts and meanders of the Antarctic Circumpolar Current common to that region," wrote Thomson and co-author James Girton, also with the UW's Applied Physics Laboratory.

The Wave Glider followed the blue line. It began in summer, off the Antarctic Peninsula and traveled north across the Drake Passage. The ocean drone zigzagged through the region where Pacific and Atlantic water meets Southern Ocean currents, in which temperatures change dramatically and most mixing occurs.

A Wave Glider harnesses energy from the waves, using the shape of the water motion below the surface to drive the vehicle forward with minimal power. With wave energy for motion and solar panels charging batteries to power its sensors, the board can operate for months without maintenance. Even so, the late-summer sun so far south did not provide enough energy to recharge batteries late into the expedition, and a research ship retrieved the instrument and its data near Argentina in late March. Though the board didn't reach South America, the real goal was the data it collected.

"The mission just completed would have cost many millions of dollars to complete with a ship," Thomson said. "An autonomous approach allowed us to collect data that has never—and would never have—been collected in this remote region."

The authors are still processing the observations collected during the voyage, which was funded by the National Science Foundation, to understand mixing on different spatial scales. They hope that future funding will allow another chance to collect more data and transition this program into regular annual monitoring of the Drake Passage.

"It's not just about having done this successfully once, it's about learning how to make this routine. We do that, and we change the game on data collection in this important region." Thomson said.

For more information, visit tos.org/oceanography/article/sustained-measurements-of-southern-ocean-air-sea-coupling-from-a-wave-glide.

WHOI AWARDED $5.7M
to Advance Seaweed Energy Production

WHOI was awarded $5.7 million from ARPA-E's Macroalgae Research Inspiring Novel Energy Resources (MARINER) Program for two projects that develop tools and technology to advance the mass production of seaweed for biofuels and bio-based chemicals.

"By focusing on the technological challenges to growing and harvesting macroalgae (seaweed) efficiently and cost-effectively, MARINER project teams are building the tools we need to fully put this resource to work contributing to our energy future," says ARPA-E Acting Director Eric Rohlfing.

"Bringing our scientists and engineers together to develop innovative solutions to important problems is a hallmark of WHOI," adds Mark Abbott, president and director of WHOI. "We're pleased and honored to be selected by ARPA-E to work on advancing new sources of renewable energy."

One of the funded projects will develop a breeding program for sugar kelp—*Saccharina latissima*, one of the most commercially important species—using the latest gene sequencing and genomic resources for faster, more accurate and efficient selective breeding.

Currently in the U.S., seaweed is primarily used in food and food processing for humans and animals, and mostly comes from imported farmed product or wild harvests. Expanding seaweed farming domestically relieves pressure on wild stocks, creates jobs and revitalizes working waterfronts. Ultimately expanded and more efficient production will lead to expanded markets including feedstocks for biofuels. The ARPA-E estimates that in the U.S. combined brown and red seaweed farming could yield about 300 million dry metric tons per year. When converted to energy, that could fuel about 10% of the nation's annual transportation needs.

"The MARINER program addresses a critical challenge that land production systems are unlikely to solve," explains biologist Scott Lindell, who is leading the research effort at WHOI. "How do we meet growing global biofuel needs and also meet the 50-100% increase in demand for food expected by 2050? Seaweed farming avoids the growing competition for fertile land, energy intensive fertilizers, and freshwater resources associated with traditional agriculture."

With $3.7 million, Lindell and a team of seaweed biologists, geneticists and entrepreneurs will develop a breeding program for sugar kelp—*Saccharina latissima*, one of the most commercially important species—using the latest gene sequencing and genomic resources for faster, more accurate and efficient selective breeding. The breeding program will build a library of genetic resources associated with plant traits that produce a 20-30% improvement over wild plants. Lindell says the team expects to develop novel genomic tools that will accelerate the production of improved plants while decreasing the need for costly offshore field evaluations.

Partners in the project include: University of Connecticut-Stamford, which will develop the kelp strains and families for breeding; the USDA Agriculture Research Service at Cornell, which will apply DNA sequencing and genomic analysis to direct selective breeding for important traits; and GreenWave, which will operate the open ocean farming system for field trials of the selectively bred families.

An illustration of the autonomous underwater observation system the WHOI team will develop for extended monitoring of large-scale seaweed farms. A REMUS (Remote Environmental Monitoring UnitS) 100 vehicle outfitted with acoustic, optical, and environmental sensors will monitor seaweed growth and health, equipment status, and water column properties. A REMUS docking station allows the vehicle to recharge and transmit data.

The remaining $2 million in funding will be used by a team from the Applied Ocean Physics and Engineering department to develop an autonomous underwater observation system for monitoring large-scale seaweed farms for extended periods of time without human intervention.

The WHOI team will outfit an unmanned underwater vehicle with acoustic, optical, and environmental sensors to monitor seaweed growth and health, equipment status, and water column properties, such as nutrient content.

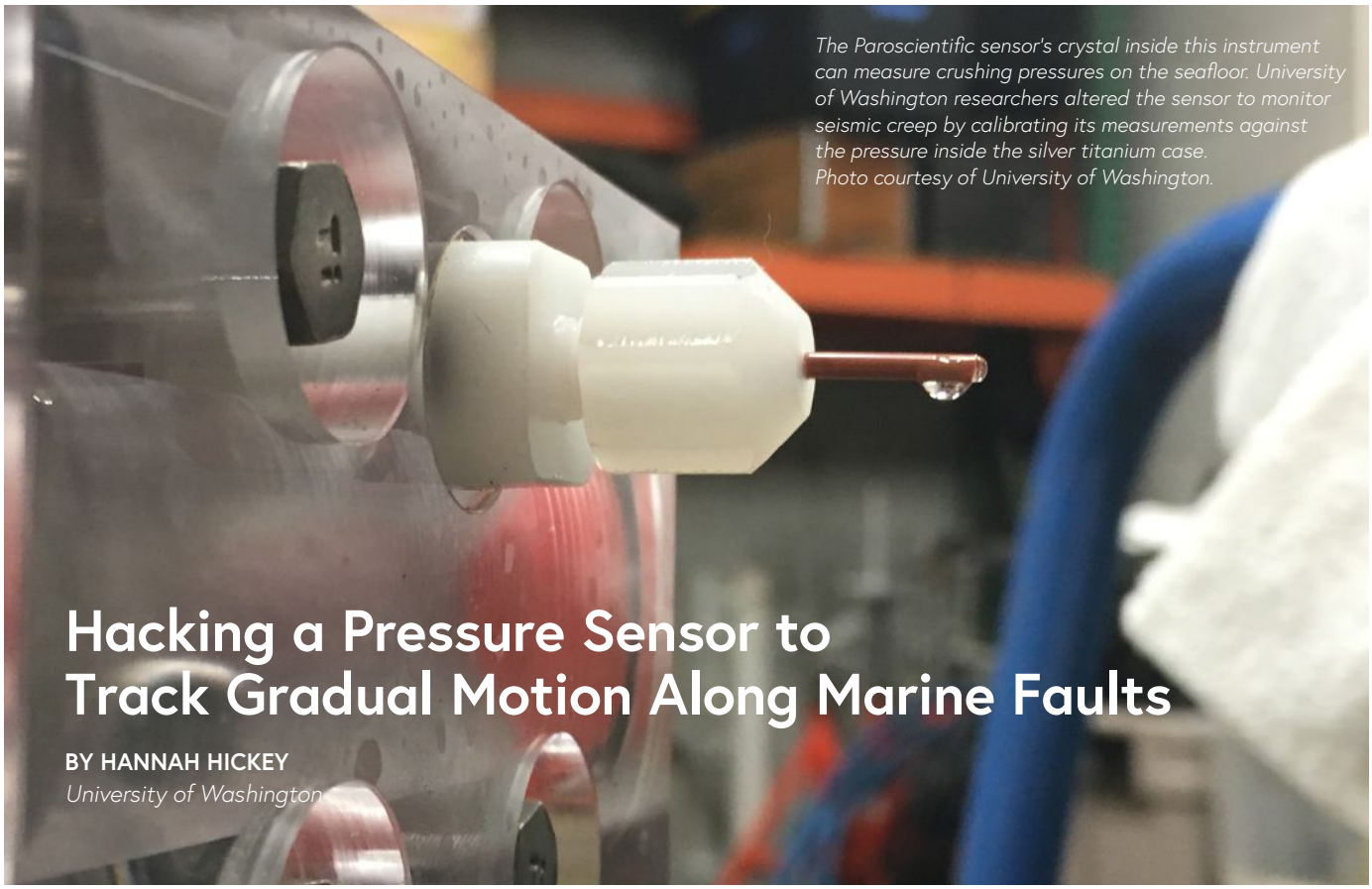
"We will be using a REMUS (Remote Environmental Monitoring UnitS) 100 vehicle, which is a small robotic vehicle developed at WHOI to survey shallow coastal areas," says Fischell. "A REMUS docking station will be the base of the system, allowing the vehicle to recharge and transmit data making long-term operation possible."

The WHOI-lead project teams will collaborate with a third MARINER project awarded to a team led by the University of Alaska Fairbanks. That project is developing scale model seaweed farms capable of producing sugar kelp for less than $100 per dry metric ton. Lindell will lead biological sampling and testing at seaweed farm sites in New England—Nantucket Sound and Long Island Sound—and Alaska.

IN THE FUTURE, our homes and vehicles could be powered by fuel made from seaweed grown at large-scale offshore farms. Researchers at the Woods Hole Oceanographic Institution (WHOI) are working to help make that scenario a reality sooner with funding from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E).

THE TWO WHOI AWARDS are among 18 innovative projects that received a total of $22 million in funding from ARPA-E.

For more information, visit www.whoi.edu.



The Paroscientific sensor's crystal inside this instrument can measure crushing pressures on the seafloor. University of Washington researchers altered the sensor to monitor seismic creep by calibrating its measurements against the pressure inside the silver titanium case. Photo courtesy of University of Washington.

Hacking a Pressure Sensor to Track Gradual Motion Along Marine Faults

BY HANNAH HICKEY
University of Washington

Deep below the ocean's surface, shielded from satellite signals, the gradual movement of the seafloor—including along faults that can unleash deadly earthquakes and tsunamis—goes largely undetected. As a result, we know distressingly little about motion along the fault that lies just off the Pacific Northwest coast.

University of Washington oceanographers are working with a local company to develop a simple new technique that could track seafloor movement in earthquake-prone coastal areas. Researchers began testing the approach this summer in central California, and they plan to present initial results in December at the American Geophysical Union's annual meeting in New Orleans.

Their approach uses existing water-pressure sensors to cheaply measure gradual swelling of the seafloor over months to years. If successful, the innovative hack could provide new insight into motion along the Cascadia Subduction Zone and similar faults off Mexico, Chile and Japan. The data could provide clues about what types of earthquakes and tsunamis each fault can generate, where and how often.

The concept began with a workshop in 2012 that brought together Jerry Paros, the founder of Bellevue-based Paroscientific, Inc., with UW geoscientists. Paros' company manufactures sensors used to measure pressure at the bottom of the ocean with high precision, which are used by the National Oceanographic and Atmospheric Administration for its tsunami sensors.

But an engineering quirk prevents the sensors from measuring the gradual ground motions that build up pressure along earthquake faults. The instruments can measure seafloor pressure, or the weight of water above the sensor, to an extremely precise fraction of a millimeter. But the readings lose accuracy over time, and the error is proportional to the quantity measured. On the ocean floor, where pressures are tens to hundreds of times that on the surface, the readings can change by 10 centimeters (3 inches) per year. In between major earthquakes, this is much more than the sea floor might shift up or down due to tectonic forces.

"If you want to measure how the seafloor is moving, you don't want your reading to change by a larger value than the thing that you're measuring," said Dana Manalang, an engineer at the UW's Applied Physics Laboratory who is working on the project.

Paros, proposed an idea that would instead calibrate the pressure sensor against the air pressure inside the metal case that houses the instrument, which is roughly one atmosphere. This would allow existing pressure sensors to autonomously track small bulges and slumps on the seafloor.

Last year engineers at the UW Applied Physics Laboratory modified an existing Paros pressure sensor. The sensitive quartz crystal that measures the seafloor pressure can now be connected to measure pressure inside its titanium instrument case, with a known pressure and another barometer to check the value. The prototype instrument was attached in mid-June to the Monterey Accelerated Research System, a cabled seafloor observatory that lets researchers communicate directly with the instrument.

"That chunk of seafloor actually does not move much. We're looking for a null result," Manalang said. "If successful, the next step would be to deploy similar instruments in some more geologically active areas."

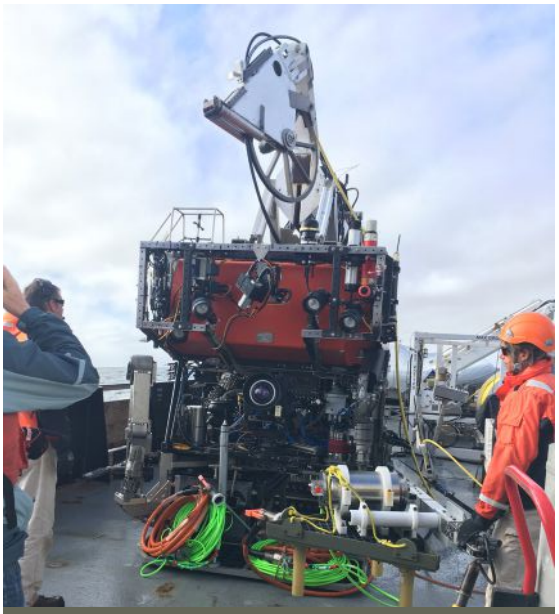
Those areas include the Cascadia Subduction Zone, the fault that could unleash the "really big one" at any time on the Pacific Northwest. Geologists studying the small rise and fall of this section of seafloor, around 1 centimeter per year, have instead been forced to develop complicated workarounds.

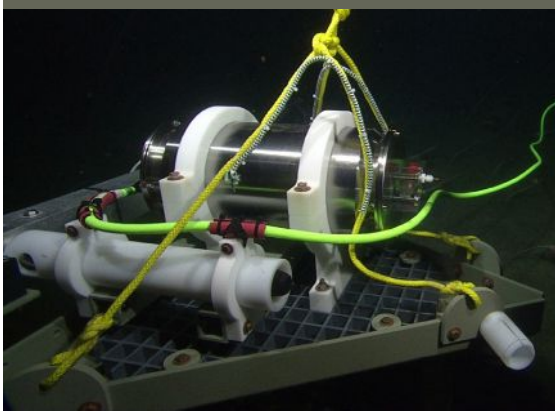
"We are trying to find a pattern of which areas are going up and which areas are going down, and how quickly, which can potentially tell us where the subduction zone fault is locked," said William Wilcock, a UW oceanography professor who holds the Paros endowed chair. "But we can't yet do that with a conventional pressure sensor."

Wilcock and seismologists at Scripps Institution of Oceanography have been monitoring seafloor movement off central Oregon, where the Cascadia Fault displays behavior that suggests it may gradually slip, releasing strain along that section of the fault. Once a year, the partners go to sea with a research ship, deep-sea robot and specialized equipment to calibrate six seafloor pressure sensors. By monitoring exactly how the seafloor has moved in this way from one summer to the next, they can compare sections of the fault and learn which zones are fully locked, building up potentially dangerous energy, and which aren't.

"The approach we are using appears to work, but it's expensive, and you can't do it very often," Wilcock said.

If Paros' modified sensors can do the job, future work might place a network of them along Cascadia or other subduction zones, in which a seafloor plate plunges beneath a continental plate. Measuring motion along different parts of these faults might answer longstanding questions about how and where a fault ruptures.





Top: The modified pressure sensor is now being tested at the bottom of Monterey Bay. Photo courtesy of MBARI/University of Washington. Bottom: This deep-sea robot, the ROV Ventana operated by Monterey Bay Aquarium Research Institute, in June attached the instrument (lower right) to the Internet-connected observatory at the bottom of Monterey Bay. Photo courtesy of MBARI/University of Washington.

From her Seattle office, Manalang now communicates with the prototype sensor in Monterey and flips the crystal about once each weekday to recalibrate it against the instrument housing pressure. She will flip it less often as the test continues, while remotely monitoring the change in pressure readings.

"We're still close to the starting line on this one, and have some initial, really promising results," Manalang said. Observations so far show that the shift in measurements is predictable, and similar at both ends of the instrument's range. "We're at the very beginning of what we hope is a fairly long-term test," she said.

If the method proves reliable, future pressure sensors could be programmed to pivot periodically on their own and gather observations over months or years. Precise long-term measurements of water pressure could not only help seismologists, but also researchers who study how sea level changes over decades.

"If you can make very accurate observations, and routinely, it would interest both the people studying what's happening beneath and what's happening above," Wilcock said. "These data would open up a whole bunch of new studies."

The research is funded by Jerry Paros and the University of Washington.

For more information, visit www.washington.edu.

River Thames Simulation Supports Safer Navigation for Tideway

The Thames Tideway Tunnel project, London's new "super sewer," which will upgrade the city's 19th century sewerage system for today's eight million plus inhabitants, requires excavation on an enormous scale.

Creating a tunnel 25 kilometers in length, and running up to 65 meters beneath the River Thames, will generate immense volumes of spoil, right in the heart of London. To minimise the impact of transporting this on the capital's roads, Tideway plans to transport around 4 million tonnes of this material by river.

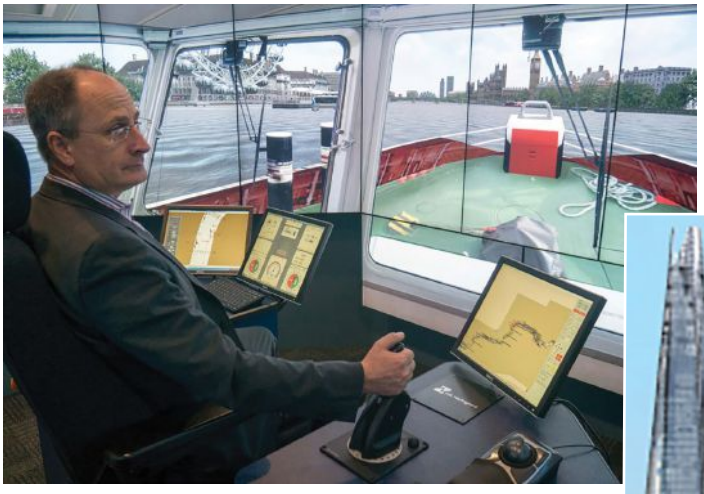
HR Wallingford is assessing Tideway's fleet of vessel masters at its UK Ship Simulation Centre to ensure they meet Tideway's health and safety standards, using a specially-created virtual reality simulation of the route the boats will take.

The £4.2 billion Thames Tideway Tunnel project is required to bring London's sewers into the 21st century, and to stop tens of millions of tonnes of untreated sewage flowing into the Thames each year. The "super sewer" is a tunnel running under the Thames that will intercept, store and transfer the sewage overflow for treatment. The tunnel starts in West London and follows the route of the River Thames to Limehouse, before heading north-east to Abbey Mills Pumping Station near Stratford. At Abbey Mills, the Thames Tideway Tunnel will connect to the Lee Tunnel, which will transfer the intercepted sewage for treatment at Beckton, East London.

Transporting the millions of tonnes of spoil by river will treble freight river traffic, and create up to 200 maritime jobs, including barge hands and vessel operators. HR Wallingford has developed a four-day course with the Tideway team, designed to ensure vessel masters are given the opportunity to demonstrate that they are fully prepared, and are aware of the health and safety requirements to work on the Tideway Project.

The course uses a virtual reality simulation of the tidal River Thames, developed at HR Wallingford's UK Ship Simulation Centre in Oxfordshire. This Thames simulation is the most detailed visualisation HR Wallingford has developed to date, covering the tidal River Thames from Putney Bridge in the west to Margaretness in the east, complete with accurate visual scenes, tides, flows, other river traffic, and changeable weather conditions.

"We know how important visual cues can be," says Dr Mark McBride, HR Wallingford's Ships group manager, "so we put a lot of effort into creating a visually rich environment for the simulation. All the vessels masters have a local knowledge endorsement and a detailed knowl-



Below: HR Wallingford has created a River Thames navigation simulation to assess Tideway's fleet of vessel masters.

edge of the river which allows them to use some relatively small features along the river as prompts and markers, so we have included detail such as lions heads on the river embankments, marker posts, and even the details on the undersides of the bridges."

In order to make the navigation experience a realistic one, HR Wallingford's hydrodynamic model uses data from tide gauges and flow measurements along the Thames to simulate realistic flow and tide conditions on the river, and its Naval Architects have developed a suite of realistic ship manoeuvring models for the vessels used in the simulation. As well as being assessed during normal operations, the vessel masters also have to demonstrate how they would respond in unexpected scenarios, examining credible emergency situations in a safe, risk free environment.

Andy Mitchell, Tideway CEO, who visited HR Wallingford to try out the simulator, said: "I can see that this could become a new standard for regular competency re-evaluation for the Thames rather like that required of airline pilots. It was truly ground breaking stuff, and I just have to thank the team who have been behind this over the past couple of years—this is exactly what we mean when we talk about being transformational."

This detailed River Thames simulation has also been made available for other groups to use, such as the Thames Skills Academy, with funding from the Trinity House Maritime Charity. They use it to provide River Awareness courses to river practitioners who are not connected with the Tideway Project.

For more information,
visit www.hrwallingford.com.

Above: HR Wallingford's River Thames navigation simulation includes fine details to provide visual clues for vessel masters. Far left: Andy Mitchell, CEO of Tideway, at the helm of a tug in the Thames simulation.

PLASTICMETAL from STRONGHOLD
QUICKLY REPAIRS ALL TYPES OF METALS

STRONGHOLD COATINGS introduces PLASTICMETAL, the industry's first two-component repair technology that can be mixed in various ratios for small and medium repairs to many types of metal.

Above, clockwise: 1. Filled; 2.Gouged; 3. Two Component Product; 4. Ground Smooth

Unlike pre-mixed polymers which have a set viscosity, PlasticMetal is a unique resin and powdered metal system that can be mixed in small quantities in thicknesses to suit particular application requirements. Whether used as a putty, paste or liquid, it yields high compression and tensile strength, and bonds to all metals. This fast-curing compound can be machined after hardening, making it ideal for the repair of defects, pin holes, blow holes and porosity in castings, and to repair machining errors and wear areas in cast iron, steel, aluminum and other alloys. It is highly resistant to physical and thermal stresses, including high chemical resistance, and temperature resistant to 250 C (482 F) continuous. With 12 formulations including those for cast iron, steel, aluminum, bronze, brass, copper, red brass, iron oxide alloy and ceramic, there are thousands of potential applications across a wide range of industries.

When mixed with various hardeners, PlasticMetal can achieve specific characteristics such as viscosity, cure speed, appearance and performance. It can be applied in place with no special tools.

Stronghold Coating Systems is the exclusive North American supplier of DIAMANT products, the world's "gold standard" in structural repair for critical applications. PlasticMetal was developed by DIAMANT and is manufactured in the USA by Stronghold in their centrally located Franklin, OH facilities which includes an extensive testing lab. A veteran owned company, they have over two decades of experience solving tough military and industrial applications involving corrosion, porosity, release properties or cost. Extensive experience with thermal coatings for ARC, plasma and HVOF application.

For more information, visit www.StrongholdOne.com.

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MERMAC R50 winch. Integrated AHC system enabling the winch to actively filter out the effects of vessel movement caused by high sea states, hereby allowing the operators to expand their window of operation.

Proven Technology for Subsea Operation

Winches come in all shapes and sizes and represent one of the most widely used equipment types across all marine industries.

Whether lowering the anchors on a navy destroyer, launching delicate oceanographic instrumentation, deploying and handling a remotely operated vehicle (ROV), operating a deep water seafloor drill or towing a side scan sonar, a winch is more than likely to be involved.

MacArtney Underwater Technology (MacArtney) offers engineering expertise in electrics, hydraulics, mechanics, hydrodynamics, fibre optics, electronics and software. From draft to delivery, MacArtney systems are fully supported by extensive in-house test facilities and quality system procedures.

A closer look at a modern electric marine winch system reveals the extent of technology and engineering effort having gone into creating a system that is fully abreast with the advanced underwater machinery it is called upon to support.

MacArtney winch and handling solutions embrace some of the most advanced and rugged solutions available and have been trusted for decades by customers and operators taking on complex challenges under harsh maritime conditions. The dedicated focus on improving existing designs and developing new solutions ensures that high quality and dependable winch and A-frame systems are always supplied. Specialising in electric winch systems, MacArtney aims to extend windows of operation and provide improved working safety for customers through the deployment of intelligent technology.

Container integrated winch and handling solution. MacArtney containerised solutions range from basic winch systems encased in a shipping/workshop container to dedicated AHC right angle winches for empowering portable, containerised ROV LARS to advanced offshore drill support and subsea mud recovery systems.

Above left: MERMAC A A-frame. The MacArtney range of dynamic MERMAC A LARS solutions include A-frames, davits, and other solutions for providing reliable and fully controllable deployment and recovery of a wide range of equipment—from small oceanographic instruments to large work-class ROV systems. Right: MERMAC S20 winch. MacArtney system supplies are typically an engineered solution, integrating products from our own product portfolio (connectivity products, multiplexers, LARS, and ROTVs) as well as third-party equipment from world leading instrument manufacturers.

Standard Winch and Handling Solutions

Apart from their extreme functionality and reliable features, winch and handling systems based on proven MacArtney standard designs offer several advantages to customers including reduced delivery time, lower costs and standardisation of spare parts. The MacArtney range of standard electrically driven winch systems includes the CORMAC B, Q, and M series spanning from basic deck reel systems to highly versatile modular and frame integrated handling systems. For even more demanding tasks, MacArtney offers the MERMAC S series of powerful general purpose marine winches and the MERMAC R series of cutting-edge ROV winches with active heave compensation (AHC). When it comes to launch and recovery systems, all MacArtney standard solutions are united under the MERMAC A series.

MacArtney's dynamic MERMAC A launch and recovery system (LARS) solutions include A-frames, davits and other solutions for providing reliable and fully controllable deployment and recovery of a wide range of equipment - from small oceanographic instruments to large work class ROV systems. MERMAC A LARS solutions are available as portable or fixed systems and form part of compact and fully integrated winch and handling solutions on board almost any type of vessel.

Custom Winch and Handling Solutions - Special Engineering and Design

A broad range of special winch and handling solutions are available from MacArtney providing design and engineering support for custom handling system projects across the globe. These special systems are used in offshore, subsea, defence, scientific, and civil engineering, which often involve close cooperation with the customer to identify technical needs and expectations.

The custom winch and handling solutions comprise the following range:

UNDERWATER WINCHES

The multipurpose underwater winch systems are used for e.g. defence industries, port security, scientific applications incl. seabed observatories, and climate change studies.

TRACTION WINCHES

Traction based winch systems are often used for handling long synthetic ropes and for cables with synthetic armouring, pipe tracking, for the oil and gas industry, and within science.

MOON POOL HANDLING SYSTEMS WITH CURSOR WINCHES

Moon pool handling systems provide easy control and handling of entire ROV systems through a vessel moon pool and are applied for diving bell systems, as well.

ARCTIC WINCHES

Winches for arctic applications are designed, manufactured, and tested to provide safe and efficient performance under extreme climatic conditions.

CONTAINER INTEGRATED WINCH AND HANDLING SYSTEMS

An extensive variety of container integrated winch and handling systems are available for empowering various standard and special applications. MacArtney container integrated solutions range from basic winch systems encased in a shipping/workshop container to advanced offshore drill support and subsea mud recovery solutions.

MILITARY SPECIFICATION WINCHES

MacArtney also supplies winches which meet the requirements of most military specifications, regulations, design criteria, and standards across the world (including United States MIL standards).

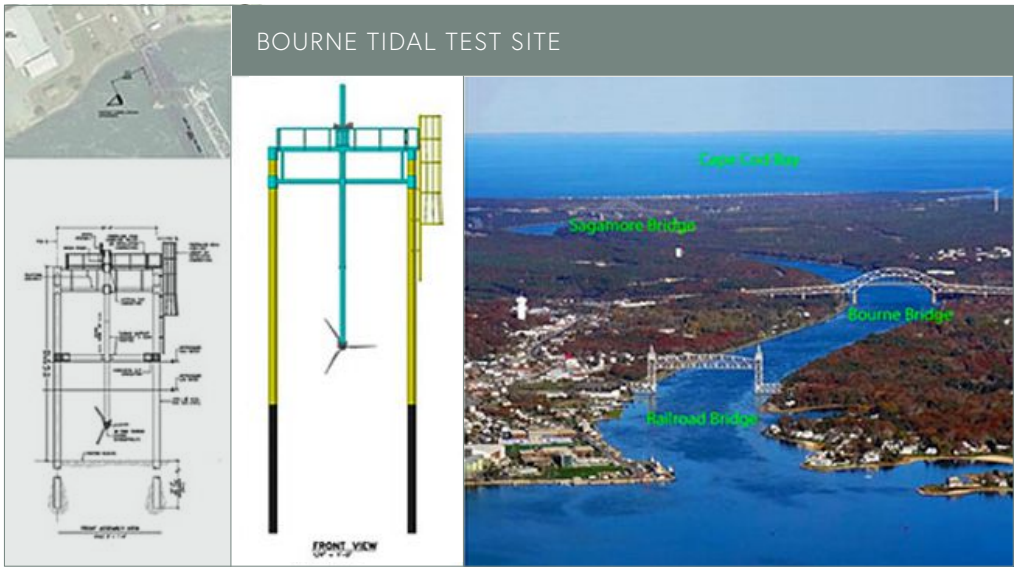
COMPLETE RESEARCH VESSEL WINCH AND HANDLING SOLUTIONS

MacArtney supplies completely integrated winch, handling, and LARS solutions to research vessels across the world. MacArtney packages often comprise both standard and custom winches in whichever combination is likely to best address the specific requirements applicable for smaller scientific boats as well as large ocean going research vessels.

First Permanent Tidal Power Test Site in the US Approved

After several environmental studies and careful review by multiple agencies, the Marine Renewable Energy Collaborative (MRECo) has received final approval from the U.S. Army Corps of Engineers to install the Bourne Tidal Test Site within the Cape Cod Canal.

"We are very pleased the Corps of Engineers has determined that the Bourne Tidal Test Site will have no impact on the critical mission of the Cape Cod Canal and the local environment," said John Miller, Executive Director of the MRECo.



Funding for the test site was provided by the Seaport Economic Council. The test stand will be installed in a sheltered spot where access is exclusively via the Army Corps of Engineers' facility (where fishing from shore is not permitted) and where it is far out of the navigational channel.

"I am pleased the U.S. Army Corps of Engineers has approved the installation of the Bourne Tidal Test Site in the Cape Cod Canal. With investment from the Massachusetts Seaport Economic Council, MRECo is now positioned to be a national and international leader in tidal turbine research. This project is one critical component in the economic development initiatives of the Buzzards Bay area," said Third Barnstable District State Representative David T. Vieira (R- East Falmouth).

Congressman William Keating is also supportive of these efforts to develop new technologies to build upon our strong marine science and maritime technology sector to bring new jobs and enterprises to the area. "Construction of MRECo's new tidal testing facility will continue to cement our region as a hub for marine science and technology," said Congressman Keating. "The development of tidal energy is important to securing the renewable energy needs of the future. I am happy to have been able to assist MRRCo as it went through its permitting process for this project and will continue to support them in future."

Water velocity has been measured at over 2 meters/second (4 knots) on the maximum tidal cycle in both directions, enough to turn different types of tidal turbines to test their efficiency, power output, robustness and more. Turbines of up to 3 meters can be tested with vertical lift provided for easy access.

MRECo expects to install the platform in November and is accepting proposals for testing in the spring of 2018. Organizations, individuals, companies, and research institutions that would be interested in using the site for testing their own tidal energy devices and/or marine and remote sensors should contact John Miller at: director@mreconewengland.org; phone: 508.728.5825.

Seaport Economic Council is funding the development of the Bourne Tidal Test Site (BTTS) as part of Baker-Polito administration's commitment to promote prosperity in seaport communities of all sizes as well as to cultivate job and economic growth in the maritime economic sector. The Seaport Economic Council, chaired by the Lieutenant Governor of the Commonwealth and administered by the Executive Office of Housing and Economic Development with support from the Office of Energy and Environmental Affairs, challenges the 78 coastal communities of Massachusetts to leverage their unique geographic advantages in order to grow jobs and the economy as well as prepare for the future as we confront the challenges posed by sea level rise and increasingly powerful coastal storms.

For more information, visit www.mreconewengland.org.

WindEurope Urges Regional Cooperation on Offshore Wind in the Baltic

The Baltic Sea is a promising market for offshore wind energy in Europe. The basin offers extremely favorable climate and logistical conditions such as strong and stable winds, low waves, shallow waters and close distances to shore.

According to the recently launched WindEurope analysis on wind energy scenarios for 2030, the Baltic Sea, where 1.5 GW of offshore wind is grid-connected today, will represent the second largest basin for offshore wind, with potentially 9 GW installed by 2030 (according to WindEurope's central scenario).

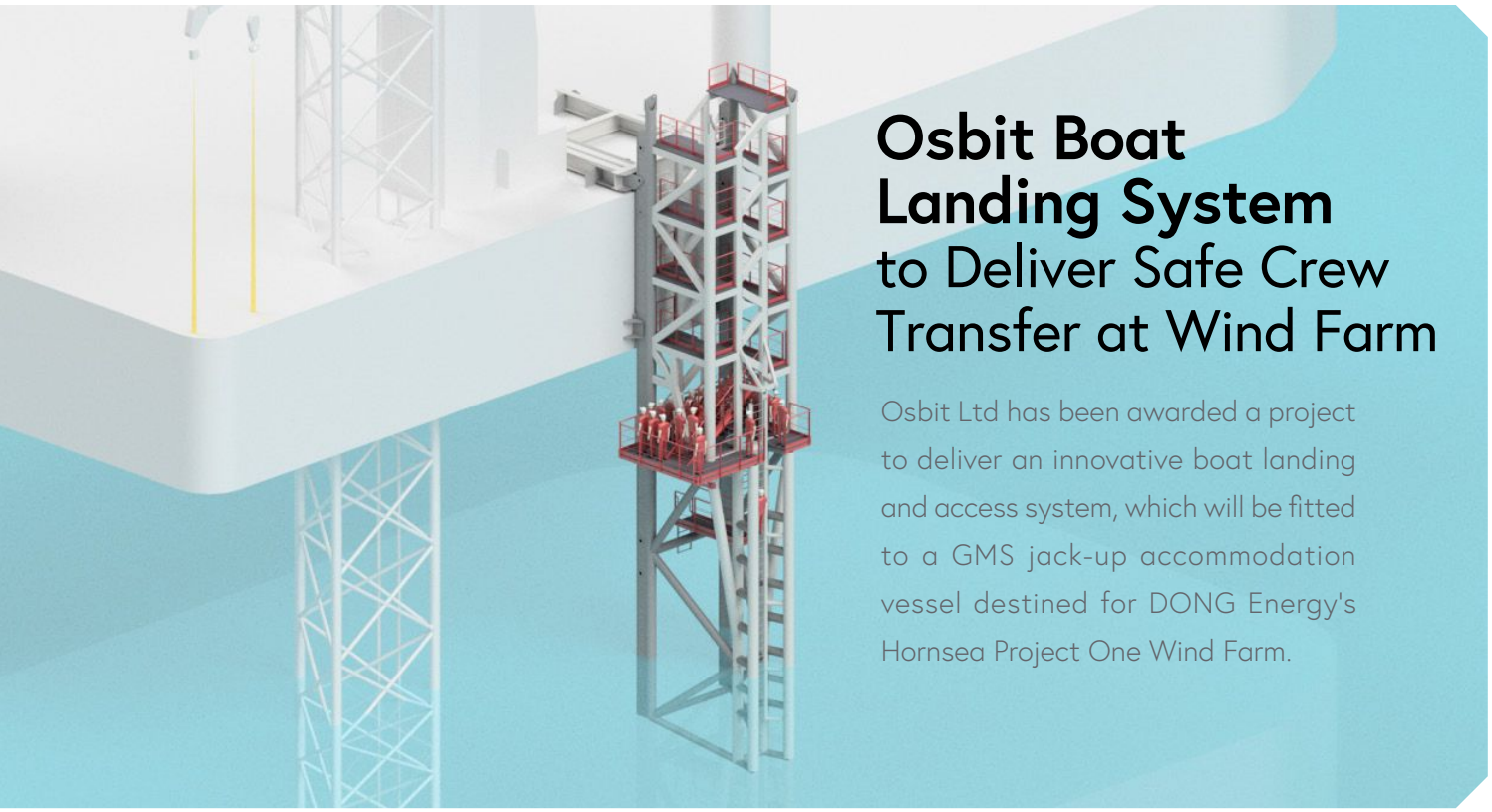
On 28 September 2017, WindEurope signed the Baltic Sea Declaration on Offshore Wind in Tallinn. The document, co-signed by wind energy associations from Estonia, Denmark, Finland, Germany, Latvia, Lithuania, Poland and Sweden, asks governments to enhance their regional cooperation with a view to supporting offshore wind deployment in the region.

On the same day, WindEurope CEO, Giles Dickson, and Martin Kruus, Chairman of the Board of the Estonian Wind Power Association, handed over the Declaration to the Permanent Deputy Secretary General for Energy of the Government of Estonia, Mr. Ando Leppiman. They urged the Estonian government, which currently holds the EU Presidency, to build the political momentum that will help replicate in the Baltics what has already been done for the North Sea.

The Declaration covers several aspects of regional cooperation in the Baltics, from the need to set stable and clear legal frameworks to enhanced cooperation on spatial planning and grid connection. The final goal is to make full use of the renewable energy potential that the basin is offering in order to support the EU's goals of decarbonisation, cost-effectiveness and security of energy supply.

A first step towards the achievement of these objectives is to ensure that governments draft clear national energy climate plans which spell out the volumes of offshore wind they want to deploy post-2020. The long-term outlook and visibility will help create confidence and an attractive market for project developers and investors.

For more information, visit windeurope.org.



Osbit Boat Landing System to Deliver Safe Crew Transfer at Wind Farm

Osbit Ltd has been awarded a project to deliver an innovative boat landing and access system, which will be fitted to a GMS jack-up accommodation vessel destined for DONG Energy's Hornsea Project One Wind Farm.

The boat landing system has been commissioned by Aberdeen-based Gulf Marine Services (GMS) UK Ltd. and will be installed on one of its self-elevating, self-propelled, dynamically positioned large class accommodation vessels.

The project is Osbit's first contract win from GMS UK and will diversify its existing access offering. GMS, intent on delivering innovative solutions to its clients, required the development of a system to specifically facilitate crew transfers to and from a jacked-up vessel to crew transfer vessels (CTVs) and offshore wind transition stations, and this original thinking has resulted in a highly practical boat landing system that is an industry first.

Utilising a unique access tower with an integrated crew transfer vessel (CTV) boat landing, technicians will be able to safely access transfer vessels regardless of whether the GMS accommodation vessel is in a floating position or has been jacked-up to a pre-determined deck height of 21 metres above sea level.

Osbit's system, in accordance with GMS' requirements, is integral to allowing work crews to remain offshore, rather than making daily trips to and from shore and will facilitate up to 50 crew transfers each day. The vessel, and its sister accommodation vessel, will be deployed 120 kilometres off the Yorkshire coast.

The boat landing system will be raised and lowered into position using the vessel's onboard crane, and will feature a waiting area and vessel interface that mirrors the buffer and ladder units found on traditional turbine transition pieces.

> “In delivering our first project for GMS UK Ltd., we are proud to be involved in the development of the world's largest offshore wind farm. This boat landing system enables safe and efficient crew transfer, with minimal operational interference.

GMS' design concept was progressed at Osbit's headquarters in Riding Mill, Northumberland. The boat landing system will be fabricated in the region, supporting GMS' local supply chain objectives, and the system will be installed when the vessel arrives in the North East at the start of 2018.

Brendon Hayward, Managing Director of Osbit Ltd., said: "In delivering our first project for GMS UK Ltd., we are proud to be involved in the development of the world's largest offshore wind farm. This boat landing system enables safe and efficient crew transfer, with minimal operational interference."

"The versatility of the system ensures transfers can take place without being affected by the jack-up vessel height and therefore won't interfere with operations or substation access. As a result, the vessel can become a hub

for technicians working on the substations or turbines, delivering more efficient and cost-effective use of the project's offshore accommodation provision, while maintaining safety at all times."

Duncan Anderson, Chief Executive Officer of Gulf Marine Services, said: "Gulf Marine Services has been at the forefront of jack-up barge innovation since the design of the original four-legged self-propelled concept in 1982, which has given us the ability to relocate rapidly between offshore installations. As a business, we have constantly been evaluating and developing more efficient means of deployment of equipment and services in shallow water. In the oil and gas industry we have led the field in light cantilever intervention development and this boat landing system we are producing in tandem with Osbit is another first of its kind in the world.

"The system gives our barges the ability to safely transfer personnel from crew transfer boats to our barges while remaining jacked up on location with the requisite air gap. Once again it reduces non-productive time for our client while enhancing and improving safety and comfort for those workers offshore who need to access offshore wind transition stations for hook up or maintenance."

For more information, visit www.osbit.com.

ENERPAC SYNCHOIST
Positions Tahkoluoto Wind Farm Foundations

Enerpac Synchoist for installation of gravity bases for offshore wind turbines.

A SyncHoist load positioning system, from Enerpac Heavy Lifting Technology, has been used by Finnish wind power production company, Suomen Hyötytuuli Oy, for the installation of gravity base foundations at the Tahkoluoto Offshore Wind Farm, Pori, Finland. The Tahkoluoto Wind Farm is the world's first offshore windfarm designed for operation in ice conditions.

Operated by Suomen Hyötytuuli Oy, the Tahkoluoto Offshore Wind Farm includes 10 offshore wind turbines, each with a capacity of 4.2 MW. Following preparation of the seabed to provide a level surface, the hollow gravity base foundations weighing up to 500 tonnes were installed. During lowering through the splash-zone and positioning on the seabed, the SyncHoist system was used below the crane hook to ensure the foundation remained as close to vertical as possible. This prevented damage to the levelled seabed surface and facilitated the subsequent addition of the turbine tower.

"The Synchoist wireless control was excellent, enabling us to make adjustments of as little as 5cm during the installation."

To handle the foundation lift without distorting the transition piece flange used to connect the turbine tower, an x-frame lifting tool was developed that connected to the flange. It comprised a lifting frame with four SyncHoist, self-contained PLC-controlled, double acting, push-pull hydraulic cylinders at each corner, and diesel hydraulic powerpack with battery back-up.

High precision manoeuvring of the foundation by the SyncHoist system was performed wirelessly by an operator working alongside the foundation installation team. This allowed the operator to lift and lower each cylinder independently to balance, tilt and position the load in response to feedback from four levelling sensors on the foundation.

"We wanted the x-frame lifting tool to be completely self-contained without any hoses or wires connected to the vessel. This way we had maximum flexibility in the movement of the foundation," says Xavier DeMeulder, marine operations manager, Suomen Hyötytuuli Oy. "The SyncHoist wireless control was excellent, enabling us to make adjustments of as little as 5 centimeters during the installation."

During installation, the level of the foundation was measured, and where necessary adjusted, at every stage of the lift. At the quayside before the lift—this was to establish the centre of gravity for each foundation, on the vessel, just above the water, 3-4 meters into the splash-zone, and 5 centimeters above the foundation.

"SyncHoist made the job of installing the gravity base foundations a good deal easier than using a tailor-made levelling system. The first foundation took 12 hours to install, later foundations took 8 hours as the installation team became more proficient," notes DeMeulder.

For more information, visit www.enerpac.com.

Gas to Become World's Primary Energy Source by 2035


Elisabeth Tørstad

Oil and gas will be crucial components of the world's energy future, according to DNV GL's forecast of the energy transition. While renewable energy will grow its share of the energy mix, oil and gas will account for 44% of world energy supply in 2050, compared to 53% today. Gas will become the largest single source of energy from 2034.

DNV GL's Energy Transition Outlook (ETO), a forecast that spans the global energy mix to 2050, predicts that global demand for energy will flatten in 2030, then steadily decline over the next two decades, thanks to step-changes in energy efficiency. The fossil fuel share of the world's primary energy mix will reduce from 81% currently to 52% in 2050.

Demand for oil will peak in 2022, driven by expectations for a surge in prominence of light electric vehicles, accounting for 50% of new car sales globally by 2035. However, the stage is set for gas to become the largest single source of energy towards 2050, and the last of the fossil fuels to experience peak demand, which DNV GL expects will occur in 2035.

Gas will continue to play a key role alongside renewables in helping to meet future, lower-carbon, energy requirements. Major oil companies intend to increase the share of gas in their reserves, and DNV GL expect an accelerated shift by 2022 as they decarbonize business portfolios.

While demand for hydrocarbons will peak over the next two decades, significant investment will be needed to add new oil and gas production capacity and operate existing assets safely and sustainably. However, the results of DNV GL's model reinforce the need to maintain strict cost efficiency in order to achieve the margins necessary for future capital and operational expenditure.

"We have seen impressive and important innovative efforts across the energy industry, resulting in cost saving and efficiency gains. The oil and gas industry must continue on a path of strict cost control to stay relevant. Coming from a tradition of technological achievements, and having the advantage of existing infrastructure and value chains, this industry has the potential to continue to contribute to energy security and shape our energy future," said Elisabeth Tørstad, CEO, DNV GL – Oil & Gas.

"Increased digitalization, standardization and remote or autonomous operations will play a central role in achieving long-term cost savings and improving the oil and gas industry's carbon footprint. We also expect the industry to turn to innovations in facility design, operating models and contracting strategies," Tørstad added.

DNV GL has published a suite of reports on the Energy Transition Outlook, which are available to download free of charge. The main ETO report covers the transition of the entire energy mix to 2050. Three sector-specific supplements will accompany this: an oil and gas supplement and a renewable, power and energy supplement are both available this week. A maritime supplement will be available later this year. DNV GL's oil and gas supplement considers some of the key trends identified by the company's model across the sector's value chain, and explores their implications.

For more information, visit eto.dnvgl.com/2017. Download a complimentary copy.

Japanese Research sees a Sustainable Future Powered by the Sea

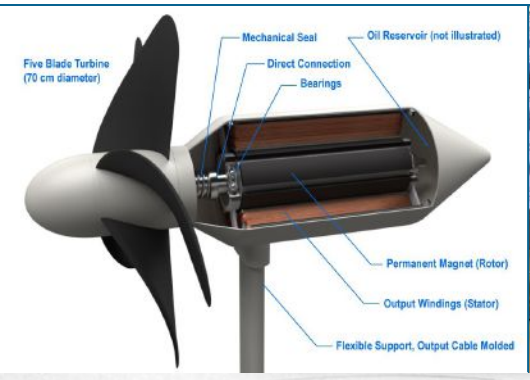
Professor Tsumoru Shintake at the Okinawa Institute of Science and Technology Graduate University (OIST) yearns for a clean future, one that is affordable and powered by sustainable energy. Originally from the high-energy accelerator field, in 2012 he decided to seek new energy resources—wind and solar were being explored in depth, but he moved toward the sea instead.

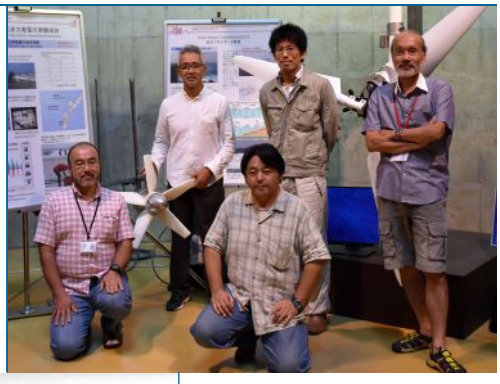
That year, Professor Shintake and the Quantum Wave Microscopy Unit at OIST began a project titled "Sea Horse," aiming to harness energy from the Kuroshio ocean current that flows from the eastern coast of Taiwan and around the southern parts of Japan. This project uses submerged turbines anchored to the sea floor through mooring cables that convert the kinetic energy of sustained natural currents in the Kuroshio into usable electricity, which is then delivered by cables to the land. The initial phase of the project was successful, and the unit is now searching for industry partners to continue into the next phase. But the OIST researchers also desired an ocean energy source that was cheaper and easier to maintain.

This is where the vigor of the ocean's waves at the shoreline comes into play. "Particularly in Japan, if you go around the beach you'll find many tetrapods," Professor Shintake explains. Tetrapods are concrete structures shaped somewhat like pyramids that are often placed along a coastline to weaken the force of incoming waves and protect the shore from erosion. Similarly, wave breakers are walls built in front of beaches for the same purpose. "Surprisingly, 30% of the seashore in mainland Japan is covered with tetrapods and wave breakers." Replacing these with "intelligent" tetrapods and wave breakers, Shintake explains, with turbines attached to or near them, would both generate energy as well as help to protect the coasts.

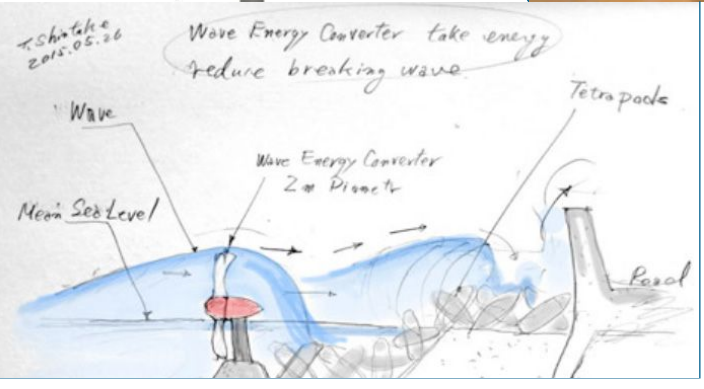
"Using just 1% of the seashore of mainland Japan can [generate] about 10 gW [of energy], which is equivalent to 10 nuclear power plants," Professor Shintake explains. "That's huge."

In order to tackle this idea, the OIST researchers launched The Wave Energy Converter (WEC) project in 2013. It involves placing turbines at key locations near the shoreline, such as





Left: (from left to right) Kenichiro Soga, Hideki Takebe, Jun Fujita, Katsutoshi Shirasawa, Professor Shintake. A WEC turbine is being held by Dr. Takebe on the left and a model of the Sea Horse turbine is shown on the right behind Professor Shintake.



Above left: The blades of this five-blade turbine are made of a soft material and they rotate on their axis when influenced by ocean waves—the diameter of the turbine is about 0.7 meters. The axis is attached to a permanent magnet electric generator, which is the part of the turbine that transforms the ocean wave energy into usable electricity. The ceramic mechanical seal protects the electrical components inside of the body from any saltwater leakage. This design allows the turbine to function for ten years before it need replacing. Left: One prime location to place turbines is in front of tetrapods at the shoreline. At this location, the turbines transform the energy from incoming waves into usable electricity—this in turn dissipates wave strength and protects the shoreline. These turbines can be easily installed and maintained by existing maintenance routes for the tetrapods. They can also be visually inspected from the shore on calm days.

nearby tetrapods or among coral reefs, to generate energy. Each location allows the turbines to be exposed to ideal wave conditions that allow them not only to generate clean and renewable energy, but also to help protect the coasts from erosion while being affordable for those with limited funding and infrastructure.

The turbines themselves are built to withstand the forces thrust upon them during harsh wave conditions as well as extreme weather, such as a typhoon. The blade design and materials are inspired by dolphin fins—they are flexible, and thus able to release stress rather than remain rigid and risk breakage. The supporting structure is also flexible, "like a flower," Professor Shintake explains.

"The stem of a flower bends back against the wind," and so, too, do the turbines bend along their anchoring axes. They are also built to be safe for surrounding marine life—the blades rotate at a carefully calculated speed that allows creatures caught among them to escape."

—Professor Tsumoru Shintake

Now, Professor Shintake and the unit researchers have completed the first steps of this project and are preparing to install the turbines—half-scale models, with 0.35-meter diameter turbines—for their first commercial experiment. The project includes installing two WEC turbines that will power LEDs for a demonstration.

"I'm imagining the planet two hundred years later," Professor Shintake says. "I hope these [turbines] will be working hard quietly, and nicely, on each beach on which they have been installed."

For more information, visit www.oist.jp.

Above: Coral reefs are another type of location with strong breaking waves. Water moving from the deep sea over a shallow reef creates fast jet flows of water. Arrays of small WECs will harness electricity from the vortex flow of breaking waves. The design—dark-colored blades on top of white bodies with thin stems—is visually pleasing, and resembles a flock of birds or group of flowers.

MONTH IN REVIEW

Aker Solutions Wins Troll FEED Contract with EPCI Option from Statoil

The order includes an option for engineering, procurement, construction and installation of the module, which will receive and process gas from the Troll West field.
http://ont.news/2zC4Bi5

Suomen Hyötytuuli Celebrates Finland's First Ever Offshore Wind Farm

Conditions for offshore wind power in Finland differ from those in the North Sea and demand different kinds of technology.
http://ont.news/2h4YNXC

RINA to Support Eni's Coral South FLNG Project in Mozambique

RINA will act as Certification Authority for the design and fabrication of subsea structures and equipment and to provide technological validation services.
http://ont.news/2yLxA3Y

Group to Develop Better Maintenance for Offshore Wind Cables

SEA, Fraunhofer, EMEC Synaptec are developing multi-functional monitoring solutions power cables used in the offshore energy industry.
http://ont.news/2gGaPKa

Statoil Achieves Climate Target Two Years Ahead of Schedule

The reduction equals the emissions from some 600,000 private cars annually, or almost every fourth car on Norwegian roads.
http://ont.news/2lh1F8v

Last Turbine on Dudgeon Wind Farm Installed

September saw the last of the 67 wind turbines being installed on the Dudgeon field and all of them are now producing electricity.
http://bit.ly/2lcuq5U


BGS
1835
RD2
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
SHK 328510-1
22U1
MGW 30,480kg
TARE 3,000 6,615

READY FOR THE NEXT *Gold Rush?*

THE UK IS PRIMED TO LEAD THE WAY IN DEEP-SEA MINING

By Kira Coley, *UK Correspondent*

Named from the German word "goblin," cobalt was once considered troublesome by medieval miners because of the toxic vapours released when smelted. It's perhaps ironic to think that today cobalt—the goblin element—is favoured by modern society and plays a critical role in renewable energy, electric cars, and even cancer treatments. Humankind's pursuit of cutting-edge technology will continue to grow into the foreseeable future, requiring considerable quantities of many raw materials. If we are to meet the demand, new unexploited sources of these scarce so called "E-tech" elements will need to be discovered, and the UK is positioning itself as a world leader in this emerging sector.

On Saturday, 29 October 2016, the RRS "James Cook" left Santa Cruz, Tenerife, bound for Tropic Seamount, some 300 nautical miles southwest of the Canary Islands.

MarineE-tech scientists undertook a holistic study of Tropic Seamount, an ancient volcanic island in the North East Atlantic, 3 km high and covering twice the area of the UK's Isle of Wight. The focus of the cruise was to discover the processes controlling the formation, composition, and distribution of cobalt-rich ferromanganese crusts. These crusts are found throughout the global oceans on the flanks and summits of submarine mountains, ridges, and plateaux, where seafloor currents have swept the ocean floor clear of sediment for millions of years.

During the six weeks at Tropic, the MarineE-tech team collected a vast amount of new data and completed one of the most thorough and detailed investigations of a single seamount ever undertaken.

The MarineE-tech research is supported by the Natural Environment Research Council, the UK's largest funder of environmental science.

Funded under their Security of Supply of Mineral Resources research program, the project aims to tackle some of the current raw material supply challenges by improving our understanding of how certain metals are concentrated by the Earth's natural processes and how they can be extracted and recovered in more environmentally sustainable ways.

MarineE-tech leads the way in exploration and assessment of cobalt-rich crusts on seamounts and, so far, has found about one million tons of cobalt—eight times the amount produced globally. But as technology continues to develop around the world, it is quickly becoming clear that even this vast volume isn't sufficient to meet product demand.

The Global Energy Metals website reports that planned battery production over the next two years will account for around 60% of total global cobalt demand in 2020—up by 58%, driven mainly by electrification of vehicles and advancements in popular technology such as mobile phones and laptops.

"According to the UK's Driving Vehicle Licensing Authority, around 37 million cars are registered in the UK today. Just imagine the demand for cobalt if the UK Government were successful in replacing all hydrocarbon cars with electric ones by 2040—and use batteries like in the new Tesla Model 3," said Dr. Bramley Murton, chief scientist and principal investigator of the MarineE-tech project, National Oceanography Center, UK.

> **"...there is a huge opportunity for the UK, which with its well-established deep-ocean research programs, world-class universities and research centers working on relevant technologies, is well placed to take advantage of future developments in this sector.**

"That would require almost half a million tonnes of additional cobalt or an extra five times the entire annual global production. Then expand that to Europe's 216 million cars, and you'd have to find around 3 million tons of additional cobalt—that's 28 times more than today's total annual output globally."

Leading the Way to Deep-Sea Metals

The UK and European economies are strongly dependent on imports of critical E-tech metals such as tellurium and cobalt from politically or economically unstable countries like the Democratic Republic of Congo (DRC). This fact is recognized by the European Commission in the research priority given to the investigation of domestic and alternative mineral resources, including those on the seabed (European Commission, Horizons 2020).

With a well-developed offshore services sector and as a global leader in underwater robotics and autonomous systems, the UK is already exploring opportunities and looking to develop capacity in the deep-ocean metal mining industry. There is also high-level political support for the development of this sector, and estimates suggest it could be worth £40 billion to the UK economy over the next 30 years.

Paul Lusty, team leader and senior economic geologist at the British Geological Survey (BGS), explains: "When he was Prime Minister, David Cameron claimed seabed mining could be worth tens of billions of pounds to the UK economy in future decades. So, there is a huge opportunity for the UK, which with its well-established deep-ocean research programs, world-class universities and research centers working on relevant technologies, is well placed to take advantage of future developments in this sector."

To fill the space in the UK's strategic research in marine minerals, MarineE-tech is the only scientific research program in the UK with the aim of assessing the resource potential of seafloor mineral deposits rich in rare earth elements, tellurium, and cobalt.

Murton said, "Deep-sea mining is waiting for two things. The first is the proof of technology. For this, Nautilus Minerals is leading the way, but has cash flow problems with investors waiting to see how the copper price moves and other investors waiting to see if the technology works as planned. The second is that the open ocean industry is waiting for the finalization of rules to allow mining from the International Seabed Authority."

The company UK-Seabed Resources Ltd.—a subsidiary of the U.S. conglomerate Lockheed Martin Inc.—is directly involved with exploration for deep-

ocean manganese nodules in the Clarion-Clipperton region of the north Pacific Ocean. Newcastle-based engineering company, Soil Machine Dynamics Ltd (SMD), has been commissioned by Nautilus Minerals Inc. to build mining equipment—currently undergoing trials—for what will potentially be the world's first deep-ocean mining operation in the Pacific Ocean.

According to MarineE-tech, deep-ocean mining has rapidly moved from a distant possibility to a reality that can make a major contribution to global mineral supply and the UK economy.

By bringing together a consortium of research and industry partners, the project has the potential to catalyse the UK sector to become a global leader in marine minerals and the practice and policy issues around environmental protection during resource recovery worldwide.

In Search of the Ocean's Hidden Treasures

Deep-ocean exploration is challenging and expensive due to its remoteness and depth. Many parts of the deep-ocean are very poorly explored. Lusty explains, "We have higher resolution maps of some other planets than parts of the Earth's seafloor. The great water depths in many parts of the ocean [where] we are currently exploring for mineral resources mean very specialist equipment is necessary for surveying and sampling. These range from fairly crude sediment sampling devices which work under the influence of gravity through to very sophisticated underwater robots and autonomous submarines. The British Geological Survey has a unique capability in this area, and we used our drilling rig to drill mineral deposits in the middle of the Atlantic last year in water depths of about 3,500 m."

During the MarineE-tech cruise, scientists deployed the NOC-developed autonomous underwater vehicle (AUV), Autosub6000, to map the height and shape of the subsea mountain as well as photograph and image the seafloor. A range of moored sensors measured water column properties at 4,000 m below the surface, and the NERC UK science-class remotely operated vehicle (ROV), Isis, took 400 samples of the mineral bearing rocks using both a newly developed drill system and hydraulic grab arms.

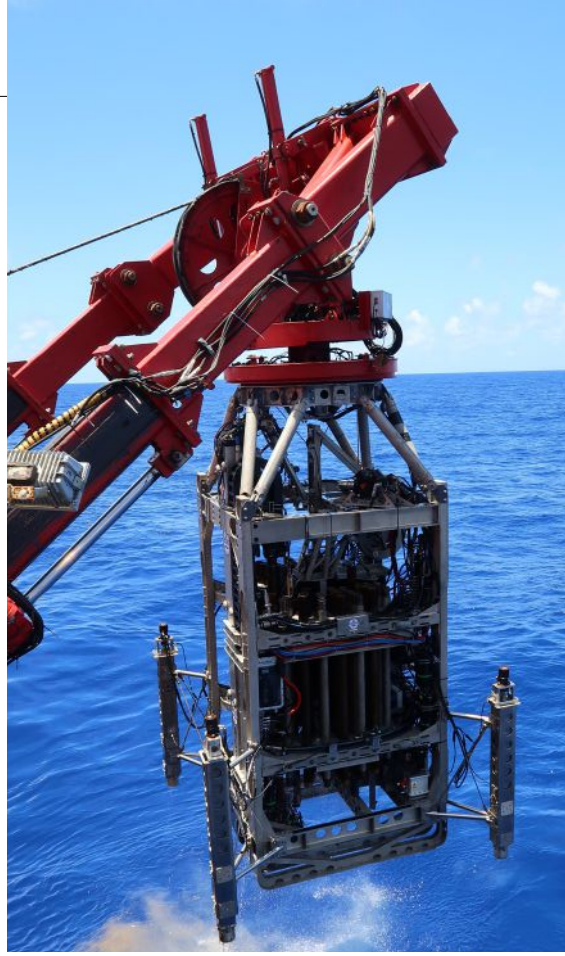
A range of new exploration tools for seafloor mineral deposits are under development. These can measure the physical properties of the seafloor to help identify the presence of mineralization and include sub-bottom acoustic imaging systems that transmit acoustic waves through the seabed to measure the thickness of the crusts.

Scientists also conducted the first-ever robotic underwater vehicle-based sediment plume generation and monitoring experiment at Tropic. Sediment plumes are one potential environmental impact of deep-ocean mining.

Murton explains, "We have done the first comprehensive drilling of crusts, the first deep-sea plume experiments, and we are the first to make a thorough study of the environmental impacts of mining on a seamount. For me, as chief scientist, the MarineE-tech project is rewarding as it offers us the potential to start a new industry that can be environmentally sustainable from the outset and that will help provide the world with essential and critical metals and elements for a low-carbon civilization."

"The cobalt resource alone will help us electrify our transport, and the tellurium we have found could be used to make enough solar panels to power 60% of the UK's electricity demand through carbon-free solar energy. Hence, I feel we can make a difference to society and humankind as a whole, releasing us from dependency on old fossil fuels and decreasing the negative impact on our planet."

In October 2018, MarineE-tech will travel to the Rio Grande Rise to study crusts on the seamount off Brazil, enabling a north-south Atlantic comparison in crust formation processes.

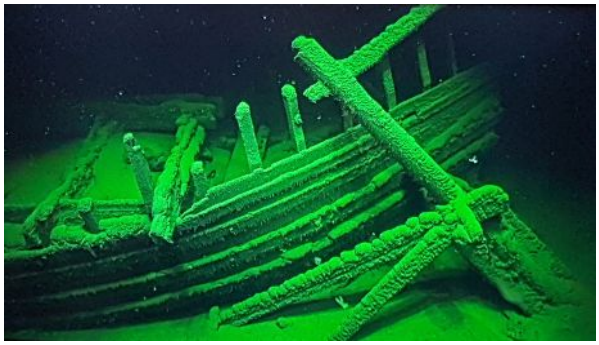
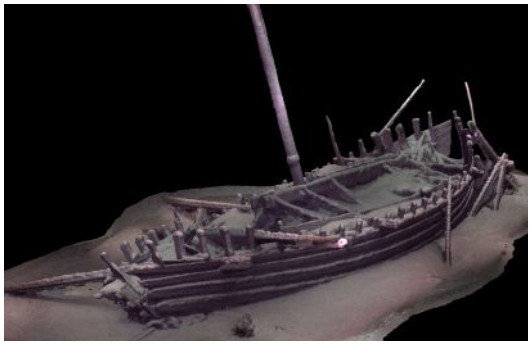


ACKNOWLEDGMENTS

Dr. Bramley Murton, *Chief Scientist and Principal Investigator of the MarineE-tech project, National Oceanography Center, UK*

Paul Lusty, T*eam Leader and Senior Economic Geologist at the British Geological Survey (BGS)*

Photos: British Geological Survey seafloor rock drill (RD2) being used drill seafloor massive sulphide deposits on the mid-Atlantic Ridge as part of the EC-funded Blue Mining project. RD2 is capable of drilling up to 50 m below the seafloor using a carousel drilling system.

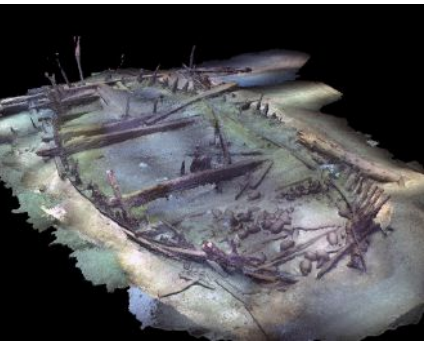
Unique Antique Shipwrecks Detected in the Black Sea

On Tuesday 19th September, after more than a month out on the Black Sea, the third year of the Black Sea MAP marine archaeological project ends.

The main objective of the project has been to map the submerged submarine landscapes along the Bulgarian coast. The water level of the Black Sea has risen significantly since the end of the last ice age, and ancient shorelines can now be found down to a depth of more than 100 meters.

During 2016 and 2017, MMT together with Reach Subsea has participated with underwater technology and survey and ROV vessels (M/V Stril Explorer, 76 meters long and M/V Havila Subsea, 98 meters long). A total search distance of approximately 2600 km has been mapped with the newly developed Surveyor Interceptor ROV. In addition, about 50 sediment cores have been collected for analysis, and as a bonus more than 60 new wrecks have been found. These have been inspected and documented with work class ROVs (Kystdesign Supporter and Shilling) down to over 2000 meters depth.

The preservation conditions for wood in the Black Sea are similar to those in the Baltic Sea. In both of these inland seas, wood and other organic materials can be preserved for a very long time. However, unlike the Baltic Sea, many custom-built trade and war ships belonging to powerful states and cultures have sailed and sunk in the Black Sea for thousands of years. Preliminary age determinations indicate that the oldest wrecks that were found and inspected during the



project are from classical Greek and Roman times. This means that some of the examined wrecks at the seabed are up to 2500 years old. The unique preservation conditions, in a dark and low-oxygen environment, result in many of the ships having intact hullsides and masts still standing up. On board the ships, many containers for wine, oil and olives have been found. Some of these amphorae have been salvaged with an ROV after first being uncovered using a suction hose. A unique example of robot archaeology! Marine archaeologists on board have been able to study ancient shipbuilding details, previously known only through paintings and inscriptions.

In addition to standard survey systems on the ROVs (Chirp, Sidescan Sonar and Multibeam Echo Sounder), MMT has equipped the different ROVs with lasers and high resolution still and video cameras. 3D, made-to-scale models of the wrecks have been created on board using this equipment (photogrammetry and laser bathymetry) and have then been printed on a 3D printer on board *Havila Subsea*. In many cases, it has been possible to have a correct scale model of a wreck less than 12 hours after it was discovered!

The project is lead scientifically by Southampton University, UK and The Bulgarian Center of Underwater Archeology with Södertörn University/ MARIS, SE and University of Connecticut, US as scientific partners. MMT has in collaboration with Reach Subsea provided the platform and technical solutions for survey, sampling and documentation. The project can also be seen as a continuation of MMT's long-term cooperation with the Marine Research Institute, MARIS at Södertörn University. A collaboration that has included, among other things, surveys in the Baltic Sea of the so-called Ghost Ship from the mid-sixteenth century, and the naval ship Mars (1564).

The project has been funded by the *Expedition and Education Foundation (EEFE)*, a foundation funded by *Julia and Hans Rausing Trust*.

For more information, visit www.mmt.se.

Photos from left to right: 1. MMT's vessel Havila Subsea and Surveyor Interceptor ROV, ©MMT; 2. 2000-year-old Roman wreck in 2000 meters water depth. (Photo Johan Rönnby, Black Sea MAP); 3. Preliminary photogrammetric model of Black Sea MAP's final discovery of 2017. A Roman ship lying in over 2000 meters water depth. The relatively slight damage at the bow and stern was sustained at the time of wrecking. Since then, nearly two thousand years ago, time has passed it by (Black Sea MAP); 4. Black Sea MAP's discovery of a late Roman ship on the Bulgarian shelf. Although the depth is relatively shallow, the wreck is extraordinarily well preserved. (BSMAP 2017).

3U TECHNOLOGIES, LLC
Supported Vulcan Inc. USS Indianapolis Project

Photo courtesy of Paul G. Allen.

3U Technologies, LLC announced that 3U engineering and management personnel supported Microsoft co-founder and philanthropist Paul G. Allen and his company Vulcan Inc. during design, manufacture and commissioning of Vulcan's new 6000 meter ROV system. This state-of-the-art ROV was used to confirm and document the wreckage of the USS *Indianapolis*, found at 5500 meters (18,000 feet) in the Philippine Sea on August 19, 2017—72 years after sinking.

The USS *Indianapolis* was lost on July 30, 1945, shortly after delivering key components for "Little Boy", the first of two atomic weapons used in WWII, to Tinian Island. The USS *Indianapolis* was torpedoed by the Japanese submarine I-58 in the Philippine Sea with 1,196 U.S. sailors and Marines aboard. Survivors were left to drift for four long days, enduring shark attacks, dehydration and sea water poisoning before 316 survivors were rescued. 3U was initially contracted by Vulcan in 2012 to investigate 6000 meter ROV solutions to extend Mr. Allen's passion for WWII Naval history, exploration and archeology to most of the world's ocean depths.

Working under the direction of Robert Kraft, (Vulcan Director of Subsea Operations) 3U personnel sourced, specified and designed all key systems/sub-systems and managed equipment manufacturing, testing and integration from a worldwide supplier base. The result is a powerful 100 kW (130 Hp equivalent) ROV which is well outfitted for deep ocean exploration.

"3U Technologies is very proud and honored to have been involved in this project, which hopefully brings some measure of closure to the 19 *Indianapolis* crew members remaining alive today," stated Carl Barrett, lead project manager from 3U. "At 3U we pride ourselves on our record of successful completion of new and unique technical projects and look forward to further opportunities to support Vulcan's exciting future projects."

"3U Technologies provided unparalleled engineering services and was instrumental in the development and acquisition of arguably one of the most technologically advanced and capable deep diving ROV systems in the world today," commented Kraft.

3U Technologies provides solutions to problems underground, underwater and under-ice—all related by harsh and unpredictable environments, challenging requirements and a need for creative technical solutions. 3U specializes in international business consulting, project management, and engineering services including specialization in submarine robotic systems, submarine cable systems and offshore subsea facilities, among a range of capabilities. 3U offers a broad range of engineering, project management and maintenance services providing unique, cost-effective solutions to difficult technical and management challenges.

For more information, visit www.3utech.com.

KEY FEATURES

- INS-based automation
- Waypoint navigation & station keeping
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- Powerful all-electric propulsion
- 4500 VAC, 17mm diameter umbilical
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- Broadcast quality HDTV video cameras
- High-megapixel still cameras
- Scanning and multi-beam sonar systems
- Multiple high bandwidth data channels
  - *Gigabit Ethernet*
  - *Serial Data*
- Dual Titan 4 manipulator
  - *Isolated hydraulic supply*
- 18 kW tooling hydraulic system
  - *Operator adjustable flow & pressure*

HYDROID DELIVERS First New Generation REMUS 100 AUV

Hydroid Inc., a subsidiary of Kongsberg Maritime, announced that it successfully completed the first delivery of the New Generation REMUS 100 autonomous underwater vehicle (AUV) to its Naval Oceanographic Office customer.

This delivery is a major milestone for Hydroid and represents the continuous evolution of the REMUS AUV product lines and ongoing growth of marine robotics technology.

"This is an exciting time for unmanned underwater technology and we are proud to play a major role in the market with our REMUS line of AUVs," said Duane Fotheringham, president of Hydroid. "The evolution of the REMUS 100 is a testament to the sustainability and longevity of our AUVs and our ability to maintain our core offering, while also integrating the latest, cutting-edge technologies."

The New Generation REMUS 100 AUV features advanced technology and capabilities that are the first of their kind in the industry, enabling customers to have increased autonomy and capability during missions. Designed based on the feedback from the AUV community, it combines the reliability of the original REMUS 100 AUV that customers know and trust with new features and capabilities, such as advanced core electronics, a flexible navigation suite with an exclusive conformal Doppler Velocity Log (DVL) and an open architecture platform for advanced autonomy.

For more information, visit www.hydroid.com.

> "The evolution of the REMUS 100 is a testament to the sustainability and longevity of our AUVs and our ability to maintain our core offering, while also integrating the latest, cutting-edge technologies.

Photo: Cutterhead search.

Recovery Operations Successful with JW FISHERS' Metal Detectors

Every day, bodies of water around the globe are used for recreational purposes, to supply food and drinking water to the growing population, to help stock our natural resource supplies, and to provide a natural habitat for marine life.

Sometimes these very same "friendly" waters take valued possessions from people or are used to discard evidence from a crime scene. JW Fishers has been manufacturing hand-held, underwater metal detectors for over 40 years and has been the equipment of choice for both law enforcement agencies and treasure hunters worldwide.

The top-rated Pulse 8X has been manufactured for over 25 years and is the "go to" tool when things go missing underwater. Its wide variety of search coils, including two boat deployable coils, are easily interchangeable giving the end user complete control over their search. The SAR-1 was introduced to the market in January of 2017. This new metal detector was developed as a result of significant customer feedback and extensive product testing. This detector was specially designed for use by public safety dive teams, law enforcement agencies, and military units that need to locate metal objects in underwater environments with poor visibility. The SAR-1 alerts the operator to the presence of metal by vibration which is transmitted through the handle. In addition to vibration, the detector also has a high-intensity LED display which is directly in front of the diver's face and easy to see in all conditions. It's snareless design with no external wires or cables, rugged construction, streamlined configuration, and bright yellow search coil help the operator find any target in zero-visibility water.

Owner William Nichols of Timber Bay Sport and Dive Center in Woodruff, Wisconsin, is an avid diver and operator of the Pulse 8X underwater metal detector. His dive center specializes in scuba diver training, equipment sales, and equipment service. Recently, a woman lost her ring in about 10-12 feet of water while on a swim raft. The bottom was about three feet of weeds with silty muck on the bottom. She recruited Timber Bay Sports to help find her irreplaceable ring. Bill says "I had to work the detector up and down in the weeds as I couldn't swing it side to side. I located 23 small targets before discovering the ring. I covered about an 18-foot circular area which took just under an hour. The family had all but given up!" Bill has found some other valuable pieces such as another ring and a $1,000 pair of glasses. He states "all of these were in little to no visibility but with a lot of patience and my JW Fisher Pulse 8X, it was not a question of if I'd find them—just when! Thanks for a great product and wonderful service!"

The Miramar Police Department Dive Recovery Team utilizes the JW Fisher Pulse 8X with a 10-inch coil. Sergeant Dillena says "We have found this unit to be extremely reliable and versatile. The Pulse 8X has a proven track record so much so that this is our second unit. We deploy the system using the long or short arm for shore based activity. Underwater we deploy it a little differently as we mount the unit on the tank strap, remove the arm and hold the coil only as we sweep the grid. This allows users to work a grid easily and accurately. This unit has been used in multiple cases where evidence was disposed in a waterway, through the use of this unit we were able to recover critical evidence that would likely not be found without your metal detector. We have had great success utilizing this unit and would highly recommend this product."

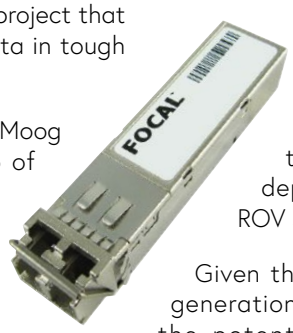
TerraAquatic Inc. specializes in hydrographic surveying, primarily addressing the needs of the near-shore and inshore industry. They recently purchased a hand-held underwater metal detector from JW Fishers Mfg. Ken Jackson states, "just after purchasing the locator, a client's cutterhead hit a large concrete block shearing the shaft and then losing the cutterhead into the face of sand they were dredging. Since it was quickly covered by sloughing sand they asked if I could give it a shot, after they snorkeled around for 12 hours, we found it in five minutes!"

Few other departments utilizing the Pulse 8X are the Wheeling Police Department in WV, the Wichita Falls Police Department in KS, Olmstead Sheriffs Dive Team in MN, Missouri State Water Patrol, Japan's National Police Agency, FBI teams, state police, and other dive teams across the globe.

For more information, visit www.jwfishers.com.

MOOG FOCAL Launches 4 Gbps Pressure Tolerant Optical Transceiver

Moog Focal announces the launch of its new 4 Gbps, pressure tolerant (PT) small form-factor pluggable (SFP) optical transceiver. The first order will be supplied to MacArtney UK Ltd. for a project that requires high bandwidth data in tough pressure tolerant conditions.



This new product is part of Moog Focal's increased portfolio of qualified pressure tolerant technology, including pressure tolerant electronics and optical products for use in subsea applications. With a standard rating of 4000m (6000psi/430 bar), and options for even higher pressures, Focal's PT products support the most challenging of applications. To ensure reliability, all designs undergo rigorous qualification testing, and each product is test screened above the design rated pressure during factory acceptance.

With this newly qualified 4 Gbps offering, several existing 1 Gbps PT systems currently deployed in the field can now be upgraded to support higher bandwidth applications. Pressure tolerant products need to be enclosed in a subsea junction box typically filled with oil. Focal has tested compatibility with many typical oils used in the marine industry and continues to validate additional fluids as new applications emerge.

In addition to pressure tolerant slip rings and fiber joints for use subsea, Moog Focal supplies reliable pressure tolerant solutions for composite video, HD video, Ethernet and serial channels, with thousands of products deployed subsea primarily in ROV systems.

Given the higher capacity of next generation multiplexer designs and the potential for integration cost savings associated with pressure tolerant technology, overall system costs for multiplexers could potentially be reduced by up to 50 percent while actually increasing data capacity.

For more information, visit www.moog.com/content/sites/global/en/products/multiplexers-media-converters/focal-multiplexer-product-line/pressure-tolerant-electronics-and-optics.html.

MONTH IN REVIEW

Add Energy and Trendsetter Engineering Introduce RWIS Lite

RWIS Lite is an exact structural replica of the original RWIS, which allows for duplicity in shared components.
http://ont.news/2z4Rp95

CGG Completes Perdido Subsalt Survey for Pemex

This landmark survey also saw the first deployment of Sercel's QuietSea™ next-generation Passive Acoustic Monitoring (PAM) system in the Mexican Gulf of Mexico.
http://ont.news/2zNSvn6

Deep Ocean Engineering: New USV Thrusters

The thrusters are of professional grade and have been tested to 300 meters of depth. Optional features include a built-in GPS and real-time kinematics.
http://ont.news/2lc6wYh

Kraken Robotics Inc. Awarded $2 Million Contract

The contract entails the delivery of advanced sensors, underwater robotics and software. Delivery of the entire contract is expected in 4Q 2017.
http://ont.news/2i2jTpa

3D FORWARD LOOKING SONAR with Local History Mapping Benefits the Oil & Gas Industry

BY CASSIE STETKIEWICZ

Commercially available, three-dimensional forward looking sonar (3D FLS) offers vessel operators improved situational awareness. These systems can provide real-time information as to the depths ahead of a vessel and the locations of potential hazards to navigation. When situations arrive where historical charts are not enough, the navigator is able to "paint" an intuitive 3D image of the seafloor contours as well as potential obstructions ahead of their vessel. This can be done in real-time, and the data can be stored for future use.

3D FLS is a game-changing tool for real-time vessel navigation and detection of not only the range and bearing to a navigational hazard, but also the depth of the hazard in the water column. FarSounder has invested heavily in a database infrastructure associated with the storage and integration of these large survey datasets. Their investments have led to the development of their new software application, Local History Mapping (LHM)™, based on a bathymetric survey engine. With plans for continued investments, the release of additional bathymetric mapping capabilities is on the horizon.

For the offshore Oil & Gas industry, LHM™ software is of great value from both an obstacle avoidance perspective and for bathymetric survey capabilities. Use of the 3D FLS enables ships to enter safely into uncertain areas, and LHM™ enables vessels to map the bottom and perform a small-scale, local survey. This is particularly valuable in the wake of disasters like hurricanes and earthquakes.

For a post-disaster application, waterways become filled with debris from broken and lost vessels and equipment as well as many other obstacles. In addition, bathymetric changes are typical and unable to be seen or predicted. It is quite a challenge for Coast Guard and other rescue ships to maneuver within these regions, particularly in shallow, littoral areas. LHM™ will allow first responders and workboats to save a 3D map of the seafloor. Updated with every ping and displayed as an overlay on top of the system's nautical chart display, vessel operators will be able to quickly see what lies ahead and future software releases will allow operators to save a map of what they've recently passed over.

New applications are being explored and introduced to various market sectors, including offshore Oil & Gas. There is tremendous potential for applying this technology to benefit the industry. It has been discovered that LHM™ can be beneficial to operators as a support tool during a variety of survey missions, such as hydrographic surveys, workboat anchor surveys, and seismic surveys.

Hydrographers are the first to admit that charts do not tell the whole underwater story, especially in remote locations and areas with seasonal weather effects. Prudent navigators should use all senses and tools available. When navigating in waters previously unexplored, having an accurate 3D image of the seafloor well ahead of the vessel is key to safe navigation. Marianne Molchan, former Hydrographer at NOAA says, "the first thing to hit a potential hazard should be the ping from a forward-looking sonar, not the bow of the vessel."

Another application for LHM™ real-time data is that a vessel could perform a small survey covering the expected extents of the area over which the vessel is expected to swing. Displaying the survey as an overlay on top of an electronic nautical chart makes it easy for the bridge crew to visualize the vessel's current position. Operators would be able to orient the vessel relative to any features or obstructions found during the survey. It would assist even when the obstruction is not within the current field-of-view of the sonar's real-time display.

Obstacles in the sea are ever changing and are both man-made and natural occurrences. This type of application has piqued the interest of operators of seismic survey vessels. It would be useful when operating from the mother ship or from a USV as it would allow operators to safely search for obstacles in the water like fishing equipment and other deep floating debris. This is often a problem during seismic surveys where equipment is towed at varying depths where the primary concern is protecting the tow-fish. An accidental collision, allision, or grounding could halt seismic surveys and cost significant time and money.

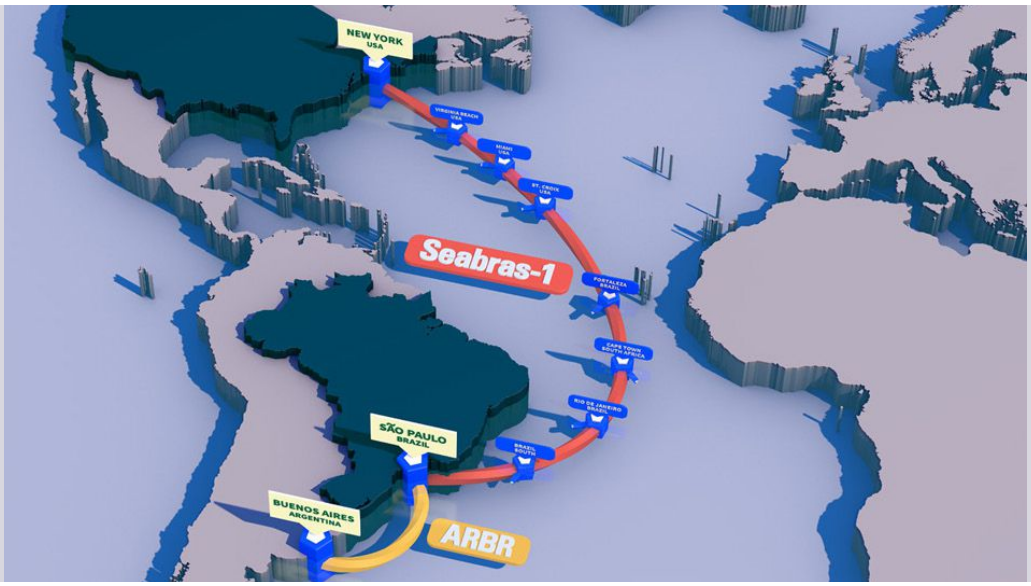
Initial and subsequent surveys are imperative to offshore Oil & Gas companies operating in areas with poor or no chart coverage. The risk of grounding is a real possibility in these unchartered waters. In 2004, the tanker British Enterprise ran aground near Anchorage, Alaska on a shoal that did not exist on charts. The charts showed they were clear to proceed. When they moved over the area, they found themselves in depths of a little over 6 m. As opportunities for offshore Oil & Gas open up with recent legislation making previously reserved areas available for new exploration, the industry is sure to be surveying these opportunities in even more uncertain regions of the globe.

With millions of nautical miles of water along the U.S. coast and in the Great Lakes, NOAA's Office of Coast Survey focuses their resources in the highest priority regions. Surveying and charting is a daunting and time-consuming task, which in turn leaves many coastal areas without updates for years. Much of these poorly charted areas are often also seasonally affected. Over the coming years, melting glaciers produce more and more ice hazards, and storms and earthquakes continue to produce dramatic bathymetric changes. 3D FLS can mitigate much of the risk.

Constantly improving safety at sea can help minimize casualties, environmental damage, and costs across all sectors of the maritime economy—3D FLS is a valuable enhancement to improving safety at sea, and with LHM™, saving the data is now a real possibility. Adopting this advanced technology on commercial ships and those carrying hazardous materials is the next step in an industry striving for safe navigation.

Cruise ship photo courtesy of PONANT cruises.

INFINERA, Seaborn Set Subsea Cable Industry Benchmark for Capacity



> "We are delighted with the performance of the XTS-3300 and the Infinite Capacity Engine 4 for subsea applications. The XTS-3300 delivers industry leading capacity-reach performance for our subsea customers where spectral efficiency is paramount and bandwidth demand is growing at more than 45 percent per year. Infinera delivers unparalleled optical performance, helping to enable the success of our customers as they transform their subsea networks to cloud scale.
>
> *—Dave Welch, President and Co-Founder, Infinera*

Infinera and Seaborn Networks announced the successful completion of a subsea field trial demonstrating the industry's highest spectral efficiency on an ultra-long-haul subsea cable. The 8QAM trial demonstrated 4.5 bits per second per hertz on the Seabras-1 cable, owned and operated by Seaborn, with a distance of more than 10,500 kilometers, enabling up to 50 percent more capacity than systems without advanced coherent technologies such as Nyquist sub-carriers and SD-FEC gainsharing. This trial raises the bar for optical performance by delivering the industry's highest spectral efficiency in a commercially shipping product.

Infinera and Seaborn validated the performance of the Infinera XTS-3300 meshponder featuring the Advanced Coherent Toolkit (ACT) on the Seabras-1 submarine cable, helping Seaborn to maximize the return on its cable assets. Seabras-1 is one of the world's longest uncompensated subsea cables, directly connecting North and South America. Seaborn is the exclusive operator of a Seabras-1 route that has deployed XTS-3300.

The XTS-3300 is based on Infinera's Infinite Capacity Engine 4 (ICE4) and is optimized for long-haul subsea applications. The groundbreaking performance of ICE4 technology incorporates unique technologies to boost capacity-reach performance including digitally synthesized Nyquist subcarriers, enhanced pre- and post-dispersion compensation, improved non-linear tolerance and SD-FEC gain sharing which is only possible with dual-channel DSPs like Infinera's. These capabilities collectively support up to 18.2 terabits per second per fiber for distances over 10,000 km, powered by ICE4's leadership in spectral efficiency.

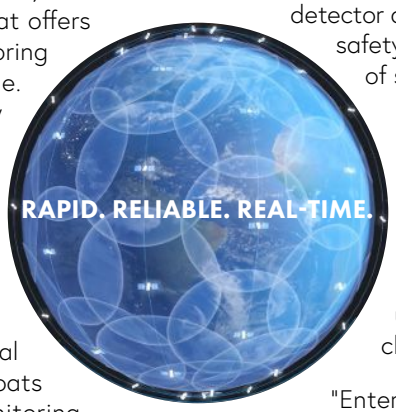
"This is an impressive achievement that far surpasses what we expected. Infinera has distinguished itself as an industry leader in delivering outstanding subsea optical performance," said Larry W. Schwartz, Chairman and CEO, Seaborn Networks. "The Infinera XTS-3300 meshponders deliver industry-leading performance over Seabras-1 and validate Infinera's technology leadership in subsea transmission. The capacity upgrade maximizes our return on investment and further underscores the uniqueness of Seaborn's capacity on Seabras-1."

For more information, visit www.infinera.com or www.seabornnetworks.com.

Agreement to Expand exactEarth Small Vessel Tracking Service Offering

For more information, visit www.exactearth.com.

exactEarth Ltd., a leading provider of Satellite AIS data services, announces that its exactTrax™ small vessel monitoring technology is now incorporated into Alltek Marine Electronic Corp's (AMEC) AIS Tracking Beacon (TB560). The AMEC TB560 is a simplified Class B AIS device that offers an efficient and cost-effective vessel monitoring solution within AIS VHF transmission range. Now outfitted with exactTrax technology from exactEarth, which extends small vessel tracking beyond traditional coastal surveillance, the AMEC TB560 can reliably be detected from space.



exactTrax allows for the secure transmission and reliable detection of signals from the millions of artisanal and small-scale commercial fishing boats and small commercial work boats currently operating around the world. Monitoring and tracking vessels equipped with exactTrax-enabled transceivers supports safety of life at sea and delivers an unprecedented ability to immediately respond in emergency situations. Tracking these vessels can also provide critical intelligence into a variety of marine applications such as fisheries protection, environmental preservation, and maritime surveillance/security through improved 'dark' target analysis.

AMEC's TB560 unit is uniquely equipped with an optional smoke detector and water submersion detector for additional safety alerts that can notify operators immediately of security incidents aboard the vessel.

"We are very pleased to add Alltek Marine to our growing list of partners for our small vessel tracking offering," said Peter Mabson, CEO of exactEarth. "Embedding exactTrax within the innovative TB560 gives us the opportunity to reach even more potential users worldwide and offer customers real choice in their platform options."

"Entering this agreement with exactEarth is very exciting for the AMEC team," said H.A. Chen, President of Alltek Marine. "We have worked hard to establish our industry-leading TB560 beacon and now partnering with exactEarth for enhanced long-range tracking of our devices will offer a distinct advantage to our growing customer base."

MICROSOFT, FACEBOOK AND TELXIUS
Complete Marea Transatlantic Cable

People and organizations rely on global networks every day to provide access to internet and cloud technology. Those systems enable tasks both simple and complex, from uploading photos and searching webpages to conducting banking transactions and managing air-travel logistics. Most people are aware of their daily dependency on the internet, but few understand the critical role played by the subsea networks spanning the planet in providing that connectivity.

The importance of those networks was underscored when Hurricane Sandy hit the East Coast of the U.S. in October 2012. The superstorm devastated coastal communities, caused billions of dollars in damage and shut down wireless, internet and home phone service for days. Flooding knocked out servers, shut down websites and disrupted connectivity across sectors, from electronic trading to online media, affecting transatlantic communications connecting some of the world's largest economies.

"It was a major disruption," says Frank Rey, director of global network strategy for Microsoft's Cloud Infrastructure and Operations division. "The entire network between North America and Europe was isolated for a number of hours. For us, the storm brought to light a potential challenge in the consolidation of transatlantic cables that all landed in New York and New Jersey."

The superstorm sparked the realization that another major event could disrupt the vital connectivity lifeline across the Atlantic. As part of its ongoing efforts to drive innovation and expand capacity of its global network, Microsoft sought options for making transatlantic connections more resilient, and became aware that Facebook leaders shared a similar perspective.

"We kept running into each other at industry events and meetings," Rey says. "We collectively recognized that we were each trying to solve the same problem and could combine our technical and engineering expertise to reinforce the transatlantic network and design a better cable for global connectivity."

Microsoft and Facebook agreed to partner on the development, design and implementation of a 4,000-mile-long subsea cable connecting Virginia Beach, Virginia, and Bilbao, Spain. Global telecommunication infrastructure company Telxius, a subsidiary of telecom provider Telefónica, joined as the third partner to manage the construction process and operate the cable.

Dubbed Marea, Spanish for "tide," it is the first subsea cable connecting Virginia and Spain. Situating the cable many miles south of the current connection points on both continents helps safeguard against natural disasters or other major events disrupting connectivity across the Atlantic.

Marea is also the highest-capacity subsea cable to cross the Atlantic, providing up to 160 terabits of data per second. That's more than 16 million times faster than the average home internet connection, with the capability to stream 71 million high-definition videos simultaneously. Additionally, Marea's landing point in Bilbao provides a convenient path to network hubs in Africa, the Middle East and Asia, and its enormous bandwidth will help meet the increasing demand for internet and cloud services.

"Marea comes at a critical time," says Brad Smith, president of Microsoft. "Submarine cables in the Atlantic already carry 55 percent more data than trans-Pacific routes and 40 percent more data than between the U.S. and Latin America. There is no question that the demand for data flows across the Atlantic will continue to increase and Marea will provide a critical connection for the United States, Spain, and beyond."

The project highlights the increasing role of private companies in building the infrastructure of the future. Microsoft and Facebook designed the cable to be interoperable with a variety of networking equipment. Through a new "open" design, the cable can evolve with technology, ensuring the highest performance for current and future users, even as the global population of internet users grows.

Najam Ahmad, vice president of network engineering for Facebook, says Marea's flexible design will allow the company to adapt to future needs and better support its increasingly data-intensive services. The cable also serves Facebook's goal of enabling users to have "deep connections and shared experiences" with people around the world, he says.

"Obviously, connectivity is one part of achieving that goal. Marea will help us connect people more quickly and

efficiently," Ahmad says. "More broadly, robust connectivity can help a wide variety of people build relationships and collaborate between countries and across cultures."

Rafael Arranz, chief operating officer for Telxius, says, "All of these applications, especially everything that is driven by video, consume a huge amount of bandwidth. So everybody needs to be connected with a high-volume, high-bandwidth infrastructure. With its unique route, this cable is going to be able to absorb and deliver back-and-forth traffic to strengthen communications, not just across the Atlantic, but across the globe."

Marea will serve what has become an increasingly important route for cross-border data flows between the United States and Europe. Transatlantic data flows are expected to continue growing as more consumers use mobile smart devices to access the internet. By 2018, 93 percent of U.S. mobile devices and 83 percent of Western Europe's mobile devices will be smart devices, according to a study by Brookings.

Taking a step to improve the resiliency of the internet infrastructure was something we saw as a positive for the entire global network, and a positive for people who rely on their digital devices for so many aspects of their daily lives.

Northern Virginia has long been one of the main internet data center hubs in the world, and for that reason Virginia Beach, on the southeastern tip of the state, was chosen as the U.S. landing point. Officials in Virginia Beach say the project will help diversify the city's economy, which is heavily dependent on tourism and the area's strong military presence.

"Marea is allowing us to become a digital port, not just a port city," says Warren Harris, director of the Virginia Beach Development Authority. "And the fact that Microsoft is a partner in the cable has given us a level of validation to talk about the benefits of what Virginia Beach can mean for companies. I'm extremely excited."

The project prompted Spanish metal manufacturer Sanjo to invest $17.5 million to build a new factory in Virginia Beach. The plant will serve as a branch of Sanjo's Barcelona headquarters and enable it to better serve its global clientele, says Santiago Cruz Jr., the company's vice president.

"Having good, high-speed communications allows us to have the two (sites) communicating at any time," Cruz says. "In the end, everything we move is data and information."

Robert Hudome, the Virginia Beach Development Authority's senior project development manager, says Marea has also prompted interest from companies hoping to open new data centers in Virginia Beach.

"We're already seeing a lot of interest in data centers being developed here because of the connectivity of the cable," Hudome says. "And it's not just national, it's also international. We see this as an opportunity for a whole new industry sector to develop and bring new capital investment and jobs with it."

The project required charting a course with average depths of almost 11,000 feet and hazards ranging from active volcanoes and earthquake zones to coral reefs. The cable, which is about 1.5 times the diameter of a garden hose, contains eight pairs of fiber optic cables encircled by copper, a hard-plastic protective layer and a waterproof coating. Some portions closer to shore are buried to protect the cable from fishing and ship traffic, but for most of its route, the cable lays on the ocean floor.

Construction of Marea started in August 2016, and the cable began its journey across the Atlantic approximately five months ago. The physical work to manufacture and lay the cable has now been completed, and it is planned to be operational in early 2018. From design through construction, Marea was completed in less than two years—nearly three times faster than the typical subsea cable project.

For Rey, Hurricane Sandy drove home the need for the cable on both a personal and professional level. He was home with his family in New Jersey when the storm hit, toppling a tree in the yard and crushing a car parked outside with a force so violent it shook the house. Rey wanted to let relatives in Europe know that the family was safe, but with connectivity down, he couldn't reach them.

"Everyone expects that whenever they turn on their computer or their tablet or their phone, they're going to work. That's what this cable is going to help enable," he says. "Taking a step to improve the resiliency of the internet infrastructure was something we saw as a positive for the entire global network, and a positive for people who rely on their digital devices for so many aspects of their daily lives."

For more information, visit news.microsoft.com.

Opposite page: The Marea cable coiled onboard a ship. Above: Marea is the highest-capacity subsea cable to cross the Atlantic, providing up to 160 terabits of data per second.

Inmarsat and Rolls-Royce Sign Ship Energy Management Agreement

Inmarsat and Rolls-Royce have signed a Letter of Intent (LOI) to have the option to make the Rolls-Royce Energy Management system available via Inmarsat Maritime's Fleet Xpress high-speed broadband service, to reduce energy consumption and support environmental compliance.

With data collected from a multitude of ship control systems and equipment sensors, Energy Management 2.0 also benchmarks efficiency against historical performance.

Marco Camporeale, Rolls-Royce, vice president, Intelligent Asset Management Solutions, "Monitoring ship fuel consumption and emissions is required by law in some areas and is also increasingly used in vessel selection criteria by charterers.

"Our energy management software quantifies the effects of optimising operational efficiency on costs and the true impact of enhancements as they are phased in. Fleet Xpress always-on connectivity and the potential for application-triggered bandwidth mean that data can be logged in real time, optimising the verifiable reporting capability already built in to Rolls-Royce Energy Management System software."

Vessels equipped with Rolls-Royce Energy Management System software can operate within the Inmarsat Certified Application Provider programme (CAP), connected via Fleet Xpress and hosted on the Inmarsat Gateway platform; and then be able to maximise their efficiency in a way that is constantly verifiable and compliant with European Union (EU) Monitoring Reporting and Verification and the International Maritime Organisation (IMO) Ship Energy Efficiency Management Plan.

Fleet Xpress seamlessly combines the power of Inmarsat's Global Xpress network, the world's only high speed, mobile and globally available broadband service from a single operator, with its ultra-reliable L-band network by means of the Inmarsat Gateway. The Inmarsat Gateway, with its rich set of Application Programming Interfaces (APIs) provides application-triggered bandwidth, a managed-cyber security solution and flexible third-party subscriptions on board Fleet Xpress vessels.

Stein A. Orø, vice president sales, Inmarsat Maritime, said "The CAP programme allows third parties to work with Inmarsat to develop content-rich applications to populate the digital maritime world enabled by Fleet Xpress. The combined Rolls-Royce and Inmarsat technological capabilities will deliver proven energy management software to shipowners with always-on connectivity."

Application-triggered bandwidth usage allows end-users to choose whether to dedicate part of their bandwidth allocation to specific vessel efficiency measures, or for the app itself to trigger bandwidth "dynamically" by the hour.

Stein A. Orø said "In the case of Rolls-Royce, the LOI envisages remote monitoring to document environmental compliance, but new digital services can also be delivered to the maritime industry that create efficiencies for users and new revenue streams for vendors. Application-triggered bandwidth pricing means this can be completely transparent."

The arrangement could provide a template for other vendors seeking to exploit the potential of Fleet Xpress, which has already attracted commitment from over 10,000 commercial ships since its launch last year.

Stein A. Orø continued, "Rolls-Royce Marine has been a pioneer in a range of initiatives using satellite connectivity to enhance the efficiency of maritime transport. This is a milestone arrangement for Inmarsat, demonstrating that the true innovators in maritime technology recognise Fleet Xpress as enabling their own strategies for digitalisation."

For more information, visit www.inmarsat.com.

Webtool Cable Gripper Gets Thumbs Up from DNV GL

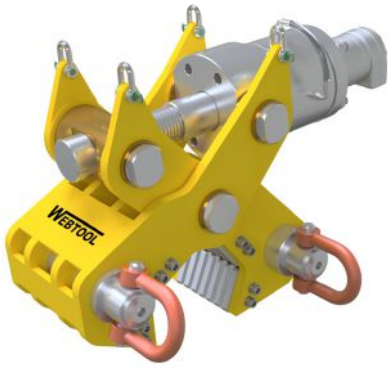
The CRT200 Cable Retrieval Tool, developed by hydraulic tools specialist Webtool, has received design verification approval from international certification body and classification society, DNV GL. It is the first cable and umbilical retrieval tool to meet the exacting design codes and standards for marine operations, and offshore and platform lifting appliances.

Designed to allow the safe and controlled recovery of damaged cable and umbilical, up to 8" (203 mm) diameter, the CRT200 meets the requirements of DNVGL-ST-N001 Marine Operations & Marine Warranty, June 2016 and DNVGL-ST-0378 Standard for Offshore & Platform Lifting Appliances, May 2016.

The CRT200 cable gripper provides a streamlined cable recovery where the gripper, guided by an ROV, is lowered onto the end of the cable without requiring preliminary clearing of the soil around the cable. The mechanically locked gripping action ensures the umbilical cannot escape during retrieval; moreover, an internal clutch mechanism prevents damage from over-tightening. By gripping the end of the cable, it makes subsequent handling much easier, enabling the cable to be recovered to a reeler or spooler on the surface vessel.

The CRT200 cable gripper weighs approx. 600 kg and has a lifting capacity of 20 tonnes. It can be used at any water depth, and is available with hydraulic hotstab or torque bucket interface options.

"Webtool is committed to developing innovative tools for offshore projects," says Keith Elliot, engineering director, Allspeeds Ltd. "The DNV GL design



verification allows us to offer industry-leading engineering to offshore contractors looking for a better way of recovering umbilical and cable from any water depth."

The Webtool range of high performance cutting tools is designed and manufactured in the UK exclusively by Allspeeds Ltd.

For more information, visit www.allspeeds.co.uk.

Power of Integration Tested at USS Dahlgren Naval Technology Exercise

Official U.S. Navy file photo of the aircraft carrier USS Dwight D. Eisenhower (CVN 69) and its Carrier Strike Group (Ike CSG) participate in a strait transit exercise.

The power of a Navy strike group's interoperability with unmanned vehicles, surface and air assets, guns, missiles, and combat systems was proven at the 2017 USS Dahlgren demonstration.

Hundreds of visitors—including 40 distinguished visitors from military, government, and academia—observed this power at the Annual Navy Technology Exercise (ANTX) as the USS *Dahlgren's* capabilities were demonstrated.

The cybernetic ship simulated the USS *Dwight D. Eisenhower* (CVN 69) strike group, hitting targets virtually and with live fire via Littoral Combat Ship (LCS) 30-millimeter guns and Aegis MK 46 gun system 5-inch guns on the Potomac River Test Range.

ANTX featured virtual and hardware representations of combat systems on the *Eisenhower* strike group that comprised USS *Gridley* (DDG 101), USS *Fort Worth* (LCS 3), USS *Milwaukee* (LCS 5), USS *Freedom* (LCS 1), and USS *Mason* (DDG 87) during live fire destruction of surface threats. Throughout the event, an MH60R helicopter, an MQ-8B MQ-8 Fire Scout unmanned autonomous helicopter, a Scan Eagle unmanned aerial vehicle (UAV) and a USV identified and tracked threats over-the-horizon. At one point, an autonomous unmanned surface vessel (USV)—equipped with an inert front-end portion of a Longbow Hellfire missile—staged simulated Longbow Hellfire salvos.

The air assets—upgraded with enhanced radar technologies—and the USV provided real-time targeting throughout the exercise. Track and engagement information was shared across the strike group proving an ability to conduct experimentation in a high-fidelity, distributed architecture.

"We are showcasing all of the good work that we and the NR&DE (Naval Research and Development Establishment) have done, and the seriousness of our role to close the gap for the warfighter," Naval Surface Warfare Center Dahlgren Division (NSWCDD) technical director, John Fiore, told the visitors before the exercise commenced. "Our partnership with industry, academia, and our brothers and sisters in the NR&DE is critical because the only thing we're here to do is to take care of the sailors and Marines who are out there and have to be effective and want to come home to their families safe."

To keep warfighters safer, the U.S. Navy plans to integrate remote sensors that feed target location data to ship combat systems. This will enable sailors to immediately engage fast

attack craft and fast inshore attack craft as well as other threats with existing gun and missile systems and emerging electric weapon systems. Currently, the integration of unmanned systems into the fleet has been limited by a lack of direct communications with shipboard combat systems.

"Our sole purpose here is to identify where the warfighter gaps are and understand how we close those gaps," Fiore emphasized to all regarding the event, hosted by NSWCDD in collaboration with Naval Air Warfare Center Aircraft Division and NSWC Panama City Division.

The visitors, including NSWCDD employees, saw Dahlgren's ANTX address these integration challenges via a layered defense demonstration focused on distributed lethality in the littorals and rapid prototyping of new Fleet capabilities. What's more, they witnessed emerging and innovative technologies align with future naval capabilities and had the chance to share new technologies, exchange ideas, and collaborate with the surface naval technology community.

"The ANTX demonstrations have been a valuable way for Marines to see targeted capabilities the Naval Warfare Centers are working on, opening the door to further discussions of future capabilities and the art-of-the-possible," said Meggan Schoenberg, Combat Direction Systems Activity Dam Neck's science advisor to the Marine Corps Forces Command.

In effect, the USS *Dahlgren* exercise gave Schoenberg and many others an opportunity to evaluate the art-of-the-possible at the research and development level in a low-risk environment before these technological innovations become militarized and integrated at the operational level.

ANTX partnered with NR&DE, universities, and industry to demonstrate emerging capabilities and innovations in surface warfare. More than 60 emerging and innovative technologies were highlighted that provide an advantage to distributed forces, including naval surface combatants, to exercise sea control across a wide area extending into the littorals. Some of these relevant technologies include integration and control of unmanned vehicles, advanced sensors and sensor integration, track management, data fusion, and tactical displays. Technologies aligning to future naval capabilities were demonstrated, allowing the surface naval technology community to see new technologies, exchange ideas, and foster collaboration.

"The ANTX events provide the fleet a first-hand opportunity to see what the warfare centers are working on in an efficient and relevant way," said Dr. Marcus Tepaske, U.S. Fleet Forces Command science advisor. "I was impressed with many of the 219 NISE (Navy Innovative Science and Engineering) projects and their alignment to naval systems and naval needs. It's great to see what can be accomplished by leveraging the Warfare Centers' internal development funding and engineering creativity. On the other end of the spectrum, the live fire scenarios showed how *Dahlgren* is pulling all of the pieces together to conduct end-to-end surface engagements jointly with Pax River (Naval Air Warfare Center Aircraft Division). I'm looking forward to future ANTX events across the Navy as they continue to mature and evolve in order to demonstrate even more capability for the warfighter."

For more information, visit www.navy.mil.

The USS *Dahlgren* ANTX accomplished several firsts, including:

- First demonstration of the newly integrated MQ-8B Fire Scout unmanned autonomous helicopter radar with LCS Combat System and Link 16.
- First prototype demonstration of a USV with the Battle Management System and Longbow Hellfire missile-launcher.
- First USV receipt of Unmanned Aerial System (UAS) cursor on-target data.
- First LCS Surface-to-Surface Missile Module simulated engagement from UAS targeting data.
- First employment of the NSWCDD-produced LCS Combat Management System (CMS) Portable Virtual Test Environment.
- First demonstration of the NSWCDD-CMS Integration Laboratory (first Navy-owned LCS CMS laboratory).
- First demonstration of the LCSCMS Integration Lab connectivity to remote Mine Countermeasures Mission Package laboratories.
- First demonstration of a MH-60R Seahawk helicopter with a newly upgraded system configuration in the USS Dahlgren Link 16 environment.

Inset photo: A visitor wearing augmented reality glasses at the 2017 Annual Navy Technology Exercise (ANTX). Bottom left: Navy engineers Gary Shearer and Ian Shafer, right, brief Marine Corps Warfighting Laboratory Commanding Officer Brig. Gen. (sel) Christian Wortman at the 2017 Annual Navy Technology Exercise.

Aircraft Carrier USS Abraham Lincoln

TEST F-35C LIGHTNING II AT SEA

"I love the F-35C. Compared to other jets it's more powerful and really just a beast."

The Nimitz-Class aircraft carrier USS *Abraham Lincoln* (CVN 72) became one of the few ships in the fleet to trap and launch the F-35C Lightning II, Sept. 3.

The "Grim Reapers" of Strike Fighter Squadron 101 (VFA 101), from Eglin Air Force Base, Florida, are the training squadron for the F-35C.

"The F-35C is still in a testing phase, so it is not fully operational yet," said Lt. Cmdr. Chris Karapostoles, a pilot assigned to VFA 101. "We are the training squadron for the F-35C, so we are onboard this ship conducting our carrier qualification training, qualifying pilots, landing signal officers and maintenance crews."

The launching and recovering of the F-35Cs presented an opportunity for the crew of the *Abraham Lincoln* to work with a new aircraft and play a role in the development of this new fighter jet.

"Being part of the primary flight control team for the landing and launching of the F-35Cs was such a unique experience," said Aviation Boatswain's Mate (Handling) Airman Mariana Monima. "The F-35Cs are so amazing and powerful. I feel privileged to have been a part of this historic event."

According to the F-35 Lightning II Pax River Integrated Test Force, the F-35C should reach its initial operational capacity in 2018.

"I love the F-35C," said Karapostoles. "Compared to other jets it's more powerful and really just a beast. Some of the controls are different, which can take a little bit of getting used to, but that's what we have training like this for."

According to the Joint Strike Fighter Fleet Integration Office, the F-35C will introduce next generation strike-fighter aircraft capabilities to the Navy Carrier Air Wings, enabling the Carrier Strike Groups and numbered fleets to effectively engage and survive a wide range of rapidly evolving threats.

The *Abraham Lincoln* is underway conducting training after successful completion of carrier incremental availability.

For more information, visit www.navy.mil.

Raytheon Enhances Tomahawk Cruise Missile to Hit Moving Targets at Sea

The U.S. Navy awarded Raytheon Company a $119 million contract to begin integrating a new multi-mode seeker into the Tomahawk Block IV cruise missile. The enhancement will enable the weapon to engage moving maritime targets.

The Navy is conducting the new seeker development as a Rapid Deployment Capability program to meet urgent fleet requirements for defeating emerging maritime threats worldwide. Raytheon is expected to deliver this new capability by 2022.

"The U.S. Navy and Raytheon are working closely together to further enhance this modern missile, keeping Tomahawk in the fleet for decades to come," said Capt. Mark Johnson, Tomahawk program manager at U.S. Naval Air Systems Command. "No other weapon on earth can match this cruise missile's capability. Proven thousands of times in combat, Tomahawk is the nation's weapon of choice."

Launched from ships or submarines, the Tomahawk missile can fly into heavily defended airspace 1,000 statute miles away to conduct precise strikes on high-value targets with minimal collateral damage.

"Tomahawk's new multi-mode seeker will add even more capability to this already advanced missile," said Dave Adams, Raytheon Tomahawk program director. "Tomahawk is second to none in destroying stationary land targets, and soon the weapon will defeat moving maritime targets. Enemy vessels at sea will not elude Tomahawk."

Raytheon is already modernizing Tomahawk's radio suite and software under a separate Navy contract. Recertification on the first Tomahawk Block IVs is set to begin in 2019. That process will extend Tomahawk's service life for 15 years and enable Raytheon to make enhancements to the missile.

For more information, visit www.raytheon.com.

General Dynamics Mission Systems

Demonstrations at ANTX 2017

General Dynamics Mission Systems and General Dynamics Electric Boat demonstrated multiple mission command, control and communication capabilities connecting Bluefin Robotics' unmanned underwater vehicles (UUV) and a third-party provided unmanned aerial vehicle (UAV) with a simulated AN/BYG-1 submarine combat control center ashore.

A Stackable Air-powered Launch System (STAPLS) designed for use aboard submarines was also used. The goal of the General Dynamics demonstrations was to provide available solutions to the communications challenges of operating in a contested, undersea environment. Each demonstration took place at the U.S. Naval Undersea Warfare Center (NUWC) in Newport, Rhode Island, as part of the Advanced Naval Technology Exercise (ANTX) 2017.

The General Dynamics team demonstrated capabilities for real-time, two-way communications from the AN/BYG-1 control center to change the mission Bluefin SandShark™ UUV, via a third-party UAV while the Bluefin SandShark was operating in the water. In another demonstration, the Bluefin SandShark communicated with a simulated undersea communications network comprised of an acoustic communication node connected to a fiber optic cable that relayed information from the Bluefin SandShark back to the AN/BYG-1 via a surface buoy.

The General Dynamics team also launched both a Bluefin SandShark UUV and a Hammerhead canister containing the third-party AUV from two platforms, a Bluefin-21 medium-weight UUV and then from a STAPLS launcher designed by General Dynamics Electric Boat.

"This demonstration proves that General Dynamics and its partners can solve significant challenges to establishing tactical communication networks quickly and effectively using assets undersea, at the surface and in the air," said Carlo Zaffanella, vice president and general manager of Maritime and Strategic Systems for General Dynamics Mission Systems. "We look forward to working with our partners and the Navy to make these capabilities mission ready." General Dynamics Electric Boat's Applied Physical Sciences organization developed the prototype STAPLS launcher as a powerful, cost-effective solution to launch tactical assets like the Bluefin SandShark™ and third-party UAV from a submarine. This simple, scalable launcher, developed with Electric Boat's internal funds, can increase submarine payload options without displacing existing payloads. Adaptable to a wide range of payloads, insertion on fielded and new construction submarines is envisioned.

Kenneth Perry, a vice president of General Dynamics Electric Boat said, "The General Dynamics team successfully demonstrated our innovative STAPLS submarine payload launcher with UAV and UUV payloads, all integrated via an air-land-undersea network. It reflects General Dynamics' commitment to delivering advanced and relevant undersea capabilities for the Navy."

General Dynamics Mission Systems and General Dynamics Electric Boat are business units of General Dynamics (NYSE: GD). More information about General Dynamics Mission Systems. Additional information about General Dynamics Electric Boat.

A notional concept of the capabilities demonstrated by General Dynamics at ANTX 2017 can be seen here. The third-party unmanned aerial vehicle mentioned in this news release was a Blackwing™ model provided by AeroVironment.

For more information, visit www.gdeb.com.

Above: Demonstrated capabilities deliver the tactical advantage to U.S. Navy operations in a contested, undersea environment.

Israel Shipyards Launched Offshore Patrol Vessel for the Cyprus Navy

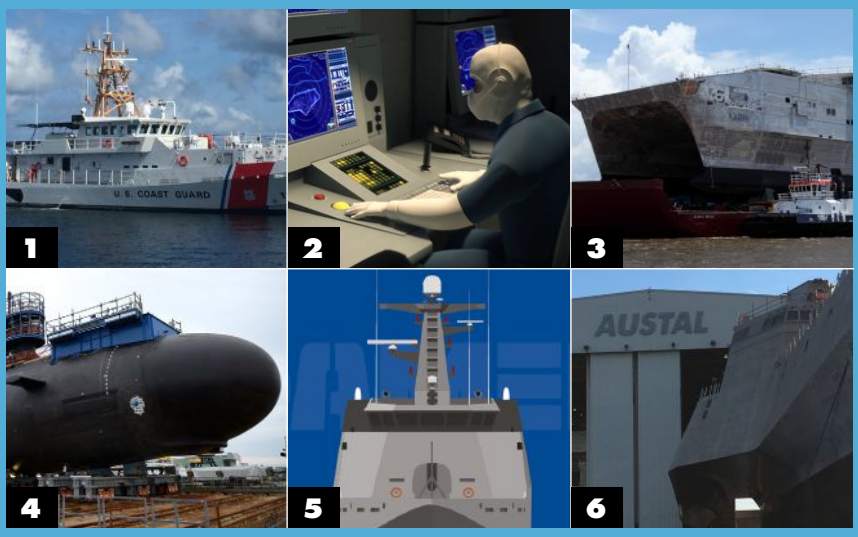
Israel Shipyards Ltd., a leading shipbuilding and repair company for the naval and commercial marine markets, launched a new Offshore Patrol Vessel (OPV) for the Cypriot Navy.

The OPV was unveiled and launched at a ceremony held last week at Israel Shipyards' facility at Haifa Bay in Israel —in the presence of senior members of the Cypriot Ministry of Defence, representatives of SIBAT (Israel MOD), and the management and employees of the company. The OPV was ordered in December 2015 and will be delivered to Cyprus towards the end of the year, to be used to protect the Exclusive Economic Zone (EEZ) of Cyprus. The project is valued at tens of millions of Euros.

According to Avi Shahaf, CEO of Israel Shipyards, "The project is of great importance for the company, and we invested our knowledge, experience and ingenuity in order to build and to supply this unique technologically advanced ship. We would like to express our deepest gratitude to the Cyprus Ministry of Defence for the trust they invested in Israel Shipyards in order to deliver this vessel."

The new OPV has a displacement of 430 tons, an overall length of 62 meters, a maximum speed of 32 knots, and carries up to 30 crew members plus a Special Forces unit. Installed on the vessel are multiple sophisticated systems including two Rafael Typhoon Weapon Stations, advanced radar, electro-optical payloads, communications systems including satellite communications, navigation systems, command and control systems, and more.

For more information, visit www.israel-shipyards.com.



1.

Bollinger Delivers Fast Response Cutter USCGC Jacob Poroo to the USCG

Bollinger Shipyards has delivered the USCGC Jacob Poroo, the 25th Fast Response Cutter (FRC) to the U.S. Coast Guard.
http://ont.news/2xmpwov

2.

BAE Systems Unveils Mine Counter Measures and Autonomy Mission System

NAUTIS 5 incorporates a number of new and improved features including: improved command and control for autonomous and off-board systems.
http://ont.news/2xkLQz7

3.

City of Bismarck (EPF 9) Completes Builder's Trials

The Navy's ninth expeditionary fast transport vessel, City of Bismarck (EPF 9), successfully completed Builder's Trials Sept. 14, after being underway for two days in the Gulf of Mexico.
http://ont.news/2lexRZM

4.

Navy Accepts Delivery of Future USS Colorado Submarine

The ship began construction in 2012 and is scheduled to commission in spring 2018. It is the fifth Virginia-class Block III submarine.
http://ont.news/2y4jgBx

5.

Damen Displays Leading Position in Global OPV Market

Damen Shipyards Group has compiled a comprehensive summary of its worldwide shipbuilding activities regarding Offshore Patrol Vessels (OPVs).
http://ont.news/2zzWDpM

6.

Austal Delivers Sixth Littoral Combat Ship to U.S. Navy

Austal Limited has delivered its sixth Littoral Combat Ship (LCS), to the U.S. Navy during a ceremony in Mobile, Alabama, at Austal's manufacturing facility.
http://ont.news/2zCf1hH

U.S. Navy Awards General Dynamics Electric Boat $5.1 billion

The IPPD contract includes funding for component and technology development as well as continued development of the Common Missile Compartment.
http://ont.news/2h50jsl

Waiting for the Natural Gas Godot is Frustrating

BY G. ALLEN BROOKS
Author, "Musings From the Oil Patch"
www.energymusings.com

Early this year, optimists expecting meaningfully higher natural gas prices this year were riding high.

We were in the midst of extremely cold weather, drawing down gas storage sharply. Major energy consulting firms were projecting only a slim increase in natural gas production for the balance of the year, which would enable only about a one percent increase in the volume of natural gas injected into storage caverns this summer. As a result, the gas price bulls foresaw prices moving substantially higher in order to draw additional supply into the market. In fact, the U.S. Energy Information Administration, in its January 2017 Short Term Energy Outlook, forecast that gas prices would jump by more than a dollar per thousand cubic feet in 2017, going from $2.51 in 2016 to $3.55. There were other, even more optimistic price forecasts being made, but a dollar per Mcf increase clearly had gas producers' attention.

The problem with those forecasts turned out to be that the ingredients to drive prices higher failed to materialize. First, natural gas production grew more than anticipated. Secondly, coal prices in the electric generation sector barely increased (+3/cents per million British thermal units) between 2016 and 2017, while natural gas fuel costs rose by over 20 percent. The result was that the gas-to-coal price spread jumped from $0.77 per million Btus to $1.33, limiting gas consumption in the power market. While the early cold snap of the winter of 2016-2017 excited people, its disappearance, without support of more gas being burned to generate electricity left the domestic natural gas market seeking another driver to boost gas producer profits.

That force turned out to be the liquefied natural gas export terminals that came on stream as 2017 started. During the great natural gas shortage era of the 1970s-1990s, the U.S. relied upon regulatory restrictions over the use of gas, as well as encouraging the construction of numerous LNG import terminals to augment domestic gas supplies. A last ditch effort to boost domestic gas supplies involved the decontrol of wellhead gas prices, something that had existed since the mid-1950s. The result, surprisingly, led to a significant boost in gas supplies. Free market pricing did exactly what economists predicted would happen—raise prices and you get more supply! Higher gas prices also trimmed demand growth. Eventually, the greater supply overwhelmed the slowing consumption growth, which resulted in today's lower gas prices. Lower domestic gas prices eventually worked against the high-cost gas arriving at the newly constructed LNG importing terminals, making them "white elephants."

Lower natural gas prices eventually stimulated gas consumption, and pressured gas producers to explore the new shale drilling technology to boost supplies. As the shale gas revolution unlocked previously thought unattainable gas supplies, the U.S. gas market soon found itself swimming in supply, to the detriment of recovering gas prices. From worrying about where additional supply would come from, industry participants began worrying about whether gas demand would materialize.

The marketplace answered the question by dropping gas prices to levels that undercut coal prices in the power generation market, at the same time concerns over carbon emissions due to burning dirty coal stirred people to push for a cleaner energy fuels. As gas seized a major share of the electricity fuel market, yet still retained the prospect of even greater gas supplies available,

CHART 1

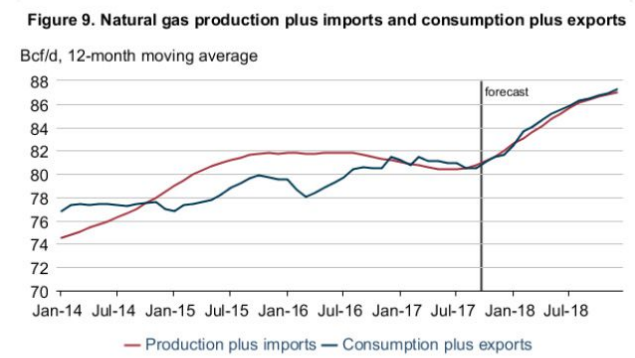
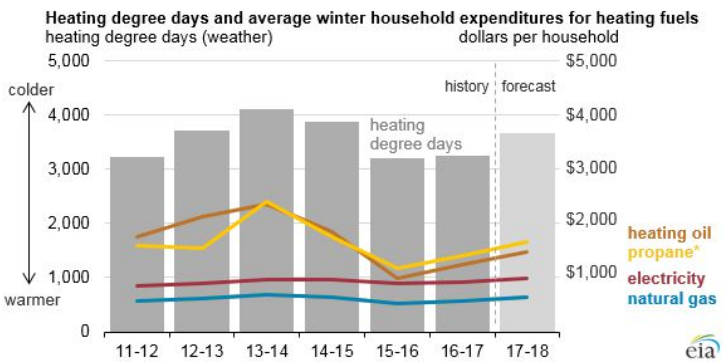


CHART 2



the industry turned its attention to converting the LNG importing terminals into exporting facilities, while some companies contemplated building new export terminals.

Now, the natural gas industry finds that even in a low crude oil price environment, both dry gas volumes and associated natural gas output are continuing to grow, opening up new opportunities to export domestic gas as LNG to world markets. For the foreseeable future, this LNG export segment will become the driving force powering the gas market. The latest STEO report shows the critical ingredients behind the market revival. The report forecasts that marketed natural gas production will increase from 77.81 billion cubic feet per day in 2016 to 84.44 billion in 2018. (Chart 1) At the same time, the EIA projects that electric power output will slip from 10.52 billion kilowatt-hours per day in 2016 to 10.45 billion kWh per day in 2017, but then increase to 10.69 billion kWh per day in 2018.

Natural gas is increasingly dependent on winter and summer electricity generation demand, the winter heating season, and the export markets, both pipelines to Canada and Mexico as well as LNG to the world. According to the EIA, the upcoming winter will be colder than recent past winters, but not sufficiently cold enough to soak up a substantial volume of gas storage. Heating degree days projected for the winter of 2017-2018 should be greater than in 2015-2016 and 2016-2017, but not as cold as experienced during 2014-2015, an extremely cold winter. (Chart 2) Also, while the EIA foresees domestic gas production growing by a healthy amount, it also sees natural gas prices jumping more than would be expected. That is bad news in the highly competitive power market, where the EIA sees coal prices per million Btus only rising from $2.11 in 2016 to $2.14 in 2017, and eventually increasing to $2.20 in 2018. At the same time, the agency predicts gas prices in the electricity market will jump from $2.88 in 2016 to $3.47 in 2017, and then increase to $3.72 per million Btus in 2018.

The lack of a severely cold winter, coupled with sharply higher natural gas prices in the power generation market as coal prices remain flat, creates a questionable outlook for the gas market of 2018. The relief valve for the natural gas market will be the growth of LNG exports. The EIA forecasts LNG exports to grow from 0.51 billion cubic feet per day in 2016, to an average of 1.84 Bcf/d this year. Importantly, the EIA expects LNG exports in 2018 to average 3.05 BCF/d, with average volumes in 2018's fourth quarter reaching 3.31 Bcf/d. What the EIA's forecast suggests is that as a share of marketed gas production over the years 2016 to 2018, LNG goes from 0.007 to 0.036 percent.

It is the safety valve of LNG exports that will keep natural gas prices from dropping sharply in 2018, but even with this export growth, prices will struggle to rise materially. The EIA is currently projecting average gas prices to rise from $3.14 per thousand cubic feet in 2017 to $3.31 in 2018. (Chart 3) While we respect the EIA for its data collection expertise, we remain skeptical of its forecast for natural gas prices rising as high as predicted in 2018, barring a much colder winter, substantially greater consumption by the power sector, or reduced supply.

When we examine the relationship between weekly year-over-year gas storage inventory changes versus the average gas prices, we get a different message. (Chart 4) The extremely flat line that has existed for all of 2017, compared to the steeper sloped trend lines for 2015 and 2016, suggests that only slight price changes are needed to bring adequate gas supplies to market. Maybe the growth of LNG exports will be sufficient to tilt that flat trend line into one predicting higher gas prices in 2018.

CHART 3

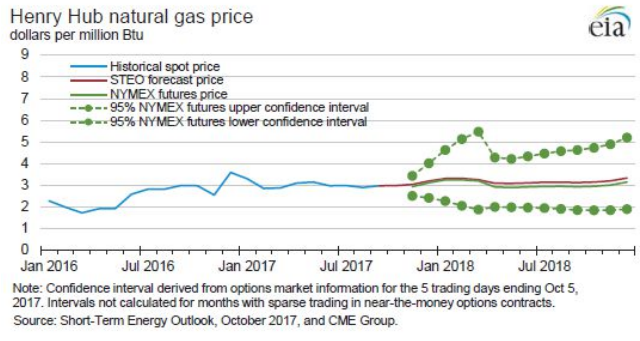
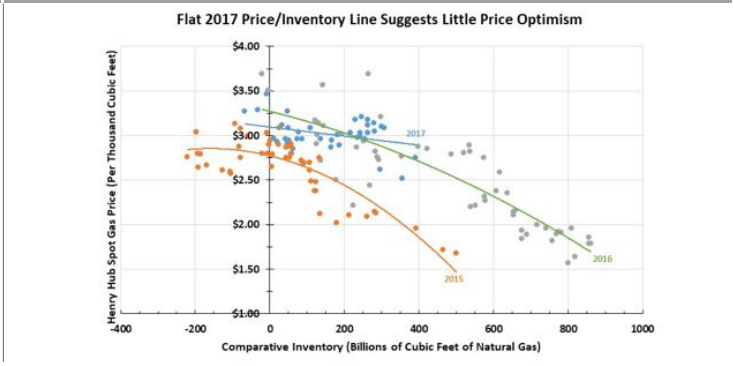


CHART 4



CRUDE & NATURAL GAS Spot Prices

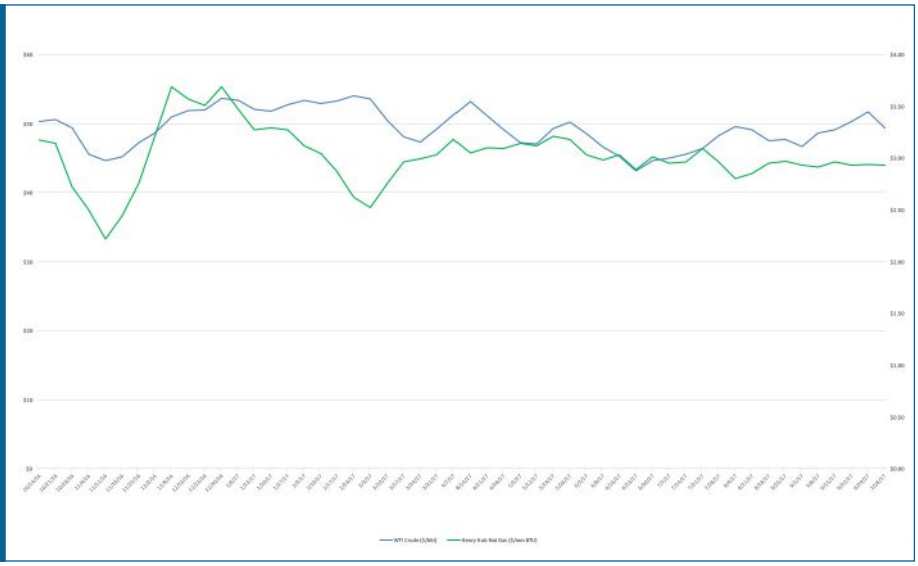
PRICES IN US DOLLARS AS OF OCTOBER 16, 2017

U.S. refinery production got back online in September following the devastating effects of Hurricane Harvey. Also, the EIA reports that crude oil production in the Gulf of Mexico is estimated to have increased to a monthly average of 1.7 million b/d in September, following Hurricane Harvey, an increase of 70,000 b/d from the August level. EIA forecasts total U.S. crude oil production to average 9.2 million b/d in 2017 and 9.9 million b/d in 2018, which would mark the highest annual average production in U.S. history, surpassing the previous record of 9.6 million b/d in 1970.

Henry Hub natural gas spot prices closed at $2.93 at the beginning of October; unchanged from the beginning of the previous month. Expected growth in natural gas exports and domestic natural gas consumption in 2018 contribute to the forecast Henry Hub natural gas spot price rising from an annual average of $3.03/MMBtu in 2017 to $3.19/MMBtu in 2018, according to the EIA. The EIA also noted that NYMEX contract values for January 2018 delivery that traded during the five-day period ending October 5 suggest that a range of $2.28/MMBtu to $4.63/MMBtu encompasses the market expectation for January Henry Hub natural gas prices at the 95% confidence level.

WEEKLY WTI CRUDE & NATURAL GAS SPOT PRICES

Last 52 Weeks



$49.34

$48.58 previous month

TRENDING UP

Cushing, OK WTI Spot Price

$2.93

$2.91 previous month

NEUTRAL

Henry Hub Spot Price

KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF OCTOBER 16, 2017

U.S. EQUITY MARKETS during September and early October continued their advances with a string of record highs.

The DJIA closed at just under 22,997 on October 16 and appeared poised to crack the 23,000 mark for the first time ever.

The S&P 500 crossed the 2,500 mark in September.

The Philadelphia Oilfield Services Index (OSX) gained back some of its summer losses, reaching 137.32 on October 16—up from a summer low of 119.42 in August. This is still, however, down nearly 30% from the start of the year when it was at 192.66.

SELECTED EQUITY INDEXES

Cumulative Percentage Change Last 52 Weeks

22,997.44

+666.09 from previous month

TRENDING UP

DJIA

2,559.36

+55.49 from previous month

TRENDING UP

S&P 500

137.32

+2.45 from previous month

TRENDING UP

OSX

SATELLITE
Washington, D.C.
March 12-15, 2018
2018.satshow.com

International Offshore Wind Partnering Forum
Princeton, NJ
April 3-6, 2018
www.bizmdosw.org/2018ipf

CUCE
Vancouver, Canada
March 25-27, 2018
www.underwaterconference.ca

Subsea Expo
Aberdeen, UK
February 7-9, 2018
www.subseaexpo.com

AUVSI XPONENTIAL
Denver, CO
April 30-May 3, 2018
www.xponential.org/xponential2018/public/Enter.aspx

WorkBoat
New Orleans, LA
November 29 - December 1
www.workboatshow.com

Ocean Sciences Meeting
Portland, OR
February 11-16, 2018
osm.agu.org/2018

GoM Oil Spill & Ecosystem
New Orleans, LA
February 5-8, 2018
www.cvent.com/events/2018-gulf-of-mexico-oil-spill-and-ecosystem-science-conference/event-summary-6ae61bf76b204d0392d48b8b-f15ed1eb.aspx

Pacific Marine Expo
November 16-18
Seattle, WA
www.pacificmarineexpo.com

Underwater Intervention
New Orleans, LA
February 6-8, 2018
www.underwaterintervention.com

World Ocean Summit
Riviera Maya, Mexico
March 7-9, 2018
events.economist.com/events-conferences/americas/world-ocean-summit

Offshore Well Intervention GoM
Houston, TX
November 1-2
www.interventiongom.offsnetevents.com

Clean Gulf
Houston, TX
December 5-7
www.2017.cleangulf.org

OilComm
Houston, TX
December 6-7
www.oilcomm.com

OTC
Houston, TX
April 30 – May 3, 2018
2018.otcnet.org

Decommissioning & Abandonment Summit
Houston, TX
February 20-21, 2018
www.decomworld.com/gom

WindEurope
Amsterdam
November 28-30
www.windeurope.org/confex2017

Submarine Networks World Europe
London, UK
February 20-21, 2018
www.terrapinn.com/conference/submarine-networks-world-europe/index.stm

Oceanology International
London, UK
March 13-15, 2018
www.oceanologyinternational.com

World Congress of Ocean
Shenzhen, China
November 3-5, 2017
www.bitcongress.com/WCo2017

ICCOE
Shanghai, China
April 27-29, 2018
www.iccoe.org

DIPEC
bu Dhabi, UAE
ovember 13-16
ww.adipec.com

arine Data Infrastructure
ubai, UAE
ebruary 12-13, 2018
ww.marinedatainfrastruc-regcc.com

Asia Pacific Deep Sea Mining
Singapore
November 9-10
www.asia.deepsea-mining-summit.com

Underwater Systems Technology
Kuala Lumpur, Malaysia
December 18-20, 2017
oes.ieeemy.org/ieeeusys17

UDT Asia
Singapore
January 30-31, 2018
www.asia-decs.com

Asia Pacific Maritime
Singapore
March 14-16, 2018
http://www.apmaritime.com

OTC ASIA
Kuala Lumpur, Malaysia
March 20-23, 2018
2018.otcasia.org

AOG Subsea Forum
Perth, Australia
March 14-16, 2018
www.sut.org/event/perth-aog-exhibition-conference-5

CALENDAR

JANUARY
Editorial: Underwater Navigation; Manned Submersibles Research & Development Services

Focus: Multibeam & Side Scan Sonar; Research & Development

FEBRUARY
Editorial: Oceanology & Meteorology; Decom & Abandonment

Focus: Buoys & Monitoring Instrumentation; Environmental Monitoring/Testing Services

MARCH
Editorial: Subsea Fiber Optic Networks; Maritime Security

Focus: Connectors; Cables & Umbilicals; Diver Detection Systems

APRIL
Editorial: Offshore Technology; Ocean Mapping & Survey

Focus: Subsea Tools & Manipulators; Batteries; Training/Safety

MAY
Editorial: Autonomous Unmanned Vehicles; Defense & Naval Systems

Focus: Tracking & Positioning Systems; Seismic Monitoring; Equipment Leasing/Rental Services

JUNE
Editorial: UW Imaging & Processing; Marine Salvage/ Underwater Archaeology

Focus: Magnetometers; Water Dredges & Airlifts; Diving Services

JULY - Digital Distribution
Editorial: Ocean Engineering; Marine Construction

Focus: Navigation, Mapping & Signal Processing; Data Processing Services

AUGUST
Editorial: Workclass ROVs; Deepwater; Pipeline/Repair/ Maintenance

Focus: Cameras, Lights & Imaging Sonars; Oil Spill Clean-Up

SEPTEMBER
Editorial: Ocean Observing Systems; Subsea Telecom; Offshore Wind Installation & Maintenance; Product & Services

Focus: Water Sampling Equipment; Cable Installation Services

OCTOBER
Editorial: Offshore Communications; Subsea Inspection, Monitoring, Repair & Maintenance

Focus: Acoustic Modems, Releases & Transponders; Marine Communications; Survey & Exploration Services

NOVEMBER - Digital Distribution
Editorial: Offshore Support, Supply & Emergency Vessels; Deep Sea Mining

Focus: Ship Protection Systems; Cranes, Winches & Control Systems; Vessel Charter/Leasing Services

DECEMBER
Editorial: Light Workclass ROVs; Commercial Diving; Year in Review

Focus: Diving Equipment & Services; Buoyancy Materials; Construction & Repair Services

SHOW DISTRIBUTION

JANUARY
UDT Asia - January 17-18*
Marine Data Infrastructure GCC - January 30-31*
Euromaritime - January 31-February 2
GoM Oil Spill & Ecosystems - February 1-9
Oi North America - February 14-16

FEBRUARY
Underwater Intervention - February 21-23
US Hydro - March 20-23*

MARCH
Canadian Underwater Conf & Expo - March 26-28
Ballast Water Management - March 29-30
MCE Deepwater Development - April 3-5
Ocean Business - April 4-6
Telecom Exchange - June 20-21*

APRIL
Int'l Offshore Wind Forum - April 19-21*
OTC - May 1-4
AUVSI XPonential - May 8-11
IOSC - May 15-18
Deepwater Decomm Workshop - May 23-24*

MAY
UDT - May 30-June 1
Offshore Wind Energy Europe - June 6-8
Seawork Int'l - June 13-15

JUNE
Teledyne CARIS User Workshop - June 19-22*

JULY - Digital Distribution
TBD

AUGUST
SPE Offshore Europe - September 5-8

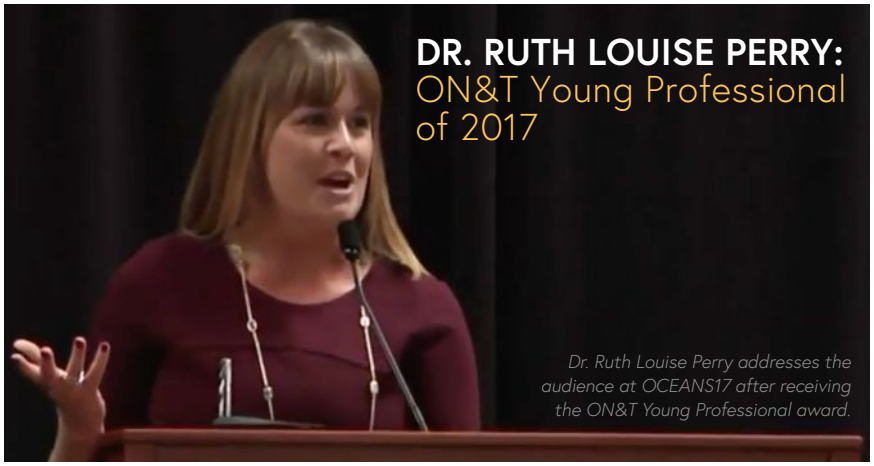
SEPTEMBER
Oceans 17 - September 17-21
AWEA Offshore Wind - October 24-25◊
WindEurope - November 28-30

OCTOBER
MTS Dynamic Positioning - October 9-11
Offshore Energy - October 9-11
Teledyne Marine Technology Workshop - October 15-18
Clean Gulf - December 5-7
Oilcomm - December 6-7

NOVEMBER - Digital Distribution
World's Congress of Ocean - November 3-5*
International Workboat - November 29-December 1*

DECEMBER
TBD

* Digital Distribution
◊ Pending



Dr. Ruth Louise Perry addresses the audience at OCEANS17 after receiving the ON&T Young Professional award.

During OCEANS 2017 in Anchorage, Alaska, Ocean News and Technology Magazine's Young Professional Award was presented to Ruth Louise Perry, Ph.D. The OCEANS conference held 18-21 September was jointly sponsored by the IEEE Oceanic Engineering Society (IEEE/OES) and the Marine Technology Society (MTS).

Each year, ON&T looks at the next generation and recognizes an individual 35 years old or younger who has already demonstrated excellence in their career and made valuable contributions through leadership positions within MTS. ON&T awards the recipient of this award with $1000.

In her acceptance speech, after thanking the presenters as well as her mentor, John Walpert of Texas A&M University, Dr. Perry said, "The society has really helped me to grow as an individual, not just as a scientist, but by teaching valuable skills that I use in all my different career paths. I really look forward to continuing my service with the Marine Technology Society and I appreciate this recognition."

Upon earning a doctorate in oceanography from Texas A&M University, Dr. Perry joined Shell Upstream Americas as a marine scientist and regulatory policy specialist. Dr. Perry is responsible for offshore marine environmental policy for Shell exploration and production offshore teams. In this capacity, Dr. Perry integrates marine science and ocean technology into regulatory policy, advocacy, and decision making.

Her work, primarily in the Gulf of Mexico, focuses in on the areas of marine sound, marine spatial planning, ocean observing, and marine mammal and life science. Dr. Perry is also responsible for helping Shell to develop public-private science collaborations, such as real-time monitoring programs to improve industry's knowledge of the offshore marine environment. Her work engages the oil and gas industry trade associations to develop and implement joint industry programs for offshore environmental monitoring and help increase understanding the effect that sound generated by oil and gas exploration has on marine life.

An active MTS member since 2009, Dr. Perry works closely with MTS leadership to build opportunities and expand partnerships with the oil and gas industry. Her research has been regularly published in the Marine Technology Society Journal. Dr. Perry is noted for initiating the OCEANS student poster competition and has continued to maintain and active role by serving for the past five years as a student poster competition judge. Additionally, Dr. Perry has dedicated countless hours to student STEM mentorship, volunteer, and outreach work.

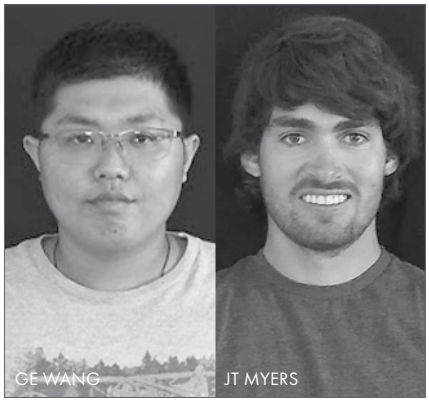
Dr. Perry is an active participant in helping to public policy forums to discuss offshore energy development. She continues to lead the promotion of ocean science and science-based decision-making processes with a cross-section of stakeholders that include academia, resource managers, industry, and policy makers. The greater science community as well as the public have benefited from these efforts. Congratulations, Dr. Perry!

RJE International Expands to South Africa

RJE International Inc, a market-leading manufacturer of underwater acoustic marking and relocation technology, has announced an exciting new partnership with the highly regarded South African distributor Fisheries Resource Surveys.
http://ont.news/2xkpzkR

New Managing Director Set to Scale Up Operations for ClearWELL

Flow assurance and production optimisation specialist, ClearWELL Oilfield Solutions, has appointed a managing director as the company looks to increase its international footprint. Alasdair Fergusson brings more than 25 years of oilfield management and marketing experience to ClearWELL, having worked for major service companies in Europe and the Middle East.
http://ont.news/2xkTRUv



Seafloor Systems Welcomes New Employees Ge Wang and JT Myers

Seafloor is pleased to welcome two new employees in October as the company continues to grow to meet demand for its products. Ge Wang and JT Myers both bring extensive marine drone experience, albeit in different capacities, to the team.
http://ont.news/2zMRueM

Introducing the New 2017 Ocean Industry Directory

The Ocean Industry Directory (OID) provides a dedicated solution for finding the product and service providers you need to complete marine projects efficiently and effectively. Avoid the confusion of searching multiple directories that are incomplete or fail to consolidate ocean industry companies in one place. The Ocean Industry Directory is a unique collection of ocean-oriented businesses that takes the mystery out of corporate listings by distinguishing between manufacturers, sellers, rental agents, and service providers.

Get Listed!

Exposure across multiple media channels is important in today's competitive marketplace. The Ocean Industry Directory is featured in every issue of *Ocean News & Technology*'s print and digital magazines. In addition, the Ocean Industry Directory is a key component of occeannews.com and updated monthly.

If you're interested in becoming a part of the OID, consider the benefits of adding your own corporate listing and contact your sales representative to discuss your options.

SeaCatalog Partnership

ON&T is also proud to announce our partnership with SeaCatalog.com, the premier online marketplace for ocean industry professionals to obtain equipment and supplies for projects around the world.

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Enhance the value of your company's Ocean Industry Directory listing with a SeaCatalog.com vendor account where customers can easily go to buy, rent or request a customized quote for your products. Join now and we'll add a SeaCatalog.com member badge to your listing at no extra cost.

To find out more, contact your sales representative today!

2017 OID PRICING

	Free Plan Digital Only Listing	Silver Plan $500 Digital Only Listing	Gold Plan $950 Digital & Print Listing
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Link to chosen categories for products and services	●	●	●
Corporate Logo		●	●
100-word company introduction		●	●
Sales contact name and email		●	●
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Manufacturer of fully integrated USBL acoustic tracking systems, both portable and vessel based, high quality multi-system compatible beacons for acoustic positioning and release, and seismic sub-bottom profiling systems for coastal, offshore or geohazard surveys. All products are supported by a network of overseas representatives providing a first class service on a global scale.

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Ocean Sonics designs and manufactures the icListen, a compact self-contained easy to deploy digital hydrophone. As the world leader in gathering ocean sound, Ocean Sonics combines very high signal performance with innovative ease of use, to give customers the best digital hydrophone technology available. It's a compact, all-in-one instrument capable of processing data while collecting in real-

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We provide advanced embedded acoustic products in the environmental research, surveying and monitoring areas. With Synchronized Multichannel Acquisition and accepting a broad range of Acoustic Transducers and Hydrophones from 3Hz to more than 1MHz, our solutions allow the user a new range of applications.

ADCP/DVL

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E-mail: inquiry@nortek.no
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Nortek excels in the development and manufacture of acoustic Doppler instrumentation. Doppler Velocity Logs (DVLs) are used for subsea navigation. Acoustic Doppler Current Profilers (ADCPs) are used to understand physical processes in the ocean, rivers, lakes and laboratories. We pride ourselves on being innovative in product development and production processes. Nortek provides solutions to engineers and scientists by offering real-time data collection and support from our responsive technical team.

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Website: www.rowetechinc.com
Contact: Chris Arends, Global Sales Director

Rowe Technologies Inc. [RoweTech] specializes in the design and manufacture of underwater acoustic Doppler products and imaging systems for the oceanographic, hydrographic and hydrologic markets. Founded in 2009, Rowe Technologies is a technology-based private company with the main office located in Poway CA, USA. Rowe's ADCP/DVL competitive advantage is single-unit configuration which allows simultaneous current profiling and bottom tracking.

BUOYS

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MetOcean Telematics designs and manufactures drifting buoys, environmental platforms, and the world renowned NOVATECH locator beacon product line. In addition to providing complete end-to-end telematics services, and one of the few manufactures in the world to achieve ISO 9001 certification. MetOcean Telematics's drifting buoy family consists of environmental and weather monitoring, oil spill response, and search and rescue drifters: NOVA profiling float, Iridium SVP (iSVP), iSPHERE, Argosphere, SLDMB, and iSLDMB.

BUOYANCY PRODUCTS

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For over 50 years, Falmat Cable has been a key supplier and a solution provider to many global OEMs and end users supporting a wide range of marine applications. We design and manufacture high performance cables for use in harsh and demanding environments. Our rugged Xtreme cables are known and preferred worldwide for superior reliability and durability in commercial and military projects. We offer XtremeMarine cables with precision coaxial components for use with SD/HD video requirements, wet rated submersible pump cables, miniature fiber optic cables, a comprehensive range of highly engineered ROV Tethers plus our well recognized Xtreme Ethernet cables. Falmat is a Certified ISO9001/AS9100 organization. Visit our web site: www.falmat.com.

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Contact: Gary Brown, Sales Manager

Since 1957, South Bay Cable Corp has designed and manufactured specialized electrical, electro-mechanical and electro-optical-mechanical cables for use in demanding marine environments. Cables are designed to meet customer requirements and include tether and umbilical cables for ROVs, tow cables, video inspection, faired cables and a host of other customer specific applications.

CONNECTORS

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BIRNS, Inc. has been serving the subsea industry since 1954, and is an ISO 9001:2008 certified global leader in the design and manufacturing of high performance connectors, custom cable assemblies and lighting systems. With a NAVSEA PRO-020 certified molding facility, the company leads the industry with sophisticated connector lines, including exceptional electrical, electromechanical, coaxial, electro-coax, optical, electro-optical and electro-opto-mechanical hybrid options. BIRNS provides the industry's highest volume of cost-effective hydrostatic and helium pressure testing, and has a wide range of ABS Product Design Assessment (PDA) certified fiber optic and electrical penetrators. BIRNS also delivers brilliant LED and tungsten-halogen marine, chamber, security and commercial diving lights trusted in the world's most extreme environments.

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Website: www.birnsaquamate.com
Contact: Eli Bar-Hai

Birns Aquamate design and manufacture underwater electrical connectors, cable assemblies, and cable terminations. The company produces a wide range of standard industry connectors such as the 5500 Series, SC, MC, LP, FAWL/FAWM, Rubber Molded, etc. BIRNS Aquamate is the only underwater connector producer that guarantees compatibility with other manufacturers. Birns also specializes in fast turn-around for custom design of special connector solutions. Stocking dealers in the UK, South Africa and Holland as well as dealers in Canada, Germany, Belgium, Norway, China, and Brazil.

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The SEACON Group are world leaders in underwater connector technology and provide an extensive and diverse range of electrical, optical and hybrid connector assemblies, submersible switches and cable system solutions for many applications within the Oceanographic, Defense, Oil and Gas and Environmental markets. With locations in California and Texas, USA, Mexico, Brazil, the United Kingdom and Norway and a worldwide network of agencies and representatives, SEACON is able to supply very quick solutions to any requirements across the globe.

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E-mail: TeledyneMIS@teledyne.com
Website: www.teledynemarine.com

Teledyne Marine Interconnect Solutions integrates the resources of ODI, DGO, Impulse, and Cable Solutions into a single organization that supplies innovative, high-performance solutions for harsh environment interconnect. Solutions for these harsh environments include wet-mate, splash-mate and dry-mate connectors, pressure boundary penetrators, cable assemblies, cable terminations, and custom-engineered encapsulation and molding. TMIS contains a broad portfolio of field-proven, time-tested electrical, optical, and hybrid interconnect capabilities optimized for applications where performance and reliability are imperative. Products are available as stand-alone items, or as complex solutions that integrate technologies into advanced, value-added systems.

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Hydro Leduc is a specialist in the design and manufacture of hydraulic piston pumps, hydraulic motors, hydro pneumatic accumulators, and customized hydraulic components satisfying customer needs with reliable products from a reliable source. As the leader in micro hydraulics, it is feasible to obtain several tons of force from a minimal power source within a restricted space envelope. The techniques of micro hydraulics allow simple solutions to problems that are often beyond the limits of traditional mechanical options. Hydro Leduc's expertise is at your service in varied applications such as oil service tools, oceanographic instrumentation, aeronautics, and any extreme working condition of temperature, pressure, medium, and environment.

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SeaCatalog Vendor

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Ocean Specialists, Inc. (OSI) is a submarine fiber optic network development company with global project capabilities. OSI works with clients during all project phases of subsea network development, from planning and design to procurement and implementation. Our customers, primarily representing Oil and Gas, Telecommunications and Ocean Observing, recognize the value of fiber optic networks to their field and services solutions, and look to OSI to deliver the skills and experience that developing these networks require.

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

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NAVIGATION & POSITIONING SYSTEMS

ADVANCED NAVIGATION

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Advanced Navigation is a privately owned Australian company that specialises in the development and manufacturing of navigation technologies and robotics. The company has a focus on generating products of the highest quality standard, both in terms of hardware and software. Advanced Navigation has specialised expertise across a broad range of fields including sensors, GNSS, inertial navigation, RF technologies, acoustics, robotics, AI and algorithms. Advanced Navigation is an ISO 9001 certified company and maintains a strict quality control system across the two research facilities and three manufacturing facilities that they operate in Australia. Advanced Navigation is a carbon neutral company, offsetting all emissions due to energy use through the planting of trees.

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EvoLogics provides the world's most advanced spread-spectrum underwater communication systems (S2C) with multi-channel data management, networking capability, built-in tracking and positioning functions with USBL. Data loggers, acoustic wake-up module and releasers optionally included. Deployments in offshore platforms (FPSO, ABS), environmental monitoring, defense systems, ROV and AUV operations and more. Applications include simple positioning and sensor information to transmission of underwater photos.

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

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Website: www.aslenv.com

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NKE INSTRUMENTATION

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- *Drifting surface buoys with temperature and GPS receiver for Surface velocity project. Contact: Nathalie Le Bris – nlebris@nke.fr or Jérôme Sagot – jsagot@nke.fr*

RBR

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RBR creates instruments to measure the blue planet. From the ocean abyss to the polar ice caps, our sensors track water parameters – temperature, depth, salinity, dissolved gases, pH, and many others. With design and manufacturing centrally located in Ottawa, Canada, our team works in a fast-paced, dynamic atmosphere to serve customers all over the globe.

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ROMOR Ocean Solutions provides instrumentation solutions for the geophysical, oceanographic, defense, security, oil & gas, and renewable energy industries. By partnering with world renowned manufacturers, ROMOR is able to offer technical knowledge, value added services, logistics expertise, and the most reliable instrumentation on the market.

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Contact: Baldur Sigurgeirsson

A manufacturer of miniature data loggers with sensors as temperature, depth/pressure, salinity, tilt/acceleration, compass direction/magnetometer, light levels, acoustic receiving/transmitting. The loggers are used for various researches, including oceanography, fishing gear studies, equipment behavioral monitoring and fish tagging. Data is presented in the application software with a time-stamp for each measurement.

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E-mail: sales@rovsco.com
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Contact: Jessica McKenney

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We also manufacture tooling items which include ROV quick release shackles (11 ton to 250 ton), hydraulic compensators (1/2 liter to 2.5 gallon), video cameras & led lights, and 'SNOKOTE' for umbilical anti-corrosive protection.

SMART TELEMETRY

OCEANWISE LTD
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Fax : +44 (0) 872 115 0560
Email : info@oceanwise.eu
Website: www.oceanwise.eu
Contact : john.pepper@oceanwise.eu

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SONAR SYSTEMS

EDGETECH
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E-mail: info@edgetech.com
Website: www.edgetech.com
Contact: Amy LaRose

EdgeTech designs, manufactures and sells industry-leading side scan sonars, sub-bottom profilers, bathymetry systems and combined sonar systems. Additionally, the company produces world class underwater actuated and transponding solutions including deep sea acoustic releases, shallow water and long life acoustic releases, transponders, reliable USBL acoustic tracking and positioning systems, and custom-engineered acoustic products.

MARINE SONIC TECHNOLOGY
120 Newsome Dr. Suite H, PO Box 1309
Yorktown VA 23692-1309
Toll Free: +1 800 447 4804
E-mail: Regan.Lipinski@na-atlas.com
Website: www.marinesonic.com

Marine Sonic Technology builds high quality, high resolution side scan sonar systems.

Located in Yorktown, Virginia, Marine Sonic has been in business for more than 25 years.

Our towed systems are rugged, easy to deploy and simple to operate. We also offer highly efficient AUV/ROV embedded systems, which occupy minimal space and low power consumption.

SOUND VELOCITY PROBES/CTDS

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Laksevag, Norway
Tel: +47 56 11 30 66,
Fax: +47 56 11 30 69
E-mail: info@saivas.no
Website: www.saivas.no
Contact: Gunnar Sagstad

- *STD/CTD, Sound Velocity probes/recorder with optional multi-parameter facilities; Turbidity, Fluorescence, Oxygen etc. The new CTD/STD model SD208 with wireless communication and high accuracy: 0.002 mS/cm, 0.002 °C*
- *Precision pressure /depth (0.01% accuracy) and temperature sensors/recorders. Applications: hydrographic profilings, installation on ROVs and towed systems, etc. Robust and compact designs are combined with accuracy and "plug and play" compatibility. Output format for sonar equipment, e.g. EM1002, EM3000, SSP, HiPAP and Reson 8125.*

SUBSEA FABRICATION

NEW INDUSTRIES
6032 Railroad Avenue
Morgan City, LA 70380
Tel: +1 985 385 6789
E-mail: bill.new@newindustries.com
Website: www.newindustries.com
Contact: Bill New

New Industries provides quality fabrication services to the offshore oil & gas and marine industries focusing on large diameter pressure vessels, suction piles, DNV buildings and deepwater subsea production equipment such as jumpers, PLETs, PLEMs and manifolds.

SUBSEA TECHNOLOGY

KONGSBERG MARITIME AS – SUBSEA DIVISION (DIVISION OF KONGSBERG GROUP)
Strandpromenaden 50
NO-3183 Horten
Norway
Tel: +47 33 03 41 00
Website: www.km.kongsberg.com

Kongsberg Maritime is a marine technology company providing innovative solutions for all marine industry sectors including merchant, offshore, subsea, naval and fisheries. The company delivers systems that cover diverse maritime applications. Within subsea, Kongsberg Maritime's sonars, Sub-bottom profilers, multibeam and single beam echo sounders, cameras, positioning and underwater communication & monitoring systems, instruments, software and Marine Robotics are used in survey and inspection operations worldwide. Working closely with customers to develop technology that pushes the limits in subsea applications, Kongsberg Maritime is also dedicated to developing innovative environmental monitoring solutions such as the K-Lander system in addition to cutting-edge Marine Robotic platforms such as the futuristic Eelume vehicle.

UNDERWATER VEHICLES/AUVS

HYDROID, INC.
A SUBSIDIARY OF KONGSBERG MARITIME
1 Henry Drive
Pocasset, MA 02559
Tel: +1 508 563 6565
Fax: +1 508 563 3445
E-mail: glester@hydroid.com
Website: www.hydroid.com
Contact: Graham Lester

Located in the U.S. and a subsidiary of Kongsberg Maritime, Hydroid is the world's most trusted manufacturer of advanced Autonomous Underwater Vehicles (AUVs). Our Marine Robotics systems provide innovative and reliable full-picture solutions for the marine research, defense, hydrographic and offshore/energy markets. Our products represent the most advanced, diversified and field-proven family of AUVs and AUV support systems in the world.

Developed by a veteran team of engineers, the innovations of Hydroid and Kongsberg Maritime provide a safe and reliable answer to the challenges that have hampered ocean exploration and security. For more information on REMUS technology, please visit www.hydroid.com.

OCEANSERVER TECHNOLOGY, INC.
151 Martine Street
Fall River, MA 02723 USA
Tel: +1 508 678 0550
Fax: +1 508 678 0552
E-mail: sales@ocean-server.com
Website: www.iver-auv.com
Contact: Jim Kirk

OceanServer Technology, Inc. is a leading provider of man-portable Autonomous Underwater Vehicles (AUVs) with over 250 AUVs deployed worldwide. The Iver AUV is an affordable, commercial vehicle used for general survey and sub-surface security work, and serves as a research platform for autonomy, behavioral and sensor development studies at universities and navy research facilities.

UNDERWATER VEHICLES/ROVS

DEEP OCEAN ENGINEERING INC.
2403 Qume Dr, San Jose, CA 95131 USA
Tel: +1 408 436 1102
Fax: +1 408 436 1108
E-mail: sales@deepocean.com
Website: www.deepocean.com
Contact: Mike Takeda

Deep Ocean Engineering, Inc. provides remotely operated and unmanned surface vehicle (ROV / USV) solutions which are used by a broad range of industry applications - security, military, nuclear and hydroelectric power plants, inshore dams and lakes, oil and gas, scientific research, fisheries, salvage, search / recovery, and pipeline inspections.

OCEANEERING INTERNATIONAL, INC.
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Houston, TX 77041
Tel: 713.329.4500
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Website: www.SeaBotix.com
Contact: Alasdair Murrie

Teledyne SeaBotix is a world leading manufacturer of capable underwater MiniROVs that perform a multitude of tasks including maritime security, search and recovery, hull and pipeline inspection, hazardous environment intervention, aquaculture, sensor deployment and oceanographic research. The Little Benthic Vehicle systems have become the benchmark in compact ROVs around the world and ROV equipment for over 30 years. We recognize that no two jobs are the same and specialize in products that are customizable for your specific applications.

UNDERWATER VEHICLES/ROVS (cont.)

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212 East High Street
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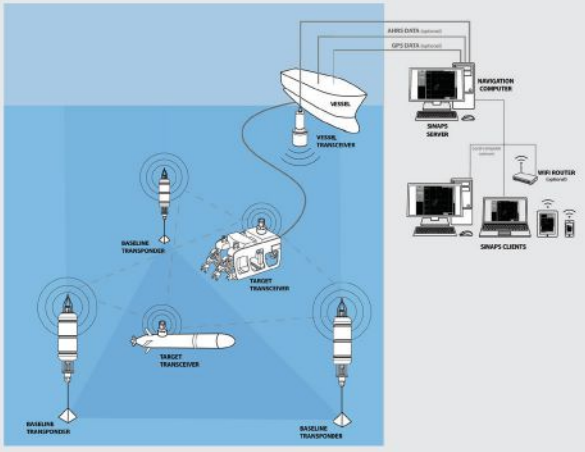

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