

March 2019

ON&T

Ocean News & Technology

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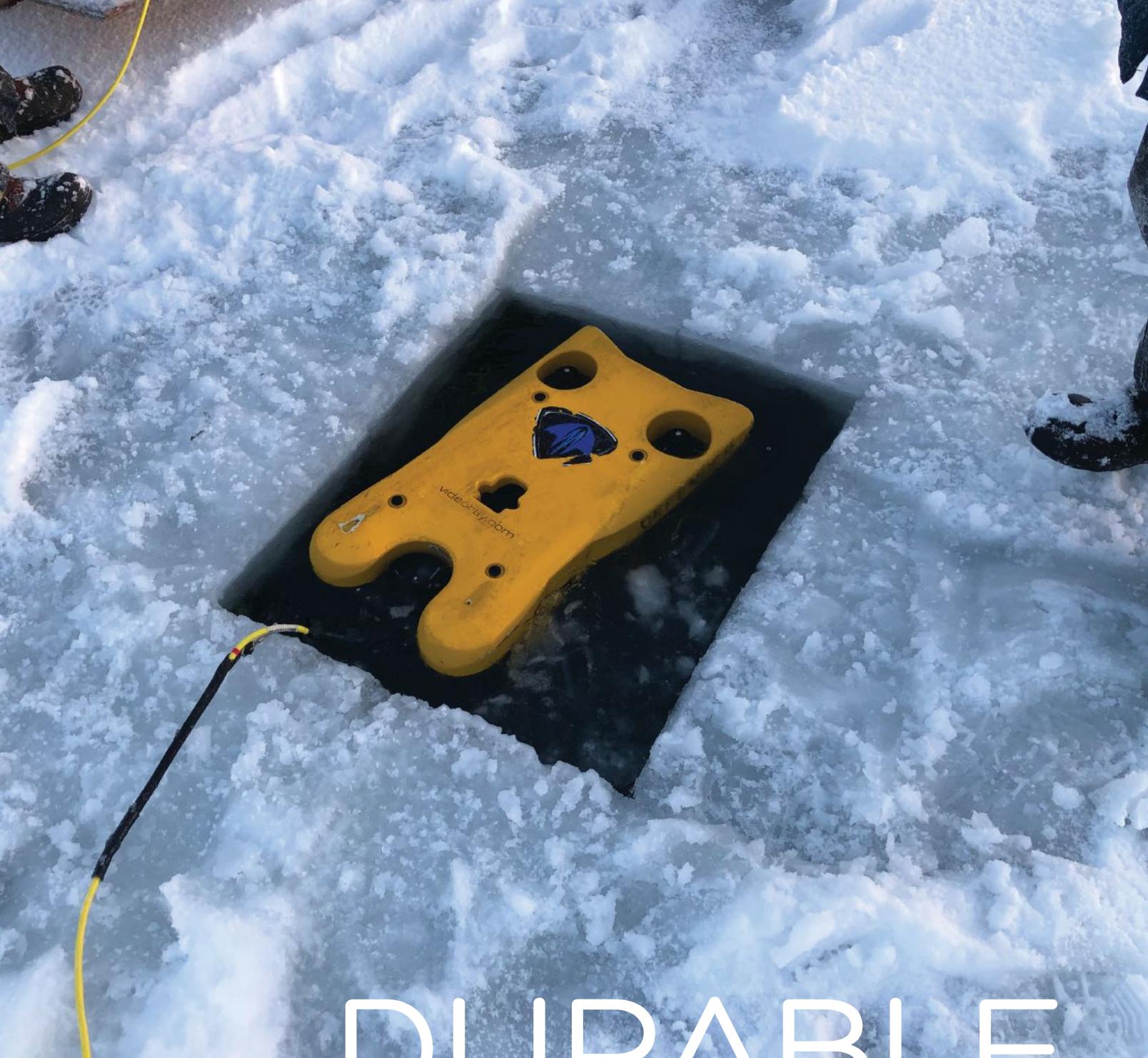


ESSENTIAL INTELLIGENCE

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**Scalable Bandwidth For
Monitoring Survey Quality pg. 30**



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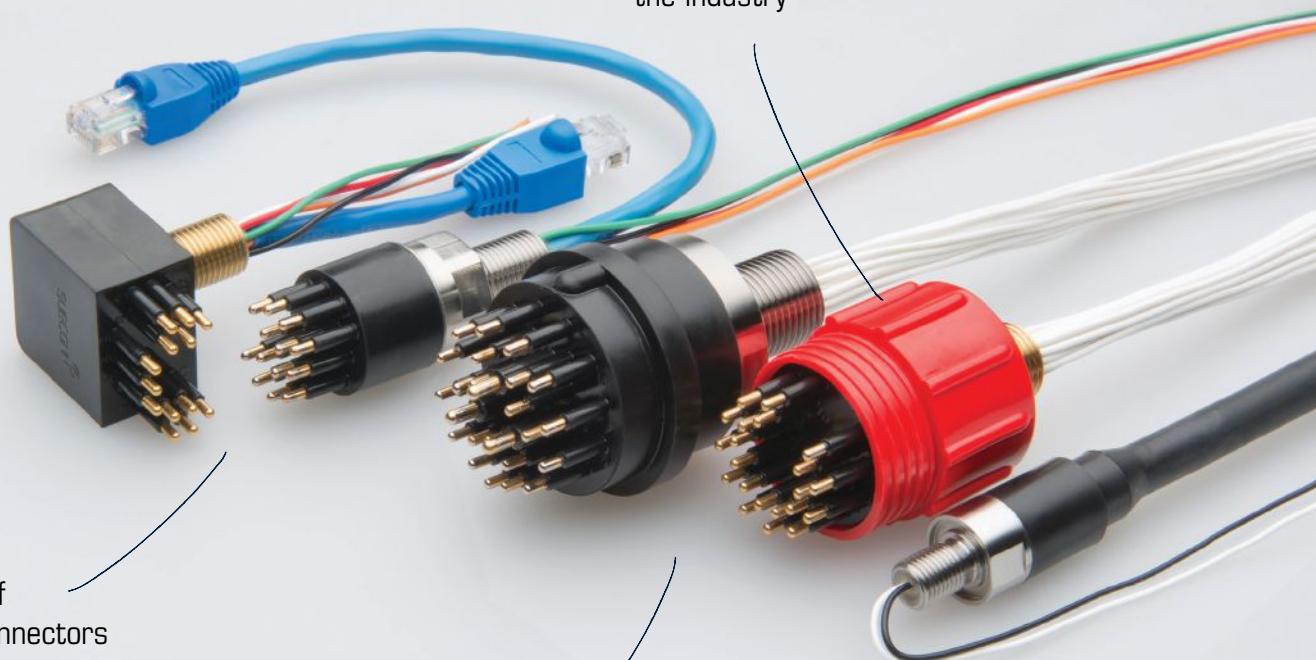


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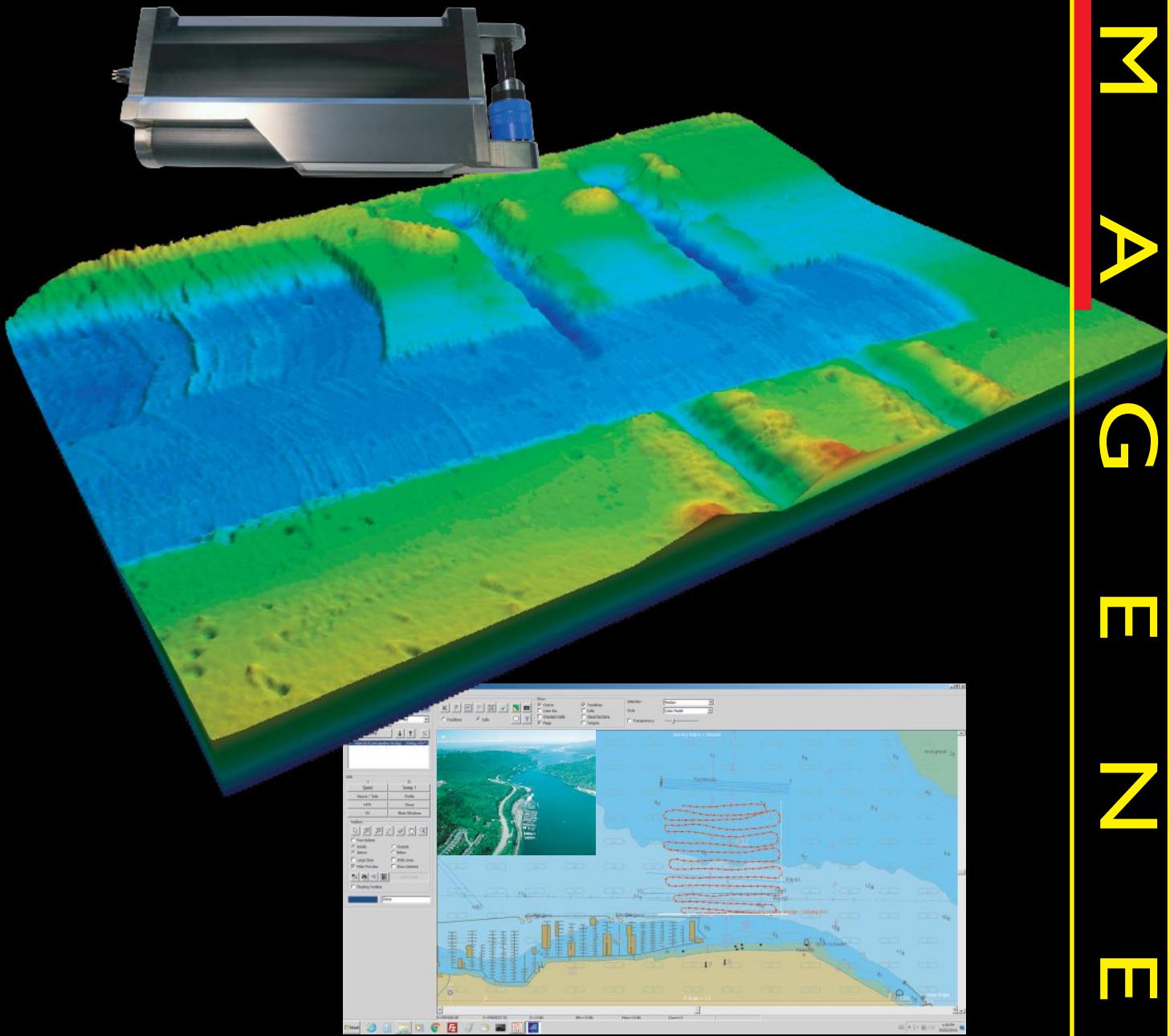
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ON THE COVER:

An AUV owned by the Monterey Bay Aquarium Research Institute (MBARI) during a cruise off Southern California. The vehicle is equipped with a swath multibeam sonar, two sidescan sonars, and a sub-bottom profiler. All components are rated to 6,000 meters depth. Photo credit: Phil Sammet © 2010 MBARI.

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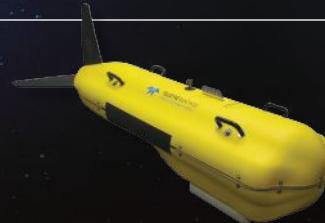


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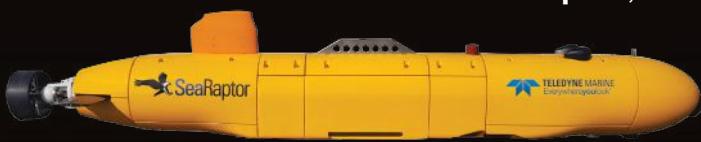


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LEGISLATION SHINES A LIGHT ON POSITIVE IMPACTS OF OFFSHORE OIL AND GAS LEASE MONEY

BY GREG LEATHERMAN,
Editor in Chief, ON&T

Readers of ON&T's newsletter know that the passage of a package of public lands legislation by the U.S. Senate on 12 February 2019 is also big news for the offshore oil and gas industry. Why? Because it also brings some positive attention to the U.S. oil and gas industry, since it would permanently reauthorize the Land and Water Conservation Fund, or LWCF.

The LWCF is not new. Created in 1964, it takes a portion of the revenues from offshore oil and gas drilling and spends it on protection of parks, forests and water supplies in all 50 states. Because of this, it enjoys broad bipartisan support.

The package reauthorizing the LWCF (and making it permanent) passed the Senate 92-8 and is expected to enjoy similar levels of support in the House of Representatives. The package enjoys a level of bipartisan consensus you rarely see in Congress. Though some House amendments, and a longer process, may slow things down, it appears we are well on our way to funding the protection of these natural areas forever—and we will have oil and gas companies to thank for that funding.

Since it was founded, the LWCF has generated \$3.9 billion in state grants for over 40,000 State projects. It has

already helped protect over 2.37 million acres. If it accomplishes that much in the next four decades, it will be one of the greatest conservation success stories in history.

It's off to a good start, insofar as the legislation's language. The Senate package significantly expands at least five national parks, creates at least five national monuments, bars mining on lands near two national parks and designates 1.3 million acres as wilderness—an official designation offering the strongest possible protections. The measure also protects from development hundreds of miles of wild and scenic rivers, and funds protection for some 380 bird species under the Neotropical Migratory Bird Conservation Act.

It also includes language expanding access for hunters and fishers to federal lands, and it includes dozens of land swaps and conveyances, which often put parcels of federal land into private use. It even promotes helium extraction, tries to improve wildland fire operations and sets up a national volcano early warning and monitoring system.

Keeping Up with Blue-Green Issues

If this seems like a lot to keep track of, I have a suggestion. Our sister publication,

Environment Coastal and Offshore (ECO) is the ideal source for keeping up with news that touches both the ocean economy and conservation. From regulatory updates to breaking ocean science stories, ECO provides essential ocean intelligence for experts, explorers, and enthusiasts.



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KNOW WHAT'S BELOW

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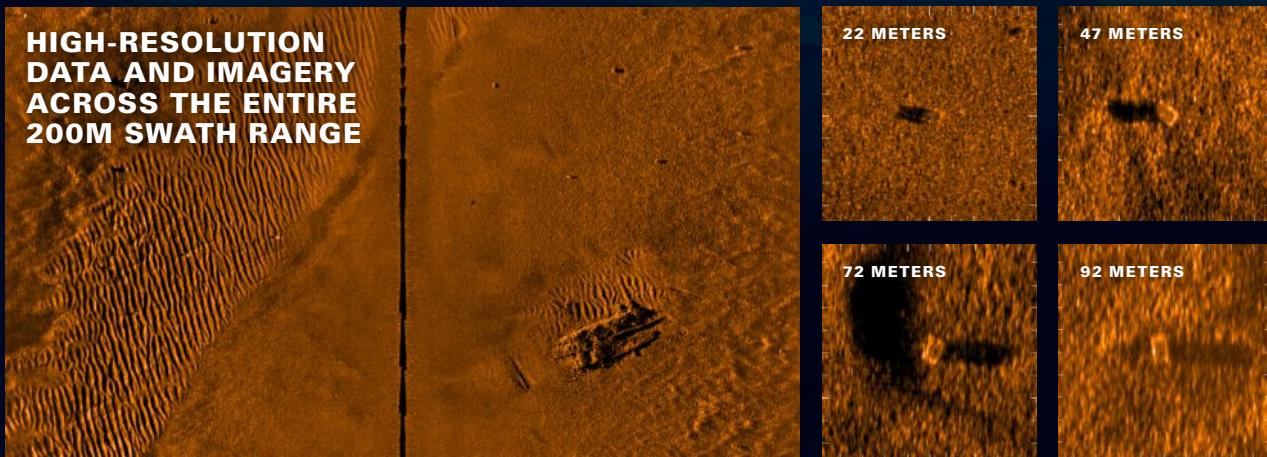
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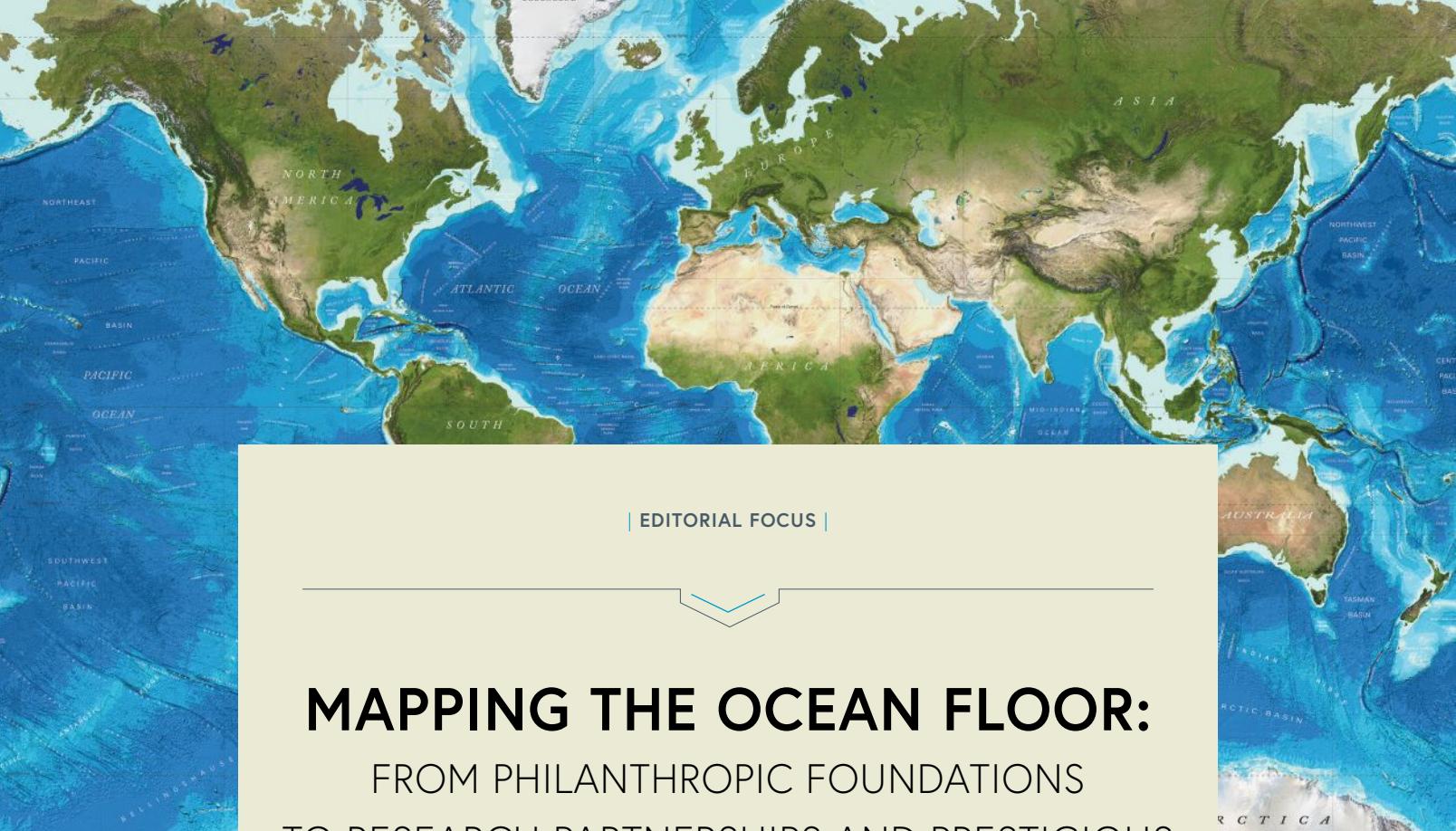
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MAPPING THE OCEAN FLOOR: FROM PHILANTHROPIC FOUNDATIONS TO RESEARCH PARTNERSHIPS AND PRESTIGIOUS PRIZES, EFFORTS TO FINALLY MAP THE WORLD'S LAST FRONTIER ARE IN FULL SWING

There is a lot going on in the world of ocean mapping these days. And though we still have a long way to go, the recent number of new players in the realm of ocean mapping make it clear that the last vast frontier on Earth, the deep oceans, is finally going to be as thoroughly mapped as its continental counterparts. Right now, of course, the consensus within the scientific community is that less than 20% of the world's ocean floor has been mapped. In fact, we know the topography of the Moon and Mars in greater detail than that of our own planet. But all of that is rapidly changing.

First, let's look at the issue at hand. Why isn't the ocean floor mapped in detail already? The first problem is the sheer amount of time it takes. While ships do use advanced sonar technology to build topographic maps, the process is slow. In fact, the vast majority of our oceans have not been sampled by echo sounders, even at a resolution of 30 arc seconds. Reasons for this have a lot to do with the

extraordinary challenges of getting the technology out there, including extreme environments, and of course, high costs.

Some very dedicated visionaries are trying to change that, both by funding innovators and creating new methods and technologies to advance the state of our ocean knowledge. For example, the Nippon Foundation has pledged \$2 million per year as seed money for its GEBCO Seabed 2030 project, which aims to map the bathymetry of the world's entire ocean floor by 2030. Initial efforts will focus on mapping the 93% of the ocean deeper than 200 meters, leaving national hydrographic agencies to cover waters closer to shore. They have called on the resources of the international maritime community for additional support. You can learn more about them at seabed2030.gebco.net.

Another noteworthy effort is The Global Coral Mapping Partnership, which is responding to the need for global coral maps and coral monitoring systems by

harnessing satellite imagery and big data processing. The partnership will provide the first-ever seamless mosaic of high-resolution satellite imagery of the world's coral reefs and will engage with the global coral reef science and management communities to deliver accurate maps of the features making up the reefs and how they are changing. This product is called the Allen Coral Atlas, in honor of supporter Paul Allen. You can find out more about this project at www.allencoralatlas.org.

Shell Ocean Discovery XPRIZE Finalists Conduct Final Field Tests for \$1M NOAA Bonus Prize

For some researchers, mapping the ocean could mean winning a multi-million-dollar prize for their teams.

XPRIZE announced in mid-February that the three finalist teams competing for the

\$1M Bonus Prize sponsored by the National Oceanic and Atmospheric Administration (NOAA), in its Shell Ocean Discovery XPRIZE, have tested their technologies in Ponce, Puerto Rico.

But that's just the beginning. The \$1M NOAA Bonus Prize is part of the \$7M Shell Ocean Discovery XPRIZE, a three-year global competition challenging teams to advance ocean technologies for rapid, unmanned and high-resolution ocean exploration.

To win the NOAA portion of the prize, competing teams need to demonstrate that their technology can identify and track, or "sniff out," a specified object in the ocean by tracing a biological or chemical signal to its source. The development of such technologies can help detect sources of pollution, identify hydrothermal vents and methane seeps, as well as track marine life for scientific research and conservation efforts. The winning devices could also be used to identify and track signals from sunken vessels including planes, ships, or submarines in the future.

"The NOAA Bonus Prize teams are developing exciting, pioneering technologies that will help us uncover the mysteries of the ocean," said Jyotika Virmani, Ph.D., Executive Director of the Shell Ocean Discovery XPRIZE. "Having the opportunity to bring these teams, and their technologies, to beautiful Puerto Rico as originally planned is a win-win for everyone involved, and we were delighted to be able to work with our local partners."

The final field test fulfills XPRIZE's commitment to Puerto Rico, after initial plans to host its round one field tests for the Ocean Discovery XPRIZE were cancelled due to the destruction and devastation of Hurricanes Irma and Maria in September 2017. Between January 20 to February 2, the finalist teams showcased their technologies by trying to detect and track a plume from two sources in a test zone established off the south coast of Ponce.

"New technologies that can detect and trace chemical and biological signals in the ocean is another stunning achievement in expanding the blue economy," said retired Navy Rear Adm. Timothy Gallaudet, Ph.D., acting undersecretary of commerce for oceans and atmosphere at NOAA. "This

great public-private partnership supports NOAA's critical mission to conserve and manage coastal and marine ecosystems and resources."

For this final field test, XPRIZE partnered with the Government of Puerto Rico, the Port of Ponce Authority, the University of Puerto Rico at Mayagüez and its Department of Marine Science in La Parguera, the United States Coast Guard, the Caribbean Coastal Ocean Observing System (CARICOOS), Ponce Yacht and Fishing Club, and multiple other government, nonprofit and commercial organizations to provide additional support technology, vessels, and logistical assistance.

The NOAA Bonus Prize finalists who opted to compete for this Prize were initially chosen by an independent judging panel of seven experts as semi-finalists for the Ocean Discovery XPRIZE. Teams in the final round include:

- **BangaloreRobotics (Bangalore, Karnataka, India)** – Led by Dr. Venkatesh Gurappa, this international team of students and enthusiasts from across the world share the common interest of making the world safe for human and other life forms through technology. BangaloreRobotics's goal is to create intelligent and autonomous robots that can replace human presence in hazardous areas. The team is developing innovative and low-cost Underwater Swarm AUVs.



» Dr. Venkatesh Gurappa, Team Lead, and Team Members Sumithra, Sahas, Sneha, Geetha, Revanth, Raghavendra, Sudarshan, Ramesh, and Avinash. Image courtesy of XPrize.

- **Ocean Quest (San Jose, CA, United States)** – Led by Danny Kim, Quest Institute has a long track record of taking on the most challenging endeavors in science and technology for the purposes of education and inspiring the next generation of leaders. Quest is looking to innovate in the deep oceans arena to help foster not only new technology and techniques, but make ocean exploration and education accessible to the students around the world. The team endeavors to design a marine STEM platform for students worldwide to enable project-based learning with new technology and techniques.



» Stephen Huber, Lead Engineer of the Ocean Quest team. The rest of the team are young students, making Team Ocean Quest the competition's only precollege-aged student team.

- **Tampa Deep Sea X-plores (Tampa, FL, United States)** – Led by Edward Larson, the Tampa Deep-Sea X-plores are an LLC registered in the state of Florida for the purpose of competing in the Shell Ocean Discovery XPRIZE. The team seeks to harness the talents and resources of Central Florida's academic and business communities to design and build a viable solution to win the competition. The team is using existing technology and side scanning sonar on multiple AUVs.



» Chief Technology Officer Art Iannuzzi and CEO Edward Larson of Tampa Deep Sea X-plores. Image courtesy of XPrize.

formed a new partnership with Ocean Infinity, the seabed survey and ocean exploration company that is credited for finding ARA San Juan, the Argentine Navy submarine which was lost on November 15, 2017. The partnership will provide XPRIZE with the highest-resolution ocean seafloor maps of the competition area. Combined with data

In addition to announcing its field test operations in Puerto Rico, XPRIZE also

from XPRIZE partner Fugro, these maps form the baseline against which teams' technologies will be judged for the Grand Prize of the Ocean Discovery XPRIZE.

The winners of the NOAA Bonus XPRIZE as well as the Grand Prize winner(s) of the Shell Ocean Discovery XPRIZE will be announced by June 2019. For more information, visit oceandiscovery.xprize.org.

NAVY-SPONSORED SCIENTIST AWARDED FOR SEA-FLOOR MAPPING

For creating the most comprehensive global map of the ocean floor, Dr. David Sandwell has received the Charles A. Whitten Medal, sponsored by the American Geophysical Union (AGU).

Sandwell, a geophysicist at Scripps Institution of Oceanography, accepted the award at the AGU Fall Meeting in December 2018. Named after scientist Charles A. Whitten, the medal is given to honor "outstanding achievement in research on the form and dynamics of the Earth and planets."

Since the 1990s, sponsored by the Office of Naval Research (ONR), Sandwell has combined satellite data with acoustic depth measurements to develop a detailed, accurate map of the sea floor—painting a vivid tapestry of the deepest, least explored parts of the ocean. The map catalogues thousands of previously unidentified underwater mountains, trenches, physical undersea connections between South America and Africa, and extinct ridges that spread the sea floor in the Gulf of Mexico.

"Dr. Sandwell's groundbreaking work provides the first high-resolution map of the ocean floor," said Dr. Tom Drake, head of ONR's Ocean Battlespace and Expeditionary Access Department. "This has opened new research areas for oceanography, marine geology and geophysics—critical topics for the U.S. Navy."

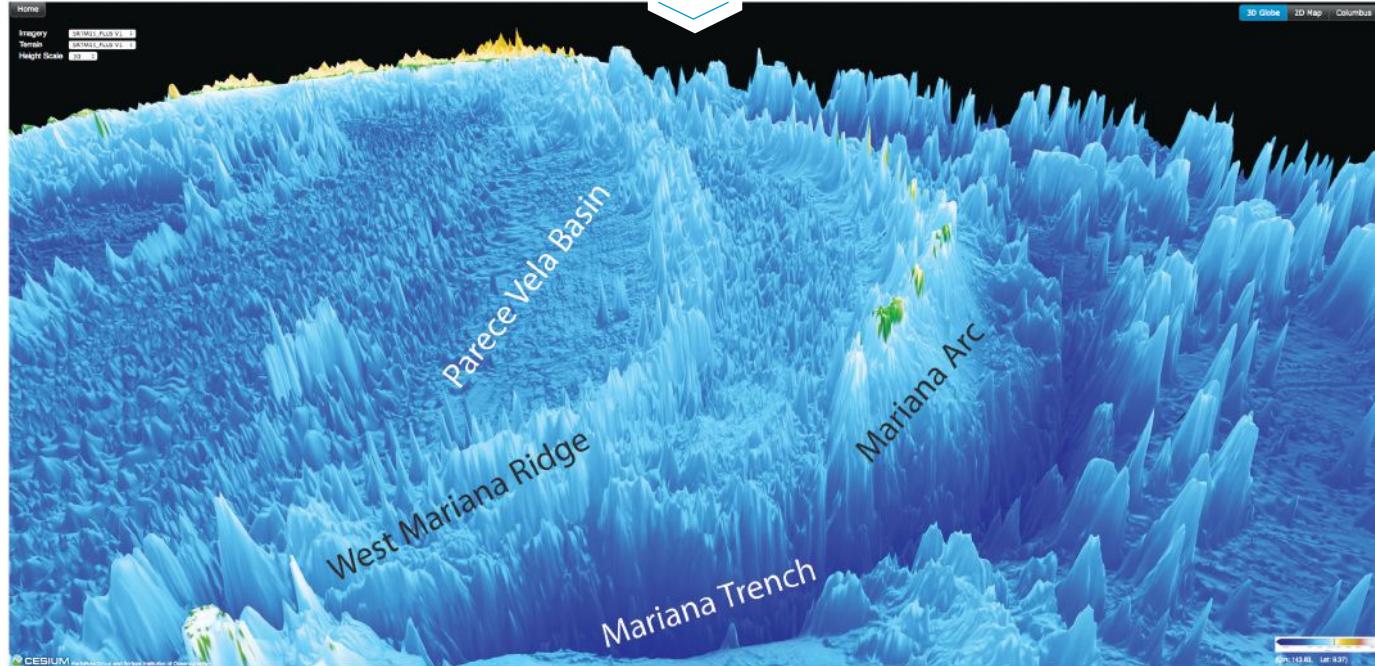
Sandwell's work relies on satellite altimetry (radar) to measure small bumps and dips on the ocean surface, which point to large-scale features on the ocean floor. For example, undersea mountains have a lot of mass, and are huge enough to exert gravitational pulls that gather water above and around them into a bump on the sea surface. Essentially, seamounts pull more water toward their center of mass. In contrast, massive cracks and rifts on the ocean floor have less gravitational attraction, resulting in a dip on the surface.

For utmost accuracy, Sandwell blends satellite measurements with traditional sonar soundings from manned research ships. This enables him to compare the topography of the sea surface with that of the sea floor and form a complete map of the bottom.

Sandwell created multiple versions of his map over the last two decades. He unveiled the first in 1997, based on marine gravitational data gathered by the Navy's GEOSAT Earth-observation satellite. In 2014, he improved the original map by adding data from additional satellites operated by the National Aeronautics and Space Administration (NASA) and the European Space Agency.

"Dr. Sandwell's map is like a smart phone that improves with each new model," said Dr. Reginald Beach, who sponsors Sandwell's work for ONR's Ocean Battlespace and Expeditionary Access Department. "Each version teaches us more about the topography of the ocean bottom, which is crucial to safe navigation for the Navy."

The ONR Ocean Battlespace and Expeditionary Access Department is responsible for Navy and Marine Corps science and technology in ocean and meteorological science, undersea warfare, mine warfare, space technology and marine mammals. Naval operations require accurate gravity models for inertial navigation and fire control, and accurate bathymetry to assess navigational hazards.



» SRTM15 PLUS Cesium globe northward view of the region around the Mariana Arc and Trench. Recently added multibeam bathymetry data have substantially increased resolution of small-scale features in this region. Image credit: Public Library of Science, Posted by R. Dietmar Müller Xiaodong Qin David T. Sandwell Adriana Dutkiewicz Simon E. Williams Nicolas Flament Stefan Maus Maria Seton.

in uncharted areas. In addition, coastal bathymetry is used for improving models of tides and currents.

The research is also of value to the offshore energy industry, in particular for remote areas. The geological features of the continental and oceanic crusts have consequences for petroleum system development. Petroleum exploration companies use satellite altimeter gravity data to locate offshore sedimentary basins in these remote areas. This information is combined with other reconnaissance survey information to determine where to collect or purchase multi-channel seismic survey data.

Sandwell is now updating the 2014 map with information gathered by another pair of satellites run by NASA and the French space agency, CNES. Other data comes from sonar soundings compiled by Australia, during that nation's participation in an international effort to scour the southern Indian Ocean in search of the wreckage of Malaysian Airways Flight 370—which disappeared in 2014. Australia made the sonar data publicly available in 2017.

"Thanks to this new data, our map can provide greater information about the world's oceans," said Sandwell, "particularly the Southern Hemisphere, which includes the Indian Ocean and south Atlantic Ocean. I'm grateful to ONR for its valuable support over the years, which has been crucial to creating the most accurate sea floor map possible."

Be sure and visit the Scripps Institute of Technology at www.scripps.ucsd.edu.

WHY MAP NOW?

Sometimes the reasons cited for ocean mapping are practical, like improving our ability to respond to shipwrecks and airplane crashes. Detailed mapping could also come into play for understanding ocean currents, improved climate forecasts, and of course, for future seabed mining purposes.

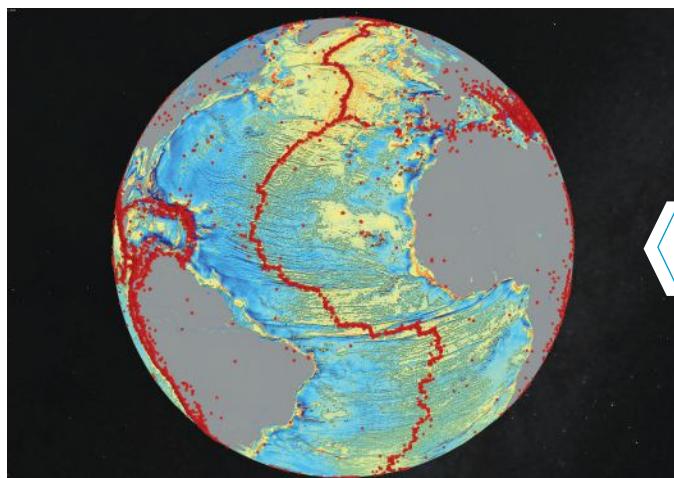
Seabed mapping touches on nearly every aspect of human life, from security and safety, to economic health. It can help improve our energy production, feed more people, and expand our reach in ways we never thought possible. It can also help protect our ever-expanding network of submarine cables, since the routing of these cables is highly dependent on detailed knowledge of bathymetry.

Other reasons are more about understanding ocean ecosystems. For example, improved seabed maps can help identify previously unknown hydrothermal vents, which is what happened in 2018 when a Schmidt Ocean Institute team using autonomous and interactive robotic seafloor mapping systems on an expedition in the southern Gulf of California, led scientists not only to a new hydrothermal vent field, but enabled the discovery of new deep-sea organisms.

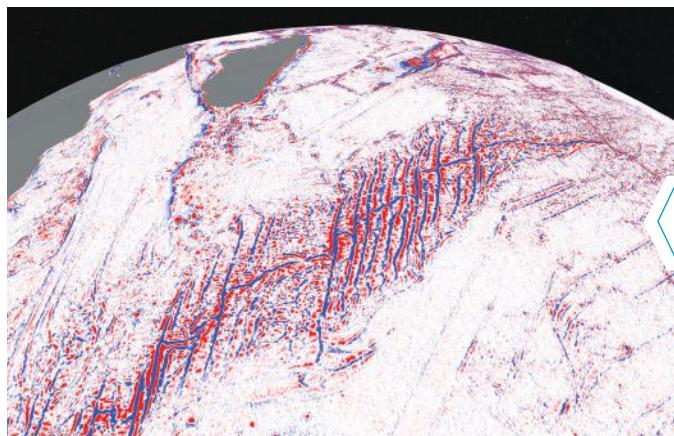
Each of these reasons alone would be enough to spur human exploration of our oceans forward. And if there is one thing to be sure of, it is that more ocean discoveries await, both in the near term and out into the coming decades.



» Artist concept of U.S.-European Jason-3 Ocean Altimetry Satellite. Jason-3 is the fourth mission in U.S.-European series of satellite missions that measure the height of the ocean surface. Sandwell's work relies on satellite altimetry (radar) to measure small bumps and dips on the ocean surface, which point to large-scale features on the ocean floor. The satellites are also used to gather critical information about circulation patterns in the ocean and about both global and regional changes in sea level. Photo courtesy NASA/JPL-Caltech.

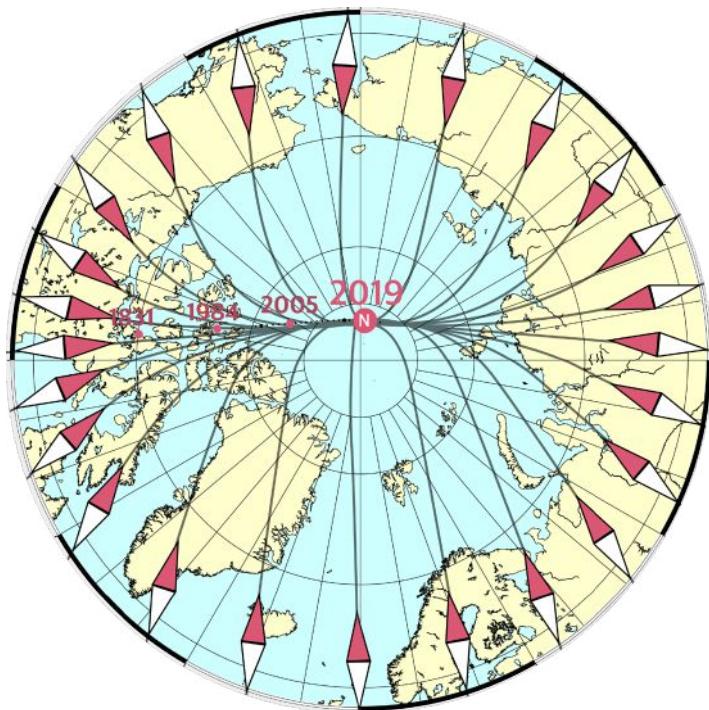


» A version of Dr. David Sandwell's sea floor map reveals details about earthquakes (red dots), sea floor-spreading ridges and faults. Photo courtesy of Dr. David Sandwell, Scripps Institution of Oceanography, UC San Diego.



» Vertical gravity gradient (VGG) model of the Southwest Indian Ridge. This is the slowest spreading ridge on the Earth and has large fracture zone signatures that record the rifting and spreading between Africa and Antarctica.

MAGNETIC MODEL ESSENTIAL FOR MODERN OCEAN NAVIGATION UPDATED



» Driven largely by the churning of fluid in Earth's core, which generates the magnetic field, the magnetic north pole has always drifted. Around 50 years ago, the pole was ambling along at around 15 km a year, but now it is charging ahead at around 55 km a year, leaving the Canadian Arctic heading towards Siberia. Image courtesy of ESA.

The World Magnetic Model, the basis for many navigation systems used by ships, Google maps and smartphones, relies on the accurate knowledge of Earth's magnetic field. Since magnetic north never stands still, the model has to be revised periodically – but a surge in pace has meant that an update was needed ahead of schedule. As reported in January by ON&T, that update had been slightly delayed by the government shutdown, but the full release is now available.

Since it was first measured in 1831, we have known that the magnetic north is constantly on the move. However, its pace has picked up recently – so much so that the World Magnetic Model required an urgent update to remain accurate enough for modern navigation. The European Space Agency's (ESA) magnetic field Swarm mission has been key for this update.

Driven largely by the churning of fluid in Earth's core, which generates the magnetic field, the magnetic north pole has always

drifted, and geological evidence shows that every few hundred thousand years or so it even flips, so that north becomes south.

Around 50 years ago, the pole was ambling along at around 15 km a year, but now it is sprinting ahead at around 55 km a year. In 2017, it crossed the international date line, leaving the Canadian Arctic and heading towards Siberia.

The World Magnetic Model is used to keep track of changes in the magnetic field and is updated every five years by the US National Oceanic and Atmospheric Administration (NOAA) and the British Geological Survey. The next update was due at the end of this year.

However, thanks in part to ESA's Swarm mission, researchers found that the pole is drifting in a way that wasn't expected. This meant that model was simply too inaccurate for it to remain until the next planned revision. So, an 'out-of-cycle' update was issued.

STATE-OF-THE-ART EXPLORER VESSEL INSTALLING FAROUNDER 3D FLS

FarSounder's flagship navigation product, the FarSounder-1000 Forward Looking Sonar (FLS), has been selected by the OceanX exploration team to help provide safe passage for Alucia2, their new 85.3m research and exploration yacht. Admarel BV, a member of the Alewijnse Group, is the FarSounder dealer in the Netherlands instrumental in securing this sale.

This state-of-the-art explorer vessel is set to discover all of the secrets of the ocean.

FarSounder's 3D FLS, with no moving parts, is an exemplary addition to Alucia2's navigation capabilities. With the inclusion of a FarSounder-1000, operators of the vessel will be able to view a true underwater 3D image ahead of the ship up to 1000 meters range. The sonar's highly-innovative technology will assist in the prevention of collisions and groundings as the OceanX team explores parts unknown.

The Alucia2 is a major refit project transforming the former Volstad Surveyor built in 2010 by Freire Shipyard into one of the most high-tech explorer vessels. This will enable the OceanX team to explore further and deeper into the world's oceans than its predecessor,



the M/V Alucia. Advanced wet and dry marine research labs as well as a media and production center, suitable for professional-grade film production are some of its innovative features. Principals involved with OceanX include Ray Dalio and his son Mark Dalio, along with famed director James Cameron.

As Alucia2 reaches to the farthest corners of the oceans, the OceanX team can rest easy knowing the potential for safe exploration is greatly increased with a FarSounder-1000 leading the way. This will ultimately help them reach their goal of shedding light on the great mysteries of the ocean.

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BREAKTHROUGH IN IDENTIFYING WHAT DRIVES OCEAN OVERTURNING

In a departure from the prevailing scientific view, a new international study has revealed that a deep-ocean process playing a key role in regulating Earth's climate is primarily driven by cooling waters west of Europe.

These findings will help scientists better forecast changes to the weather and climate by improving understanding of the influence of the ocean upon them.

The study focused on part of the Atlantic meridional overturning circulation (AMOC), a system of ocean currents in the North Atlantic responsible for the transfer of huge amounts of heat from the ocean to northwest Europe, keeping its climate relatively mild.

National Oceanography Centre (NOC) scientists collaborated on this study alongside colleagues from 16 research institutions across seven countries.

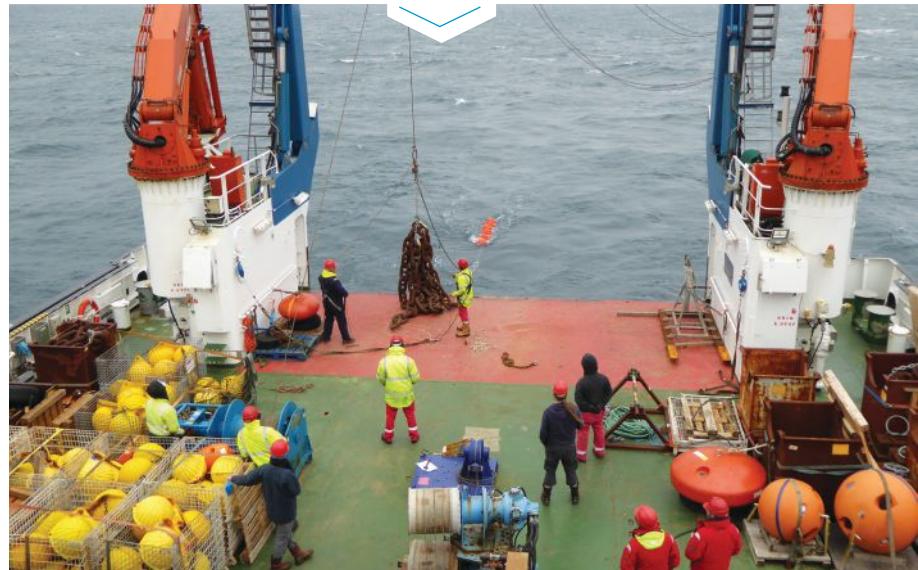
The prevailing scientific view, based on modelling studies, had been that most of the AMOC's overturning and variability occurs in the Labrador Sea, off Canada. Whereas this new research, published in the *Journal Science*, shows the overturning and variability actually happens in regions between Greenland and Scotland. There, warm, salty, shallow waters are carried northward from the tropics by currents and wind, sink and convert into colder, fresher, deep waters moving southward through the Irminger and Iceland basins.

Overturning variability in this eastern section of the ocean was seven times greater than in the Labrador Sea, and it accounted for 88 percent of the total variance documented across the entire North Atlantic over the 21-month study period.

"These findings, unexpected as they may be, can help scientists better predict what changes might occur to the Atlantic meridional overturning circulation and what the climate impacts of those changes will be," said Susan Lozier, the Ronie-Rochele Garcia-Johnson Professor of Earth and Ocean Sciences at Duke University's Nicholas School of the Environment.

"To aid predictions of climate in the years and decades ahead, we need to know where this deep overturning is currently taking place and what is causing it to vary," said Lozier, who led the international observational study that produced the new data.

"Ocean overturning carries vast amounts of atmospheric carbon from human activity



deep into the ocean, helping to slow global warming," said co-author Dr. Penny Holliday of the NOC. "The largest reservoir of this carbon from human activity is in the North Atlantic."

"Overturning also transports tropical heat northward," Holliday said, "meaning any changes to it could have an impact on glaciers and Arctic sea ice. Understanding what is happening, and what may happen in the years to come, is vital."

"I cannot say enough about the importance of this international collaboration to the success of this project," Lozier said. "Measuring the circulation in the subpolar North Atlantic is incredibly challenging so we definitely needed an 'all hands-on deck' approach."

This paper is the first from the £24 million, five-year initial phase of the OSNAP (Overturning in the Subpolar North Atlantic Program) research project, in which scientists have deployed moored instruments and subsurface floats across the North Atlantic to measure the ocean's overturning circulation and shed light on the factors that cause it to vary. Lozier is lead investigator of the project, which began in 2014.

"As scientists, it is exciting to learn that there are more pieces to the overturning puzzle than we first thought," said co-author Johannes Karstensen of the GEOMAR Helmholtz Centre for Ocean Research Kiel, in Germany.

"Though the overturning in the Labrador Sea is smaller than we expected, we have

learned that this basin plays a large role in transporting freshwater from the Arctic," Karstensen said. "Continued measurements in that basin will be increasingly important," as the Arctic changes unexpectedly.

The new paper contains data collected over a 21-month period from August 2014 to April 2016.

Primary funding came from the U.S. National Science Foundation's Physical Oceanography Program and the United Kingdom's Natural Environment Research Council. Additional funding came from the European Union 7th Framework Programme and Horizon 2020.

Co-authors hailed from Duke; the UK's National Oceanography Centre; Woods Hole Oceanographic Institution; the Scottish Association for Marine Sciences; the Royal Netherlands Institute for Sea Research and Utrecht University; Memorial University in St. John's, Canada; GEOMAR Helmholtz Centre for Ocean Research in Kiel, Germany; and the Bedford Institute of Oceanography in Dartmouth, Canada.

There were also scientists from the University of Miami; the University of Oxford; Scripps Institution of Oceanography; the Ocean University of China and Qingdao National Laboratory for Marine Science and Technology; the Laboratoire d'Oceanographie Physique et Spatiale in Plouzané, France; and the University of Liverpool.

NEW DEEP SEA ANIMAL DISCOVERIES IN COSTA RICAN WATERS

Scientists aboard Schmidt Ocean Institute's research vessel Falkor surveyed deep-sea seamounts outside Isla del Coco UNESCO World Heritage site revealing coral communities with surprising diversity.

A three-week expedition off the coast of Costa Rica has just expanded our knowledge of deep sea ecosystems in the region. Led by Dr. Erik Cordes, Temple University, the scientists aboard research vessel Falkor surveyed the continental margin for seamounts and natural gas seeps, where specialized biological communities are found. The seamounts extending from the mainland to the Cocos Islands National Park provide an important corridor for the animals occupying the area.

Investigating these systems on all biological size scales, the team focused on relationships between species, from microbes to fauna like fish and corals. At least four new species of deep-sea corals and six other animals that are new to science were found. This expedition represents the first time that seven of the seamounts in the area have been surveyed. The survey results, including description of the coral communities that they host, will support the effort to create a new marine protected area around these seamounts ensuring that

they are not impacted by fishing or potential mining activities.

During one of the 19 remotely operated vehicle dives the accumulation of trash at 3,600 meters depth (more than 2 miles) was discovered. Threats to the deep sea already exist, including fishing and energy industries that are moving into deeper water, and the persistent risk of climate change. There are rare organisms and spectacular habitats on the seamounts; it is important to preserve them before they are impacted by these and other threats.

One unique discovery during the expedition was the consistent zonation of seamounts related to the amount of oxygen present. Decreasing oxygen in the ocean due to a warming planet may eventually affect these zones dominated by corals, sea fans, sponges, brittle stars and small oysters. "Every dive continues to amaze us," said Cordes. "We discovered species of reef-building stony corals at over 800 meters depth on two different seamounts. The closest records of this species are from the deep waters around the Galapagos Islands. The deep sea is the largest habitat on Earth. Understanding how that habitat functions will help us to understand how the planet as a whole works."

WWW.SCHMIDTOCEAN.ORG



» Isla del Coco UNESCO World Heritage site



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NEW FORM FACTOR:

Next Generation "Tiny" Modems from EvoLogics



EvoLogics S2C R, S2C M and S2C T 18/34 modems (left to right)

**Evo
Logics®**

EvoLogics GmbH (Berlin, DE) introduces the company's latest addition to their range of underwater acoustic modems: the new generation S2C T modems. The light and ultra-compact design represents a size reduction of almost twenty percent compared to EvoLogics M-series mini-modems at only 25-centimeter standard height and 1200 grams weight.

The new model features a fully-fledged S2C engine with no compromises in acoustic performance. It is a great fit for small AUVs and ROVs where size and weight are critical. Perfect as transponders for positioning, the S2C T are capable of simultaneous tracking and reliable bi-directional data transmissions with advanced networking. The S2C T series form factor will be available for EvoLogics high frequency models, catering to various applications with 4 frequency range/directivity options.

EvoLogics reliable S2C spread-spectrum communication technology stems from bionic concepts and over the years evolved into a whole ecosystem of products. This includes several series of underwater acoustic modems, modular underwater positioning systems (USBL, LBL, SBL), as well as a framework for developers in both networking and hardware design. The S2C R "standard" build modems are highly configurable. They offer the widest selection of options and depth ratings to find an exact match even to most unique and application-specific tasks.

The S2C M "mini" devices are smaller and lighter, providing essentials for numerous communication and positioning scenarios. The new S2C T - the "tiny" line - steps up to enable smarter, lighter and more effective solutions to modern subsea applications that demand fast and reliable communication.

The driving force behind EvoLogics is the attitude that nature has evolved over millions of years to generate the most efficient design. Uncovering these design elements can advance humankind in their development of technologies that are both superior in performance and also environmentally safe. The company's S2C technology is based on the physics of dolphin communication.

EvoLogics is a Germany-based high-tech enterprise. It was founded in 2000 by a group of leading international scientists and R&D experts to develop innovative key technologies for the aerospace, maritime and offshore industries through interdisciplinary cooperation between engineering and life sciences.

EvoLogics' showcase at Ocean Business 2019 in Southampton, UK will feature the company's recent technology launches and R&D efforts. Visit them at stand E6 to learn more.

WWW.EVOLOGICS.DE

FIVE DEEPS EXPEDITION EMBARKS ON SECOND DIVE

For the second time, The Five Deeps Expedition has set sail on a mission to reach one of the most remote points on the planet: the deepest point of the South Sandwich Trench in the Southern Ocean. Currently measured at 7,235 meters/23,736 feet deep, this destination presents many challenges related to logistics and weather conditions, yet holds the possibility of groundbreaking scientific discovery due to the fact that it has not been thoroughly explored and is the only subzero Hadal zone (deeper than 6,000 meters) in the world.

The Five Deeps crew set sail from Montevideo, Uruguay on January 24 and will travel 7 days (1,450 nautical miles) southeast to Grytviken on the island of South Georgia and then another 2-3 days (550 nautical miles) to the South Sandwich Islands and Trench itself where multibeam sonar mapping and the deep dives will take place over 3-4 days, weather permitting.

"This is an especially exciting dive for our whole crew based solely on the fact that we are sailing into quite unknown territory, while trying to overcome the potential for treacherous weather and sea conditions," said Victor Vescovo, the expedition creator and chief sub pilot. "If the weather holds and we have the opportunity, it is our intention to dive the Southern Ocean Deep, and then go north to possibly dive the Meteor Deep. We also plan to map the heck out of the trench and deploy landers to collect multiple sediment and biological samples."

"All together, the EYOS Expeditions team have led more than 800 safe and successful expeditions to Antarctica; but this one is unique. This is pure exploration in the same spirit as the original polar pioneers such as Amundsen, Shackleton and Scott," said Rob McCallum of EYOS Expeditions. "This is one of the most remote corners of our planet, and we will traverse more than 2,000 miles just to reach the Trench. Being this far from home we need to be well prepared, so we have added one of the world's most accomplished expedition physicians to the team as well as an Ice Pilot with decades of experience."

"The Triton Submarines team is aboard the good ship Pressure Drop once again to assist Mr. Vescovo, with an attempt to complete the second and perhaps most challenging of the Five Deeps Expedition objectives; the world's first dive to the deepest point of the South Sandwich Trench in the Southern Ocean. The Triton 36,000/2 or Limiting Factor submersible makes it possible for Mr. Vescovo to be the first person in history to visit two of the most hostile and least understood Hadal zones on our planet. We are thrilled to be a part of this remarkable and unprecedented journey of discovery."

The Five Deeps mission is being filmed by Atlantic Productions for a five-part Discovery Channel documentary series due to air in 2020.



» The Triton 36,000/2. Image credit: Triton

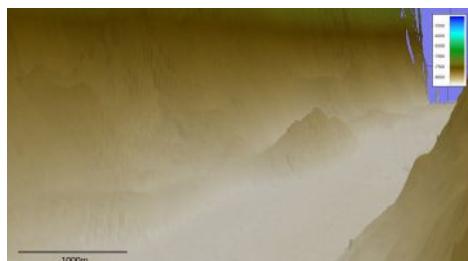
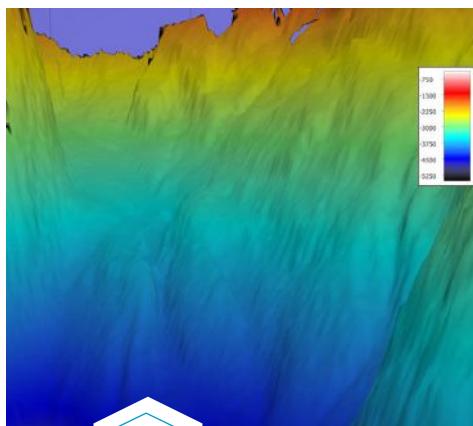
For updates on the expedition, visit www.fivedeeps.com. The website also has all of the information one might need regarding the technology, scientific goals, crew and team bios, and an expedition overview.

OKEANUS DELIVERS WINCH SYSTEM TO DEPARTMENT OF DEFENSE

Okeanus Science & Technology, LLC (Okeanus), an established marine equipment and engineering service provider, announced the delivery and supply to the United States Department of Defense with a DT3100EHLWR winch to expand and enhance their maritime efforts.

Darrell Troville, director of production at Okeanus said, "This was another great opportunity for Okeanus Science and Technology to showcase the capabilities and reliability of our products to the Department of Defense." Okeanus has long relationships with government and defense clients which has allowed them to play a significant role in the flexibility and enhancement of defense-related industries. "I know they will be extremely happy with the first-rate quality of the Okeanus winch system and we look forward to the DOD joining our defense-related clients. Our high-quality products and customer service focus are why we have long term relationships with the major companies in the defense sector," Troville added.

The DT3100EHLWR is a 100-horsepower winch complete with level wind and remote control and heat exchanger. This winch holds 1000 meters of Amsteel $\frac{1}{2}$ " diameter synthetic line and has a line speed and pull bare drum rating of 16,550 lbs at 125 fpm. This powerful winch can be a huge asset to a maritime operation, and the high quality provides a long life of service. To learn more, visit www.okeanus.com.



» Image courtesy Five Deeps Expedition

KONGSBERG EM 124 SONAR USED IN FIVE DEEPS EXPEDITION

Kongsberg Underwater Technology, Inc. announces that their newest multibeam echo sounder, the EM 124, installed aboard the DSSV Pressure Drop, played a key role in the deepest solo human submersible dive in the Atlantic led by the Five Deeps Expedition team. Victor Vescovo, in his private submersible, reached the bottom of the Puerto Rico Trench, a depth of 8,376 meters. The EM 124 was specifically used to precisely map the ocean floor to determine the deepest point in the trench prior to the dive.

The EM 124, released in 2018, is the fifth generation of a range of new multibeam systems from Kongsberg Maritime and is the successor of the highly accomplished EM 122, the de-facto standard in deep water multibeam systems. It is a modular, state-of-the-art multibeam echosounder that performs high resolution seabed mapping from shallow waters to full ocean depths (11,000 m) with unparalleled swath coverage and resolution. It has a broad range of functionality, including the simultaneous collection of seabed and water column imagery. These capabilities save time and increase efficiency during the planning, execution and analysis phase of a mission. The low-noise electronics are compact and flexible in design for easy installation and integration into a vessel of any size.

"The EM 124 is already a proven success, with this very first delivery producing fantastic results," said Chris Hancock, vice president of

sales for Kongsberg Underwater Technology. "The Five Deeps Expedition leaders and the crew of the DSSV Pressure Drop were excellent to collaborate with throughout the installation and commissioning phase of this project. Our expert technical team was able to optimize system performance and conclude successful sea acceptance trials just prior to the scheduled dive in the Puerto Rico Trench. Over the next 12 months, we will continue to work together and support the expedition remotely through our Mapping Cloud service."

"The EM 124 is arguably the most advanced underwater sonar currently installed on a civilian vessel," said a Five Deeps Expedition representative. "It produced digital 3D renderings of the sea floor that were used to identify and verify the deepest point in the trench that ultimately determined the dive location. This was crucial to the success of the mission."

The Five Deeps Expedition is the first manned expedition in a commercially-certified submersible seeking to reach the deepest points in the five oceans by the end of 2019. The journey will cover 40,000 nautical miles (74,000 km) and the submersible will have descended through at least 72,000 m (236,220 ft.) of water.

To learn more about the expedition, visit www.fivedeeps.com.

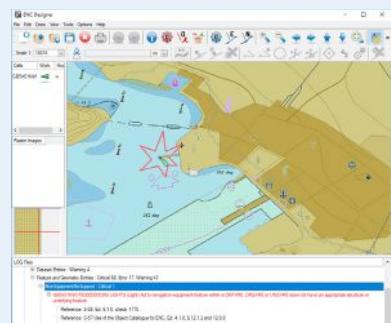
INTRODUCING 7CS ANALYZER 4.0

For more than 20 years, numerous digital chart producers (Hydrographic Offices, Waterway Authorities, and other organizations) have used SevenCs validation tools for quality control and quality assessment of digital charts such as ENCs, IENCs, and AMLs against the relevant standards.

SevenCs have been working hard to improve their validation solutions and are delighted to announce that the new 7Cs Analyzer Version 4.0 is now available. The new Analyzer is based on SevenCs latest S-100 Kernel technology and provides the most comprehensive validation tool on the market. With a fresh look and feel, modern graphics, and a simplified user interface, the tool is a powerful engine to apply validation checks in a user-friendly way.

The Maritime World is now moving beyond the validation of S-57 data, and this powerful application can be used for both validation of S-57 and S-100/S-101 nautical chart products. With 7Cs Analyzer 4.0 validation results are consistent between these standards, making the transition from an S-57 to an S-101 based product stream easy.

7Cs Analyzer 4.0 is fully compliant to the latest Edition 6.1 of S-58 ENC Validation Checks. It is already capable of validating S-101 datasets to the extent that validation rules have been defined, and S-58 checks are applicable.



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RESEARCHERS DEFINE A DISTINCT MANTLE DOMAIN IN THE SOUTHERN OCEAN

New data collected by University of Wyoming researchers and others point to a newly defined mantle domain in a remote part of the Southern Ocean.

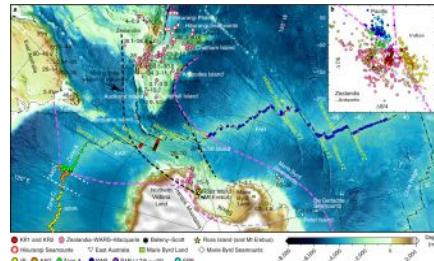
UW Department of Geology and Geophysics Professor Ken Sims and recent Ph.D. graduate Sean Scott are co-authors of an article, "An isotopically distinct Zealandia-Antarctic mantle domain in the Southern Ocean," published by the scientific journal *Nature Geoscience* in January.

"The Australian-Antarctic Ridge is the remotest mid-ocean ridge in the world's oceans and one of the last explored ridge segments, and, lo and behold, our isotope measurements of the samples we collected provided us with quite a surprise -- an entirely new domain in the Earth's mantle," Sims says.

The two were part of a group investigating the Australian-Antarctic Ridge (AAR) that

included researchers from the United States, South Korea and France. Known as the last gap in the mapping and sampling of seafloor spreading centers, AAR is a 1,200-mile expanse in the most remote parts of the ocean ridge system. Specifically, the team was looking to resolve questions surrounding the boundaries of Earth's mantle domains as seen in ocean basalt formations created during mantle melting.

Those basalt formations are pushed up from the Earth's mantle beneath the Indian and Pacific oceans through the ridges and have distinct isotopic compositions. That has created a long-accepted boundary at the Australian-Antarctic Discordance along the Southeast Indian Ridge. This boundary has been widely used to place constraints on large-scale patterns of the mantle flow and composition in the Earth's upper mantle. However, sampling between the Indian and Pacific ridges was lacking, because of difficulty in obtaining samples.



Now, Sims, Scott and company present data from the region that show the ridge has isotopic compositions distinct from both the Pacific and Indian mantle domains. The data define a separate Zealandia-Antarctic domain that appears to have formed in response to the deep mantle upwelling and ensuing volcanism that led to the breakup of ancient supercontinent Gondwana around 90 million years ago. The Zealandia-Antarctic domain currently persists at the margins of the Antarctic continent.

The group surmises that the relatively shallow depths of the AAR may be the result of this deep mantle upwelling, and large offset transformations to the east may be its boundary with the Pacific domain.

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» Teledyne Bowtech GigE subsea camera.

CHECK THE TECH!

Each issue, Ocean News & Technology highlights a few of the latest products from our friends in the ocean industry. Some are from big companies with storied histories, some come from new inventors with big ideas, but no matter the pedigree of these emerging technologies, they all share one thing in common:

This is where cutting-edge concepts become real-world tools.

TELEDYNE MARINE LAUNCHES NEW RANGE OF BOWTECH GIGE UNDERWATER CAMERAS

Teledyne Marine announces the launch of a new range of GigE underwater cameras with the sale of multiple units to Seatronics for standard fit on their new VALOR ROV.

Launched in 2018, the VALOR (Versatile and Lightweight Observation ROV) from Seatronics is the first vehicle in its class to standardize on such high-performance industrial cameras.

Leveraging the latest in CMOS technology from Teledyne Dalsa, leaders in high performance digital imaging and semiconductors, the new range from Teledyne Bowtech brings this next generation of sensors under water.

Using Global Shutter technology, Bowtech's GigE Vision cameras allow transmission of sharp, high-speed video images and related control data over ethernet networks with almost zero latency. With frame rates of up to 862 frames per second achievable (depending on model selected) video is streamed in the uncompressed RAW format such that each frame can be paused and viewed individually, eliminating the need for a separate digital stills camera & allowing vehicles to fly faster, reducing the time taken to complete visual inspections.

Such high performance coupled with a well-documented software development kit, will allow developers to advance applications such as automated control, machine learning and photogrammetry, adding value through enhanced resolution, better control and faster operations.

"With the VALOR, Seatronics' engineering team took a fresh look at what is important when it comes to an observation class vehicle," said Scott Gray, UK General Manager at Seatronics. "The VALOR is therefore not only light and powerful but has been designed from the beginning to support the latest sensors and accommodating multiple GigE cameras was a must. Teledyne's rare blend of expertise in both machine vision and underwater engineering made Bowtech the natural choice and also builds upon many years of close collaboration between Seatronics and the Teledyne team around the world"

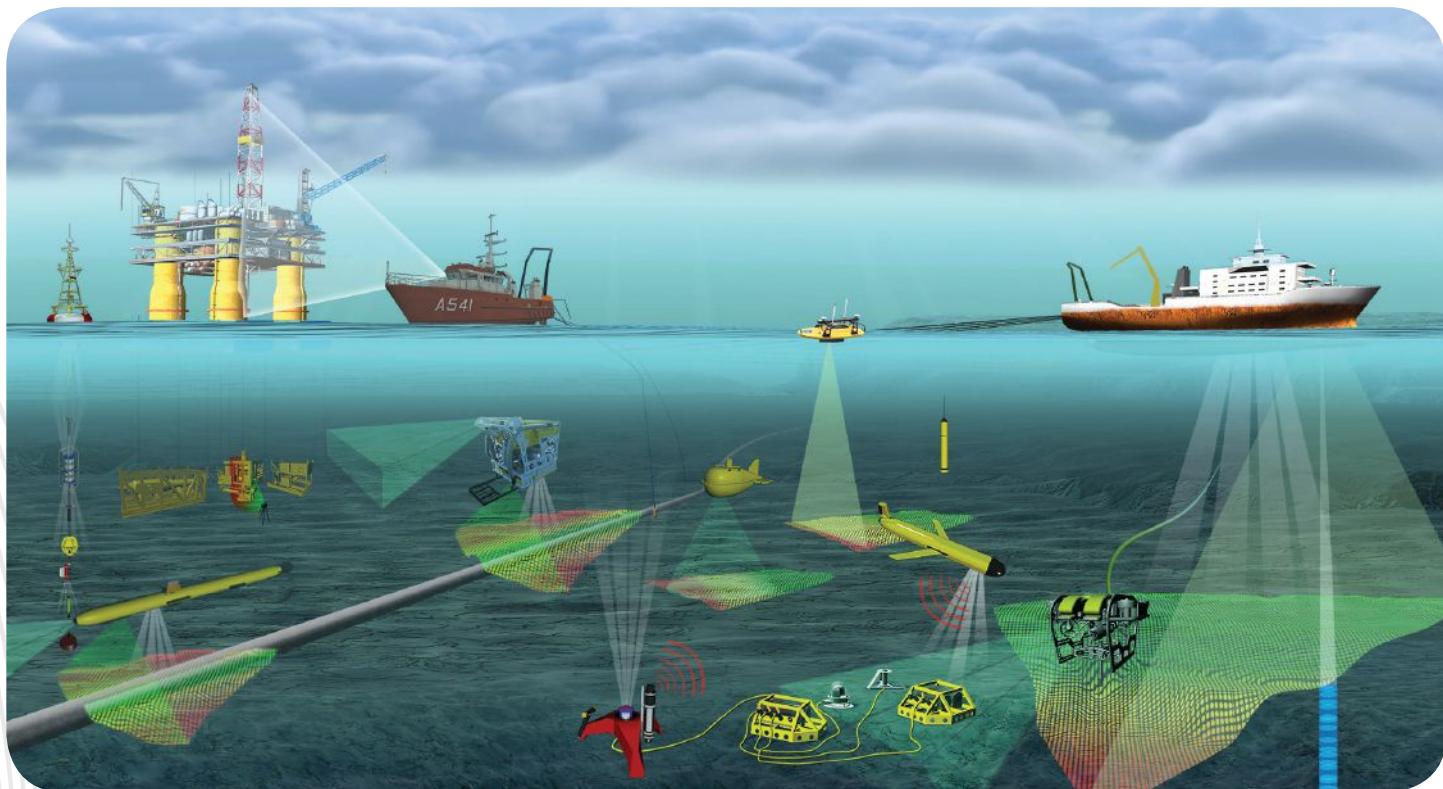
"We are delighted to partner with our colleagues at Teledyne Dalsa to bring this new range of cameras to market," said Stewart Sim, business manager at Teledyne Bowtech. "The vision of Seatronics to launch their new vehicle with such advanced cameras is truly a testament to the development team's uncompromising approach to the design of their new ROV. The GigE vision standard opens up new possibilities and we look forward to partnering with Seatronics and other developers to bring enhanced capabilities to the underwater inspection market."

For more information, visit

WWW.TELEDYNEMARINE.COM/BOWTECH

From the seafloor to the surface...

Teledyne Marine delivers solutions



Teledyne Marine is a group of leading-edge undersea technology companies that have been assembled by Teledyne Technologies Incorporated. Through acquisitions and collaboration, over the past 14 years Teledyne Marine has evolved into an industry powerhouse, bringing the best of the best together under a single umbrella. Each Teledyne Marine company is a leader in its respective field, with a shared commitment to providing premium products backed by unparalleled service and support.

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FIRST TURBINE AT HORNSEA ONE OFFSHORE WIND FARM PRODUCING ELECTRICITY



The first turbine at the world's biggest offshore wind farm has been installed and is now producing electricity.

When fully operational, Hornsea One offshore wind farm will be nearly double the size of the current world's largest, Walney Extension, and capable of powering well over one million UK homes with renewable electricity, generated by wind.

The project is located 120km off the Yorkshire Coast and will consist of 174 Siemens Gamesa 7MW turbines. Having set sail from Hull on February 5th, where the majority of blades were manufactured, the first turbine was installed just five days later.

The wind farm is a joint venture between Ørsted, the global leader in offshore wind, and Global Infrastructure Partners.

Ørsted, recently voted as the world's most sustainable energy company, began offshore construction just over a year ago, and expects the project to be completed by Q1 2020.

Claire Perry, Energy & Clean Growth Minister said: "The UK renewables sector is thriving. Last year we saw the world's largest wind farm open off the coast of Cumbria, and today it's joined by an even bigger one starting to produce power for the first time."

"British innovation is central to our modern Industrial Strategy and our upcoming sector deal will ensure UK offshore wind is a global leader as we transition to a greener, smarter energy future."

Matthew Wright, UK Managing Director at Ørsted, said: "Hornsea One is the first of a new generation of offshore power plants that now rival the capacity of traditional fossil fuel power stations. The ability to generate clean electricity offshore at this scale is a globally significant milestone, at a time when urgent action needs to be taken to tackle climate change."

"Ten years ago, the thought of a project of this size was just a dream, but thanks to continued innovation, a determined effort from both the industry and supply chain to drive down costs, and the natural geographical benefits that surround us, the UK has positioned itself as a world-leader in offshore wind."

"Our company's vision is a world that runs entirely on green energy, and this flagship project is a significant step on that journey, proving that large-scale renewable energy is not just an idea of the future, it's here, right now."

Duncan Clark, project director for both Hornsea One, and its sister project Hornsea

Two, also under construction, said: "It's amazing to think that just over a year ago we began offshore construction on Hornsea One, and now, 120km off the coast, it has already started to generate clean electricity. I'd like to thank the thousands of people responsible for delivering this milestone safely and completely as planned. It's taken hard work from so many different people, long shifts in all weather conditions, ingenious solutions and disciplined professional collaboration – which has all been worthwhile."

"To make this next generation of wind farm possible, the entire supply chain has stepped up to a massive challenge. This has involved scaling up, improving products and processes, refining skills, and together leading offshore wind to its market leading position for new projects today, where it is now competitive on cost of electricity, on scale, on sustainability and on lead time. I would also like to thank those communities that have welcomed us during the construction phase of the project, including onshore cable laying, and all the authorities and businesses whose support and skills are necessary in developing this scale of infrastructure."

"There is still a long way to go, 173 turbines to be precise! But I'm confident we will continue to work to the high standards already demonstrated by the teams involved, and together deliver the biggest renewable energy project in the UK, helping to deliver a cleaner, greener energy system for the future."

To date, 172 out of 174 monopile foundations have been installed at the site, and turbine installation is expected to continue until late summer 2019. The electricity generated by the turbines will pass via undersea cables through one of three massive offshore substations, and the world's first offshore reactive compensation station, all fully installed, before reaching shore at Horseshoe Point, Lincolnshire. The electricity is then transported via underground cables to the onshore substation in North Killingholme, where it connects to the UK National Grid, in order to reach well over one million homes in the UK.

Additional Information

- Ørsted has chartered two wind turbine installation vessels;
- **BOLD TERN**, owned by Fred Olsen Windcarrier
- **SEA CHALLENGER**, owned by A2SEA
- Each installation vessel will carry all components for four wind turbines: four towers, four nacelles, 12 blades and lifting equipment
- Both vessels will do installation simultaneously

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BIRNS has been proudly supplying high performance subsea military products since 1957, and we've been innovating technology to anticipate the changing needs of the defense industry ever since. Today our advanced, field-proven 6km-rated electro-optical BIRNS Millennium™ cable assemblies provide massive data rates in a tiny footprint for the most demanding subsea defense applications. These robust assemblies feature low insertion losses (typical .1dB SM, .25dB MM) and can be customized to include all titanium components for the ultimate in corrosion resistance.

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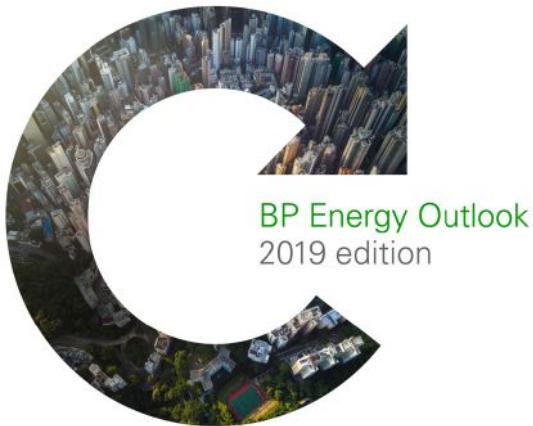
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BP ENERGY OUTLOOK 2019



The 2019 edition of BP's Energy Outlook explores the key uncertainties that could impact the shape of global energy markets out to 2040. The greatest uncertainties over this period involve the need for more energy to support continued global economic growth and rising prosperity, together with the need for a more rapid transition to a lower-carbon future. These scenarios highlight the dual challenge that the world is facing. The Outlook also considers a number of other issues including the possible impact of an escalation in trade disputes and the implications of a significant tightening in the regulation of plastics.

Much of the narrative in the Outlook is based on its evolving transition scenario. This scenario and the others considered in the Outlook are not predictions of what is likely to happen; instead, they explore the possible implications of different judgements and assumptions.

In the 'Evolving Transition' scenario, which assumes that government policies, technologies and societal preferences evolve in a manner and speed similar to the recent past:

- Global energy demand increases by around a third by 2040, driven by improvements in living standards, particularly in India, China and across Asia.
- Energy consumed by industry and buildings accounts for around 75% of this increase in overall energy demand, while growth in energy demand from transport slows sharply relative to the past as gains in vehicle efficiency accelerate.
- The power sector uses around 75% of the increase in primary energy.
- 85% of the growth in energy supply is generated through renewable energy and natural gas, with renewables becoming the largest source of global power generation by 2040.
- The pace at which renewable energy penetrates the global energy system is faster than for any fuel in history.
- Demand for oil grows in the first half of the Outlook period before gradually plateauing, while global coal consumption

remains broadly flat. Across all the scenarios considered in the Outlook, significant levels of continued investment in new oil will be required to meet oil demand in 2040.

- Global carbon emissions continue to rise, signaling the need for a comprehensive set of policy measures to achieve a substantial reduction in carbon emissions.

The new Outlook was launched in London on February 14, 2019, by Spencer Dale, group chief economist, and Bob Dudley, group chief executive.

"The Outlook again brings into sharp focus just how fast the world's energy systems are changing, and how the dual challenge of more energy with fewer emissions is framing the future. Meeting this challenge will undoubtedly require many forms of energy to play a role," said Bob Dudley.

"Predicting how this energy transition will evolve is a vast, complex challenge. In BP, we know the outcome that's needed, but we don't know the exact path the transition will take. Our strategy offers us the flexibility and agility we need to meet this uncertainty head on."

"The world of energy is changing," agrees Spencer Dale. "Renewables and natural gas together account for the great majority of the growth in primary energy. In our evolving transition scenario, 85% of new energy is lower carbon."

Beyond the evolving transition scenario, the Outlook considers a number of additional scenarios. Some of the key ones are outlined below.

MORE ENERGY

More energy will be needed to support growth and enable billions of people to move from low to middle incomes; this is explored in the more energy scenario.

There is a strong link between human progress and energy consumption; the UN Human Development Index suggests that increases in energy consumption of up to around 100 gigajoules (GJ) per head are associated with substantial increases in human development and well-being. Today, around 80% of the world's population live in countries where average energy consumption is less than 100 GJ per head. In order to reduce that number to one-third of the population by 2040, the world would require around 65% more energy than today, or 25% more energy than needed in the evolving transition scenario. The increase in energy required over and above the evolving transition scenario is roughly the equivalent of China's entire energy consumption in 2017.

Together with the more energy scenario, the Outlook also highlights the need for further action to reduce carbon emissions. This is the dual challenge for the world – to provide more energy with fewer emissions.

RAPID TRANSITION

The rapid transition scenario is the combination of analyses throughout the Outlook which brings together in a single scenario the policy measures in separate lower carbon scenarios for industry and buildings, transport and power. Doing so results in around a 45% decline in carbon emissions by 2040 relative to current levels – which is broadly in the middle of a sample of external projections with claim to be consistent with meeting the Paris climate goals.

Iver3 Autonomous Underwater Vehicles



This fall reflects a combination of: gains in energy efficiency; a switch to lower-carbon fuels; material use of CCUS; and, of particular importance in the power sector, a significant rise in the carbon price.

The power sector is currently the single largest source of carbon emissions from energy use and it is therefore critical that the world continues to seek ways to reduce emissions from this sector. Reductions in carbon emissions from the transport industry in all scenarios to 2040 is relatively small in comparison.

"Policies aimed at the power sector are central to achieving a material reduction in carbon emissions over the next 20 years...most of the low-hanging fruit in terms of reducing carbon emissions is outside of the transport sector," said Dale.

Even in the rapid transition scenario, a significant level of carbon emissions remain in 2040. In order to meet the Paris climate goals, in the second half of the century these remaining emissions would need to be greatly reduced and offset with negative emissions. This year's Outlook considers which technologies and developments may play a central role in this reduction beyond 2040.

A key development would be a near-complete decarbonization of the power sector – requiring greater use of renewables and CCUS in conjunction with natural gas – together with greater electrification of end-use activities (including transport). For those end-uses that cannot be electrified, other forms of low-carbon energy and energy carriers will be crucial, potentially including hydrogen and bioenergy. Additionally, the importance of the circular economy and greater adoption of carbon storage and removal techniques are highlighted.

LESS GLOBALIZATION

International trade underpins economic growth and allows countries to diversify their source of energy. In the less globalization scenario the Outlook explores the possible impact that escalating trade disputes could have on the global energy system.

"The message from history is that concerns about energy security can have persistent, scarring effects," said Dale.

The scenario highlights how a reduction in openness and trade associated with an escalation in trade disputes could reduce worldwide GDP and therefore energy demand. Moreover, increasing concerns about energy security may cause countries to favour domestically-produced energy, leading to a sharp reduction in energy trade. The greatest impact is on net energy exporters, who suffer a material slowdown in the growth of oil and gas exports.

SINGLE-USE PLASTICS BAN

The single-largest projected source of oil demand growth over the next 20 years is from the non-combusted use of liquid fuels in industry, particularly as a feedstock for petrochemicals, driven by the increasing production of plastics. Growth of non-combusted demand in the evolving transition scenario is, however, slower than in the past, reflecting the assumption that regulations governing the use and recycling of plastics tighten materially over the next 20 years.

Given the heightening environmental concerns regarding single-use plastics, the Outlook also considers a single-use plastics ban scenario, in which the regulation of plastics is tightened even more quickly, culminating in a worldwide ban on the use of all single-use plastics from 2040 onwards.

In this scenario, oil demand rises more slowly than in the evolving transition scenario. However, the Outlook cautions that the full impact on energy growth and the environment will depend on the alternative materials that may be used in place of single-use plastics. A ban on single-use plastics could result in an increase in energy demand and carbon emissions without further advances in alternative materials and the widespread use of collection and reuse systems.

To download the report go to www.bp.com/en/global/corporate/energy-economics/energy-outlook.html

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NEW EXECUTIVE DIRECTOR SHARES PLANS TO GROW MARINE TECHNOLOGY SOCIETY

In January 2019, after an extensive search, the Marine Technology Society (MTS) appointed Kathleen Herndon, PhD as their new Executive Director. Judging from the buzz in the exhibition room at the recent Underwater Intervention conference in New Orleans, they made an excellent choice.



ON&T Editor Greg Leatherman spoke with Dr. Herndon about what she brings to MTS.

"MTS is made up of many wonderful experts in the field of marine technology, and there remains an opportunity from a society management perspective, to leverage its infrastructure and grow capacity, so that the society can better serve its members. I bring experience in accomplishing that goal."

Dr. Richard Spinrad, President of MTS, said "Dr. Herndon is an accomplished association executive whose experience in the U.S. Foreign Service and with statewide professional associations has uniquely prepared her for the challenges of supporting MTS as we usher in the era of the New Blue Economy. She is

well equipped to support MTS in our goal to promote awareness, understanding, advancement, and application of marine technology worldwide."

In her conversation with ON&T, Dr. Herndon said that her immediate goals for MTS are to "grow our membership and fulfill our mission," but that doesn't just mean reaching out to new members. It also includes staff retention and an increased emphasis on interconnectedness.

"MTS is uniquely positioned to foster cooperation between ocean engineers, technologists, policy makers, and educators," says Dr. Herndon. "For example, when you're talking about bathymetry and all of the ocean mapping on the private sector side, that is a great example of where MTS can serve as a forum for discussions that might facilitate moving data out to the broader community."

Dr. Herndon also described some exciting plans that will put MTS technical experts in the spotlight.

"Right now, our newsletter (*Currents*) goes out every other month. That's too infrequent, given all that goes on with our members. Besides, keeping people in the loop is one of the main functions of a professional society. The people that make up MTS are consumers of information, but it has to be timely information, because the thing about technology is that it accelerates. If you are not already at a dead sprint, you're falling behind. That's why we are going to get the news out in a more timely manner and increase the frequency of our media relations. We're also going to take advantage of digital media including

embedded video, audio clips, and weekly podcasts from subject matter experts."

No one who meets her will question Dr. Herndon's enthusiasm, and with an extensive background in research and program evaluation, as well as over 10 years of experience in the nonprofit sector, it's clear that she is well-suited for promoting MTS as the leading authority and advocate for marine technology and resources, while enabling member success and public understanding.

A graduate of the College of William and Mary and Monroe Scholar, Dr. Herndon earned her Doctor of Philosophy (PhD) in Psychological Research and Program Evaluation from Walden University. Dr. Herndon has led numerous research studies and has served as the managing editor of multiple trade industry publications.

MTS was incorporated in June 1963 to give members of academia, government and industry a common forum for the exchange of information and ideas. Their mission is to: facilitate a broader understanding of the relevance of marine technology to wider global issues by enhancing the dissemination of marine technology information; promote and improve marine technology and related educational programs; advance the development of the tools and procedures required to explore, study and further the responsible and sustainable use of the oceans. To learn more, visit www.mtsociety.org.

EMPOWERING



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SAAB

SAAB SEA-EYE

THE FUTURE IS ELECTRIC

SCALABLE BANDWIDTH FOR MONITORING SURVEY QUALITY

By Travis Hamilton, Product Manager, Teledyne CARIS

Over the past few years, the seabed mapping industry has been adopting unmanned surface vessels (USVs) as a tool to increase efficiency and safety during field operations. Much effort has been directed toward the operational aspect of deploying and operating USVs for conducting bathymetric surveys, and this effort has culminated in many examples of very successful missions by both government agencies and private survey contractors. The organizations operating these systems are also starting to expand their capabilities by simultaneously operating multiple USVs and sending them further away from the operations base (Field, 2018).

As surveyors are becoming more comfortable with the operational aspects, efforts are now focused on how to effectively manage the data being collected by the survey systems, and how to ensure that quality data is being collected. While a simple remote desktop connection to software running on the USV may be practical when operating within WiFi range, or while only operating a single USV, this approach becomes more challenging as operations scale up.

MONITORING SURVEY QUALITY

When operating one or more USVs, the surveyor must be able to ensure that each platform is collecting quality data while also keeping each platform tasked to the optimal area to meet the operations goals as efficiently as possible. The most critical piece of information to support the surveyor's operational decision-making is the survey data itself. This may be in the form of depth information, data quality and density, or in the case of search and recovery surveys, the identification of an area of interest. Having all sensors integrated into a processed product allows the surveyor to monitor that survey requirements are being met, and the overall coverage is in line with the operational plan.

When considering the key role processed data plays in supporting effective and efficient management of the survey operation, any significant delay between the acquisition and processing/review of the data is immediately detrimental. A delay in data processing and quality review would risk prolonged collection of poor-quality data and cause additional transit time in order to return to areas in need of further investigation or re-survey. USVs typically have



some form of communication back to the operations base, but it is a technical challenge to review the survey quality via this link as the available bandwidth has to serve three functions. In order of importance these are vessel control, sensor control, and survey data quality monitoring.

Depending on the requirements of the first two tasks, there can be very little bandwidth remaining for reviewing the survey quality (Field, 2018). It is often not possible to transfer the full resolution data, so we are presented with the requirement to process the data on the USV, producing information products (i.e. images of the processed surface) which are small enough to transfer over the remaining bandwidth, while still containing enough information to effectively monitor the survey quality.

CARIS ONBOARD

In order to process data automatically on the vessel and to provide information about survey operations to the surveyor in real-time, the high-volume raw data must be reduced to information products which are small enough to be easily shared over a low bandwidth connection. Teledyne CARIS™ has released CARIS Onboard™ with this exact goal in mind. Running on the survey vessel, CARIS Onboard automatically processes the raw sonar data, along with positioning, motion, tidal and sound velocity data, and generates a processed surface that provides information about the surveys quality and coverage by providing access to depth, density, standard deviation and uncertainty bands.



Because CARIS Onboard is web enabled, it can be accessed and controlled from any PC which is networked to the USV. The available communication between base and the USV will vary depending on the operating environment, but is typically a long-range radio, cellular modem, or satellite internet. The amount of



» DriX USV operating with support vessel in the background. Image courtesy of iXblue.

available bandwidth from the USV to the support vessel will vary depending on the communication technology, and the bandwidth requirements for the vessel operations. To take advantage of the varying degree of bandwidth available, CARIS Onboard provides a selection of methods for connecting to the information products which have a sliding scale from higher bandwidth and more information, to lower bandwidth and less information.

To access the largest source of information, any of the CARIS™ desktop applications can be operated from a computer on the support vessel. Through this, the surveyor can connect to the surfaces being produced by any number of USVs, showing various attribute layers such as depth, quality (for example, depth standard deviation per cell or number of CUBE hypotheses per cell) or data density. By having access to all the various information layers, the surveyor can ensure conformance with survey requirements by qualitative assessment of the surface, but also with quantitative assessment of density per cell and the computed total propagated uncertainty (TPU).

When scaling up to use several USVs on a single project or using a single USV as a force multiplier for a manned vessel, the application of CARIS Onboard in combination with a remote installation of CARIS has a very distinct advantage. With remote desktop, each USV would have to be monitored in isolation. CARIS

Onboard allows accessing the surfaces from all platforms on the survey in a single view. This ensures the surveyor is provided with overall more complete view of the operation, allowing any overlapping coverage to be directly compared, making management of multiple platforms more efficient and streamlined.

The second option on the sliding scale is to review the survey quality through Control Centre, which is a web application accessed through any web browser. In addition to providing the processing controls and results, Control Centre is built around a webmap, which displays all surfaces and backscatter mosaics processed through CARIS Onboard. While reviewing the surface in Control Centre, the bandwidth requirements are further reduced as the surface is converted to tiled images in the Portable Network Graphics (PNG) format, and it is only the tiled images which are live streamed to Control Centre.

By providing access to processed products in a web application, CARIS Onboard allows the dataset to be automatically processed on the vessel to a point where low bandwidth information can be streamed to the operations base, thus providing real-time survey visualization in support of efficiently managing a survey. By monitoring the 3G modem during a previous trial, it was recorded that less than 1GB of data was transferred from the vessel during a 3-day period (8hr/day operations). The transfer rates peaked at approximately 1 Mbps, however dependent on the location of the vessel, they were as

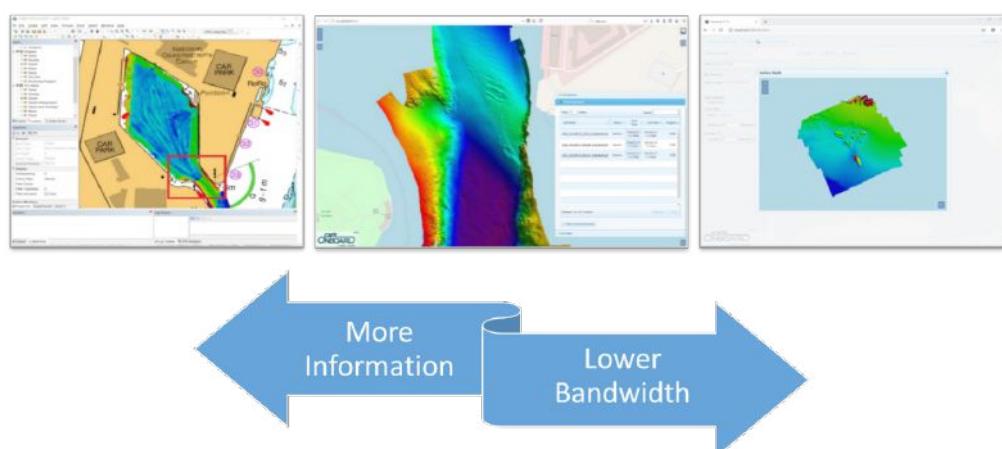
low as 150Kbps, demonstrating that even with a low bandwidth connection, CARIS Onboard's Control Centre was able to provide real-time survey visualization.

The third option on the sliding scale is a lower bandwidth option which has been added to Control Centre. Control Centre Lite removes the live webmap for use during periods of low bandwidth availability and replaces it with a dialogue which can be opened at any point in time to see a snapshot of the surface at that moment in time. With this extension to Control Centre, the surveyor has control over when data is or is not transferred, providing capabilities to review data during moments of optimal bandwidth availability.

Between all three methods of connecting to the surface generated and served by CARIS Onboard (CARIS App, Control Centre, Control Centre Lite), the surveyor has the ability to scale the amount and frequency of information, to match the amount of bandwidth available to use at any point during operations. This ensures that the surveyor is able to have a clear representation of how operations are progressing. Finally, survey operations can be efficiently managed and any issues which may arise are identified at the time they happen, not after the USV is retrieved, when it is too late to make corrections.

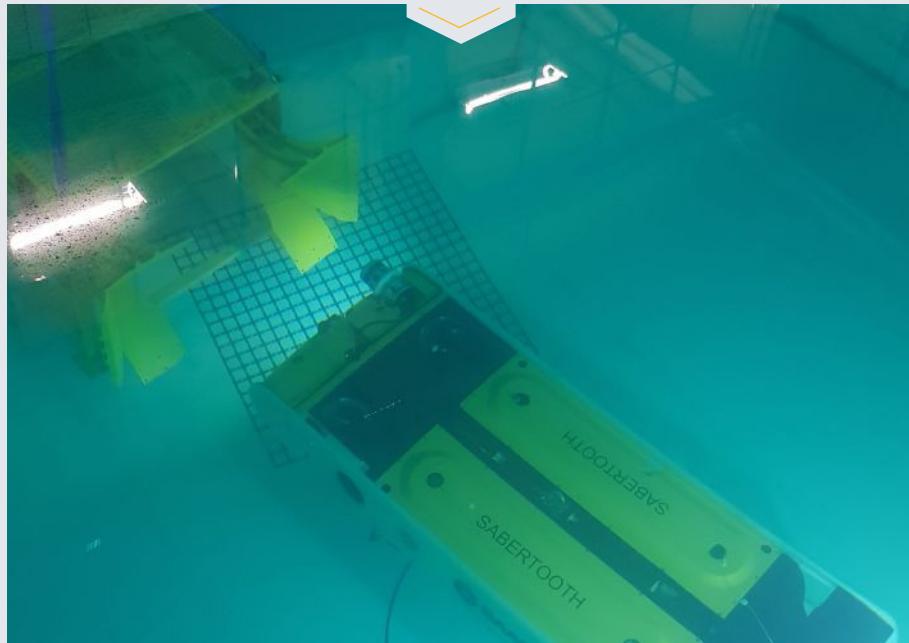
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Field, David, Hamilton, T., "Monitoring Quality of Over the Horizon Autonomous Surveys", Proceedings of HYDRO 2018, Sydney, Australia.



» CARIS Onboard has three options for remotely reviewing survey quality, with a sliding scale of bandwidth vs information. From left to right is the CARIS desktop application, Control Centre, and Control Centre Lite.

SAAB SEAEDGE IN WORLD FIRST RESIDENT E-ROBOTICS BREAKTHROUGH



» Sabertooth in tank trials. Sabertooth fitted with Blue Logic charger is the world's first system capable of remote docking operations.

In a world first, Saab Seaeye has shown that underwater e-Robotic vehicles can deepwater dock at remote sub-resident resident docking stations for data transfer, assignment instructions and battery charging.

This breakthrough is significant for both the offshore energy industry and ocean science who have been watching developments in residency technologies for the substantial operational and financial benefits possible from remote residency.

Saab Seaeye says that their iCON based Sabertooth AUV/ROV vehicle, fitted with a Blue Logic inductive device, can now successfully dock in a safe and controlled manner at different kinds of remote stations.

This development places Saab Seaeye in the forefront of offshore residency as the only system at this advanced stage in the market.

"The Sabertooth is the only hovering autonomous system that can operate in both AUV and ROV modes," says Jan Siesjö, chief engineer at Saab Seaeye, Sweden, "and is the only vehicle currently on the market capable of undertaking long term residency operations in difficult to access locations."

He adds that the Sabertooth's outstanding manoeuvrability, stability and ability to work in tough and challenging environments, "makes it a remarkable vehicle that is capable of many different tasks."

The 3,000m rated Sabertooth can be based at a remote location docking station ready to be launched on pre-programmed or man-controlled missions, including inspection, repair and maintenance, research tasks and environmental monitoring. At the docking station, tooling packages are stored, batteries recharged and data transferred via satellite or cable to shore.

Blue Logic's managing director, Stig Magnar Lura, says they were delighted to work with Saab to integrate the Blue Logic 2kW charger into the Sabertooth.

"It was very satisfying seeing how easily and efficiently your team handled this new technology and handling connections in both the horizontal and vertical plane. It was a world class demonstration of flexibility and agility," he declares. "The experience really supported the 'plug and play' promise we offer our customers."

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Choosing the right SBP for geological surveys

Sub-bottom profiler (SBP) data acquisition and analysis of seafloor, lake, fluvial or any other waterways from natural and anthropic origins can provide crucial information for underwater studies. SBPs are used to identify and characterize the sediment layers below the seabed. Applications fields such as subsea construction inspection, biomass monitoring, resource control, pollution tracking, geo-archaeology or sedimentology are increasing and represent a growing market share that needs to be explored.

To meet the various needs of the sub-bottom profiling market, iXblue, a global company that provides innovative solutions for navigation, positioning and underwater imaging, conceived a complete range of sub-bottom profilers: the Echoes Series. Developed over the past 30 years in close collaboration with the French Navy and several International Oceanographic Research Institute laboratories, including the French Research Institute IFREMER, iXblue's products quality and technology expertise come from extensive practicing and cumulative return on experience coupled with constant innovation and evolution.

High-performance thanks to complete vertical integration

Today, sub-bottom profilers use a broadband frequency shifting from low to high frequencies providing a wide range of penetration, resolution and directivity for the first 200 m of sediments. These acoustic signals use frequency (FM) and amplitude (AM) modulation over a defined duration. This signal is commonly called a

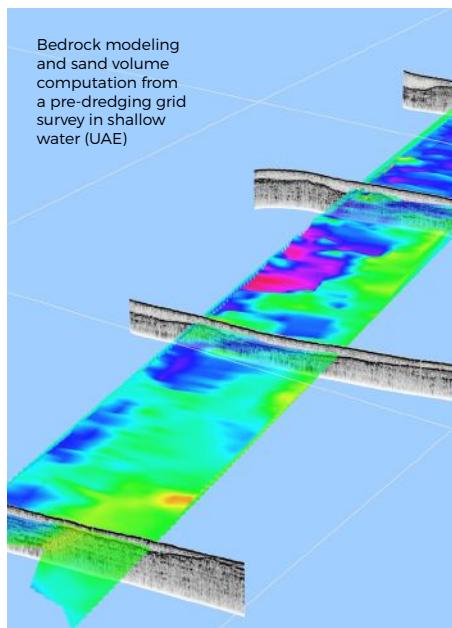
"chirp" (Compressed High Intensity Radar Pulse). Sub-Bottom Profilers transmit this signal in water and listen to the reflected signal from the bottom and sediment layers. The received acoustic signal is digitized and then deconvoluted. This technique provides penetration that is comparable to low-frequency systems with a resolution of high-frequency systems. In addition, the correlation of the received data with the transmitted chirp signal performs a strong noise filtering to yield an additional gain in the signal to noise ratio.

iXblue know-how in sub-bottom profiling is built from a custom Piezo-electric transducer design activity in the 150Hz to 400kHz range. These high-power and wide bandwidth devices were especially suited for the development of a complete range of controlled pulse sub-bottom profiler projectors. Enhanced by in-house designed low distortion and high efficiency power amplifiers, all components are manufactured internally when many other companies only integrate off-the-shelf components. This mastering of the acquisition chain ensures that the acoustic signal transmitted is very close to the theoretical chirp waveform, thus ensuring the highest degree of resolution and quality resulting from the signal processing.

Covering the full spectrum of applications

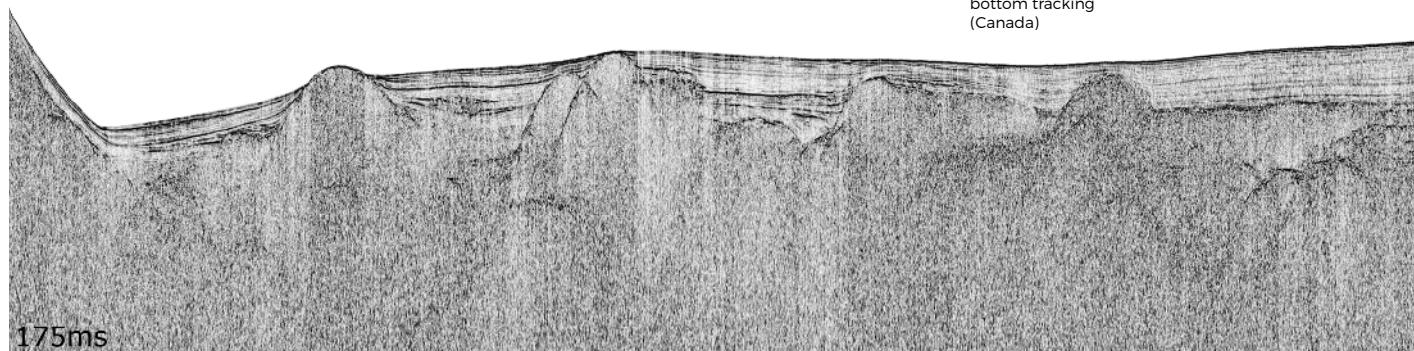
The Echoes Series can be pole, hull-mounted or integrated on Unmanned Surface Vessels (USV) and are therefore easily operated and mobilized from

vessels of opportunity, covering a full spectrum of applications, from shallow to deep water: tomography, physical oceanography, sea-floor mapping, oceanographic survey, industrial survey, geotechnical survey, marine archaeology, broadband projectors and deep ocean operations. Further to this, iXblue also develops an open software suite for acquiring, processing and mapping all kinds of hydrographic and geophysical data. The Delph Software Suite naturally makes the best from the Echoes sub-bottom profiler's data with possible improvement on the chirp processing and complete 3D geo-referencing of survey data both in real-time and offline.



Estuary survey from shallow to down slopes with efficient bottom tracking (Canada)

75 ms



TELEDYNE GAVIA TO INTRODUCE SEARAPTOR AUV AT OCEAN BUSINESS

Teledyne Gavia announced that the company will formally introduce their new 6000 meter rated AUV, SeaRaptor, at Ocean Business in April.

The newly designed SeaRaptor AUV incorporates a broad range of Teledyne content including acoustic modems, ascent and descent weight releases, a black box pinger locator, sub-bottom profiler (Teledyne Benthos, Falmouth, MA), multi-beam echosounders, obstacle avoidance multi-beam sonar (Teledyne RESON, Denmark), Doppler Velocity Log (DVL), Current, Temperature, and Depth sensor (CTD) (Teledyne RD Instruments, San Diego, CA), and onboard processing software (Teledyne Caris, New Brunswick, Canada). In addition, the first vehicle delivered also carried an Edgetech Side Scan Sonar with Dynamic Focus capability, an iXblue Phins 6K INS system, and a CathX Camera and strobe system. The integration of Teledyne Marine's industry leading vehicle design, instrumentation, imaging, and interconnect solutions from a single supplier, as well as the incorporation of third party sensors into a turnkey package for customers, makes the company unique in the unmanned underwater vehicle market.

"Teledyne is excited to formally introduce the market to SeaRaptor, our new deep rated AUV", said Thomas Altshuler, Vice President and Group General Manager for the Teledyne Marine Vehicle group. "In SeaRaptor, the Teledyne Marine team has introduced a high performance AUV capable of carrying the most advance marine sensors available in the market. We have already delivered our first vehicle and see significant opportunities for SeaRaptor."

To learn more, visit stand U12 at Ocean Business 2019 and experience the SeaRaptor for yourself!

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TELEDYNE WEBB RESEARCH AWARDED \$4.4 MILLION IDIQ CONTRACT

Teledyne Webb Research, a division of Teledyne Technologies, and a leading provider of neutrally buoyant, autonomous drifters and profilers, autonomous underwater gliding vehicles, and moored underwater sound sources, has received an indefinite delivery/indefinite quantity (IDIQ) for autonomous profiling floats by the Naval Oceanographic Office. This contract includes the APEX profiling float, with optional air-deployment capability and APEX repair services. The contract runs for up to three years, with a ceiling estimated at \$4.4 million.

Teledyne Marine has been providing APEX floats to the Naval Oceanographic Office since 1998. Teledyne Marine Vehicles Vice President and Group General Manager, Thomas w. Altshuler, Ph.D., stated, "Teledyne Marine is proud to continue our longstanding relationship with the Naval Oceanographic Office. The U.S. Navy has been, and continues to be among Teledyne Marine Vehicles Group's most valued customers."

OCEAN INFINITY SUCCESSFULLY LOCATES STELLAR DAISY

Ocean Infinity, the next generation seabed survey and ocean exploration company, has successfully located the wreck of the lost South Korean tanker, Stellar Daisy, at a depth of 3461 meters in the South Atlantic Ocean, approximately 1800 nautical miles due west of Cape Town.

Stellar Daisy sank on 31 March 2017, transporting iron ore from Brazil to China. Tragically, 22 of the 24 crew members were lost.

Working from Seabed Constructor, the search operation involved the deployment of four Autonomous Underwater Vehicles (AUVs), which, over 72 search hours, explored approximately 1,300 square km of seabed. Representatives of both The Government of South Korea, who awarded Ocean Infinity the contract to conduct the search, and the families of Stellar Daisy's crew, were present throughout the operation.

Ocean Infinity's AUVs are the most technologically advanced in the world. They are capable of operating in water depths from 5 meters to 6,000 meters. The AUVs are not tethered to the vessel during operations, allowing them to go deeper and collect higher quality data for the search. They are equipped with a side scan sonar, a multi-beam echo-sounder, a sub-bottom profiler, an HD camera, a conductivity / temperature / depth sensor, a self-compensating magnetometer, a synthetic aperture sonar and a turbidity sensor.

Oliver Plunkett, Ocean Infinity's CEO, said, "We are pleased to report that we have located Stellar Daisy, in particular for our client, the South Korean Government, but also for the families of those who lost loved ones in this tragedy. This operation is further testament to Ocean Infinity's leading, technology led, search capability. Through the deployment of multiple state of the art AUVs, we are covering the seabed

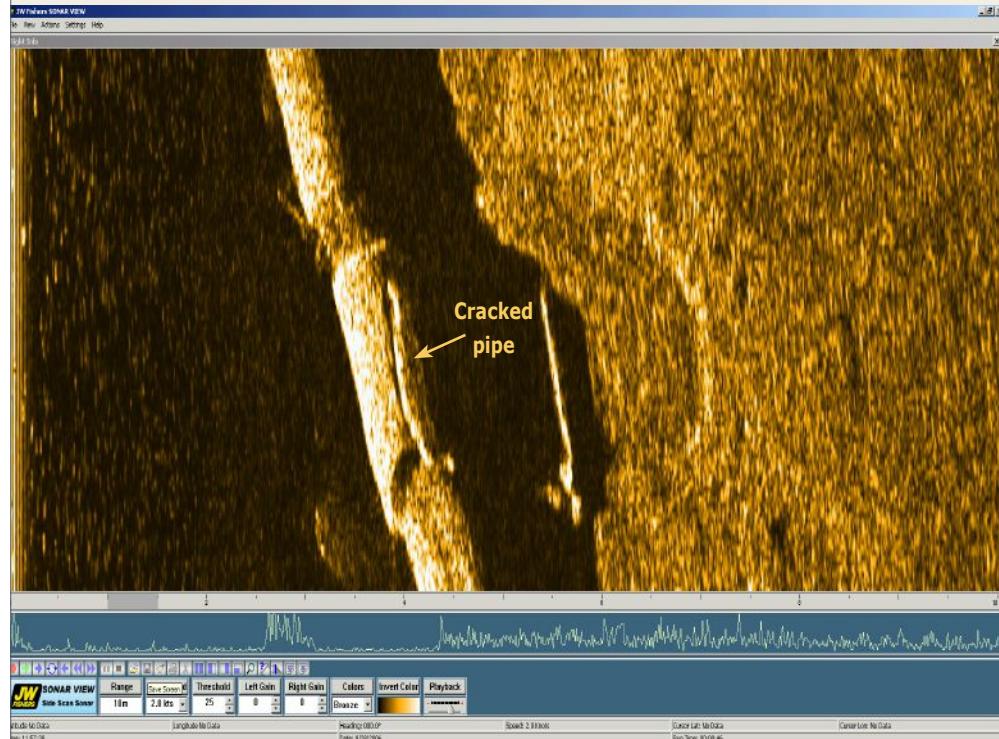
with unprecedented speed and accuracy. I would like to thank the Government of South Korea for their support, as well as all of the team onboard Seabed Constructor."



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SNAKE ROBOT TESTED TO GO ON WATCH IN THE DEEP SEAS

By Idun Haugan
Gemini Research News

A snake robot will soon be relieving divers and mini-subs in the North Sea. But first researchers have to test its mettle in the Trondheim Fjord.

The Åsgard oil and gas field off the Norwegian coast is between 240 and 310 meters deep. The oilfield is among the largest developments on the Norwegian shelf, with numerous wells and a lot of extraction equipment on the seabed.

This equipment needs to be monitored and maintained, which is no simple matter. So, snake robots have been developed to assist as smart inspectors and repairers.

Before the snake robots are sent down into the depths of the Åsgard field, they will be spending a few weeks at a depth of 360 meters in the Trondheim Fjord as a final test before heading out to work.

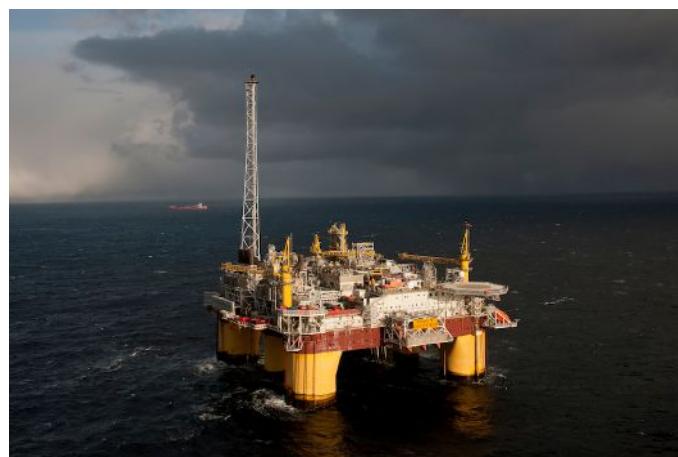
17 NORTH SEA DIVERS DIED, SEVERAL HUNDRED INJURED

If we turn the clock back a few decades to Norway's early years as an oil-producing nation, documentaries such as the Norwegian Broadcasting Corporation's series "Lykkeland" (Happy land) show divers being lowered into the depths to inspect and repair installations on the seabed. It didn't always go well.

Through the 1960s, 70s and 80s, 17 divers lost their lives in operations like these in the Norwegian sector of the North Sea. Several hundred people were injured for life.

In the 1990s, remote-controlled underwater vehicles (ROVs) began to take over some of the divers' inspection and mechanical tasks in the North Sea.

The new generation of snake robots will further improve safety and reduce exposing divers to risk.



▲ The Åsgard B platform is only part of the Åsgard installation. The newest parts of the installation are on the ocean's bottom. Photo: Øyvind Hagen, Equinor.



▲ This creature is ready to be tested and trained in the Trondheim Fjord. Photo: Eelume.

Operational costs will also drop considerably. Robots stationed at subsea installations can be controlled from shore and carry out missions at any time. The savings potential for oil and gas companies is huge.

Inspection and maintenance of subsea installations is currently done by remotely controlling underwater vehicles from expensive surface vessels.

Snake robots also have interesting potential for the fish farming industry and offshore wind turbines.

FIRST SNAKE ROBOT WAS ANNA KONDA

The history of snake robots started about 15 years ago, when NTNU and SINTEF began to collaborate on developing the technology.

The first snake robot that saw the light of day was Anna Konda, a flexible robot designed to go into burning buildings to extinguish fires and thus avoid putting firefighters' lives in danger.

"In the early days, we developed several different, promising snake robots, but struggled to effectively integrate their function, design and use," says Pål Liljeback.

FROM LAND TO WATER

NTNU Amos – the Centre for Autonomous Marine Operations and Systems – was established in 2012. The land-based snake robot and the cyberneticists joined this ocean-based research community.

"When we changed our perspective from land to water applications, we suddenly saw lots of new possibilities for the robot. Up to that point not much innovation had occurred in water with this type of technology. This was when the Eelume company started up," says Liljeback, who was doing cybernetics research

at NTNU at the time. Now he is co-owner and technology manager at Eelume, which has nine employees.

GETTING CHARGED UP FOR WORK

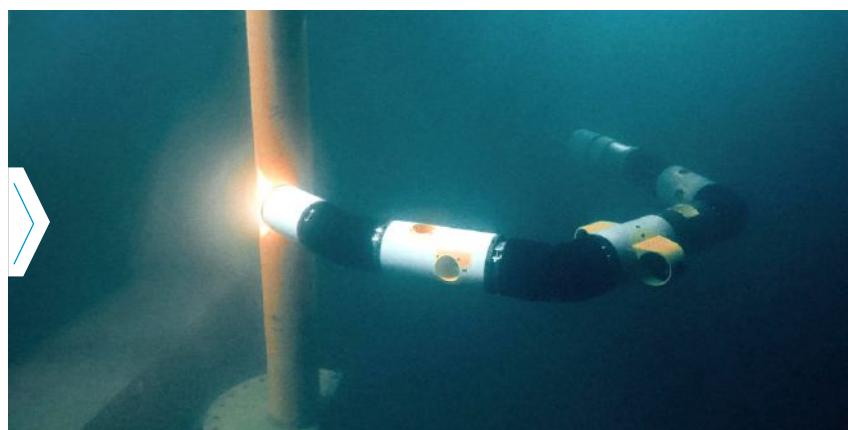
The robot incorporates several technologies and can be controlled with or without an attached cable. The unique thing about the technology is that the robot has a flexible body that simultaneously functions as a robot arm. Thus, the robot can operate both as a torpedo-shaped water vessel and also use its flexibility to perform more complex operations.

It can also get to and operate in places that are inaccessible to larger underwater vehicles. In addition, the snake robot can conduct inspections along pipelines and screw on subsea valves.

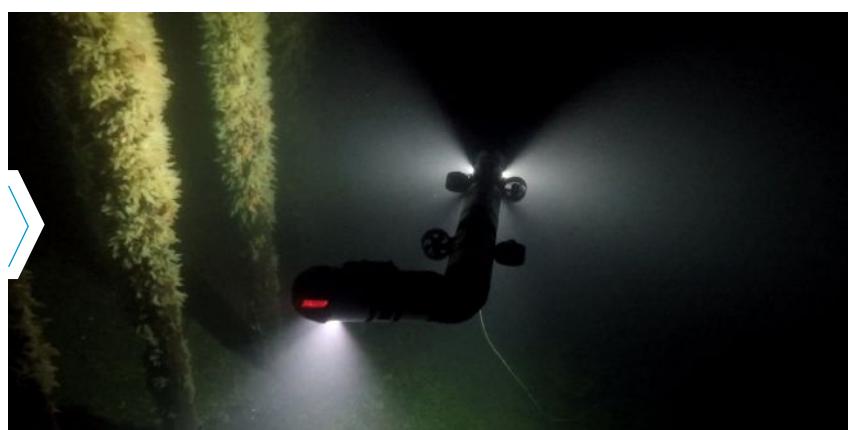
"The robot we're testing in early 2019 is called EELY500. It has improved manoeuvrability over previous versions, a better camera and light, and a stronger battery and data capacity," says Liljebäck.

Now Eelume is working on the docking station where the robotic inspector will go to get charged and pick up tools before it heads out on new assignments.

Equinor, Kongsberg Maritime, the Research Council of Norway and Innovation Norway funded the spin-off company Eelume in its start-up phase.



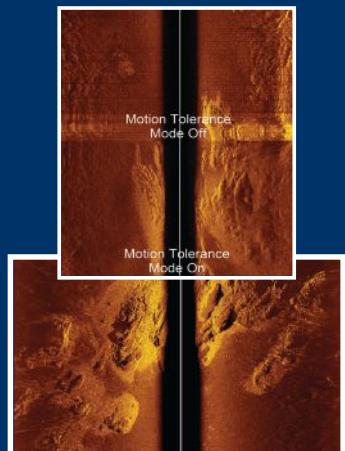
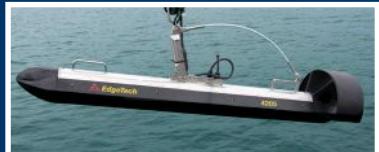
▲ The Eelume snake robot is infinitely flexible, and can go around corners with no difficulty. Photo: Eelume.



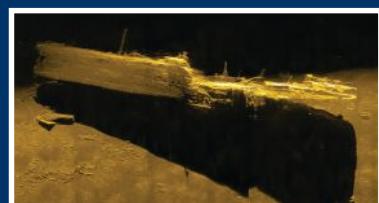
▲ The snake robots can be controlled with or without an attached cable. Photo: Eelume.

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JOINT TRIALS TO TRACK UNDER-WATER ROBOTS IN AQUACULTURE ENVIRONMENT

INTEF Ocean hosted trials at its facility in Trondheim, Norway. Image from SINTEF Ocean.



Joint trials by Norwegian research institute SINTEF Ocean and marine resource technology company Sonardyne International Ltd. have proven the ability for an acoustic positioning system to track underwater robots as they move through industrial-scale fish pens.

Being able to accurately track remotely operated vehicles (ROVs) in aquaculture operations, including cage and mooring inspection and removing perished fish, will help operators to increase efficiency and productivity and reduce the need for divers.

Until now, there has been a misperception that acoustic tracking systems do not work in fish farm applications, due to the volume and density of fish within the pens or cages. Fish have an air-filled swim bladder that helps them regulate their buoyancy and this organ can interfere with the transmission and reception of acoustic signals from the surface to an ROV. In a farm with up to 200,000 fish in any one cage, it has been thought that this could pose significant challenges for some acoustic based systems.

In the trials, at the Korsneset SINTEF ACE site near Trondheim, Norway, a Micro-Ranger 2 Ultra-Short BaseLine (USBL) positioning system was used to track an Argus Mini ROV through a pen containing an estimated 150,000-200,000 salmon. Micro-Ranger 2 is Sonardyne's latest USBL positioning system, designed for users with no previous experience of USBL equipment. It features a small acoustic transceiver deployed from a vessel or pontoon and an acoustic transponder attached to the ROV. Micro-Ranger 2 uses Sonardyne's Wideband 2 acoustic signals combined with highly sensitive receivers, which can detect the unique acoustic signals, even in challenging acoustic environments.

Elizabeth Paull, Business Development Manager at Sonardyne, says, "The demonstration, with SINTEF, showed that our systems function to their usual high standards in low to medium fish densities, both inside and outside of the cage, with the ROV being tracked consistently and accurately. When tracking the ROV through the highest density of fish, the frequency of position

updates did decrease, but, the positioning of the ROV was still accurate when acoustic paths were available. And, by moving the ROV away from the net, the frequency of updates could be improved.

"These positive results mean that those in the aquaculture industry can now use Micro-Ranger 2 for ROV tracking, knowing that the system will track even with high densities of fish," adds Paull. "This means that items of interest, such as holes or tears in the net, can be located and then relocated quickly and easily, reducing the time needed to make repairs."

WWW.SINTEF.NO/EN/OCEAN/#/

WWW.SONARDYNE.COM

TGS TO CONDUCT MULTI-CLIENT 3D SEISMIC SURVEY OFFSHORE BRAZIL

TGS announces a new multi-client 3D seismic survey in the Campos Basin in Brazil. The survey will cover approximately 11,200 km² within the granted permit area and will be acquired by Shearwater with the Amazon Warrior.

The survey will provide contiguous 3D coverage over the highly prospective Brazil Round 16 blocks located in the outer Campos Basin. TGS will utilize advanced imaging (RTM) and velocity model building (FWI) technologies to create accurate and high-resolution images of the prolific Pre-Salt objectives.

Fast Track products will be available in Summer 2019 ahead of Round 16 with final products available in Q2 2020. This project is supported by industry funding.

"The project fits well with our strategy of increasing our footprint in the prolific basins in the South Atlantic region", states Kristian Johansen, TGS CEO. "Furthermore, the survey provides additional visibility to our guided multi-client investments for 2019, with more than USD 200 million already committed"

WWW.TGS.COM



PORT OF MARSEILLE-FOS TO BUILD NEW SUBSEA CABLE LANDING INFRASTRUCTURE

Globalization does not simply mean more ships; it also means more information flows. No wonder that data traffic is predicted to grow at a rate of 45% per year over the next decade. This dramatic increase in volume, along with the diversity of the content which is exchanged, requires upgraded interconnection infrastructure as well as data storage facilities. The Port of Marseille-Fos is ready.

The Port of Marseille-Fos announces the construction of new subsea cable landing infrastructure which will provide a reliable and convenient plug & play interface for subsea cables coming from all over the world to the Marseille area. The port will deliver the first phase of the dedicated infrastructure by Q3 2019, which can welcome up to six cables. A one-stop shop system within the French administration for permitting process will be implemented simultaneously in Marseille to facilitate applications. The Port aims to offer a fully

integrated landing solution to clients, and is also building secure facilities tailored to accommodate the Power Feed Equipment of subsea cables.

The Port of Marseille-Fos is now fully positioned as a maritime digital gateway. Not only is Marseille ideally positioned at the crossroads of Europe, Africa, Middle East and Asia, but also benefit from a favorable seabed for this type of infrastructure. Connecting submarine cables through the Port of Marseille also makes sense given the current location of carrier-neutral data centers, both within and near the port area.

This investment is yet another landmark in the development of the French Smart Port in the Med, a port that is always at the forefront of innovation in order to create value for the region in a digitalized world.

"Interxion welcomes this initiative from



Aerial view of the port of Marseille. The port will deliver the first phase of the dedicated infrastructure for subsea cables by Q3 2019.

the Port of Marseille Fos, especially as two of Interxion's data centers – MRS2 and MRS3 – are located within the port's area. We share a common goal with the Port of Marseille Fos which is to foster Marseille's attractiveness for international, national and local investors, help the whole territory to grow and reinforce the role of the city as a global-scale digital hub." said Fabrice Coquio, Managing Director of Interxion France.

WWW.MARSEILLE-PORT.FR



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Morgan & Eklund, Inc.

Morgan & Eklund, Inc. (M&E) is a multidisciplinary survey firm specializing in the acquisition and processing of bathymetric, topographic, and geophysical data. M&E has a 34-year history of providing accurate and reliable hydrographic and geophysical survey services in support of marine and coastal infrastructure projects, beach restoration, and large-scale water management projects.

Since 1985, M&E has demonstrated command of the personnel, principles, techniques, facilities, equipment, and administrative considerations associated with both large- and small-scale survey programs. Since becoming a part of the CSA family two years ago, M&E has been able to leverage CSA's capabilities, equipment, and technology to offer a comprehensive, multi-disciplinary range of geophysical, oceanographic and metocean survey services. The expanded scope of services includes acoustic Doppler current profiler and CTD surveys, as well as the ability to provide additional hydrographic survey teams should they be required.

Even though the partnership between CSA and M&E is relatively new, the relationship is not. M&E and CSA have worked together closely on both large- and small-scale projects for over 25 years and the integration of personnel and equipment resources has considerably expanded both companies' capabilities.

M&E conducts topographic, hydrographic, and geophysical surveys as well as other field investigations for beach nourishment, restoration projects, and engineering evaluations including detailed underwater infrastructure assessments for submarine cables and pipelines, dredging, habitat investigations, and oceanographic studies. M&E has also been involved in coastal monitoring programs, port and harbor improvements, and critical post-hurricane emergency surveys. Measuring coastline erosion caused by hurricanes is extremely important as these survey data aid in government sponsored recovery programs.

M&E's staff includes four Registered Land Surveyors, four survey crews and one dedicated hydrographic survey crew. All team members are highly experienced, with many having over thirty

years of experience in their respective disciplines. The team is professionally trained on the latest software, and many participate in continuing education to remain on top of key industry developments and trends.

M&E clients include consulting and engineering firms, construction contractors and federal, state, and local government entities involved in maritime projects. While under contract to the U. S. Army Corps of Engineers, Jacksonville District, M & E performed numerous large-scale management-intensive topographic surveys for the Comprehensive Everglades Restoration Project (CERP).

Additionally, M&E has successfully completed projects for the following Florida counties, water management districts, and government entities:

- » Brevard County
- » Miami-Dade County
- » Indian River County
- » South Florida Water Management District
- » St. Lucie County
- » St. Johns River Water Management District
- » Martin County
- » US Army Corps of Engineers (Jacksonville District)
- » Palm Beach County
- » Florida Department of Environmental Protection
- » Broward County

With Florida offices in Vero Beach, Stuart, Boca Raton, and Miami, M&E is well positioned to service southeast Florida and the Caribbean. Work locations include coastal shorelines, ports and harbors and offshore sites in support of projects for our public and private clients. From field data collection to reporting and ongoing data management, M&E has always focused on quality and reliability while delivering results in a timely fashion and within our client's budgets.

For more information, visit www.morganeklund.com

OCEANEERING INKS CONTRACT WITH TOTAL FOR TYRA

Oceaneering International, Inc. has been awarded a two-year Integrity Management contract with Total E&P Danmark to support its significant Tyra Redevelopment project in the Danish North Sea.

Oceaneering's scope includes the full development of Tyra's integrity management program, developing risk-based assessments (RBAs) that will enable effective and optimised inspection and monitoring for all pressure systems and piping, topsides and jacket structures as well as pipelines.

Managed from our Aberdeen office, Oceaneering will use a multi-disciplined team of corrosion, inspection, structural and pipeline engineers, with specialist experience in delivering large-scale integrity scopes.

In addition to the Tyra Redevelopment, Oceaneering provides a range of other

services to Total, from topsides inspection management services in the UK North Sea to ROV, tooling and survey support globally.

Tyra, in production for over three decades, is a unique field. It processes 90 percent of the Denmark's gas production.

Redevelopment not only secures production at the field for the next 25 years, but the infrastructure will enable operators to pursue new gas projects in the northern part of the Danish North Sea.

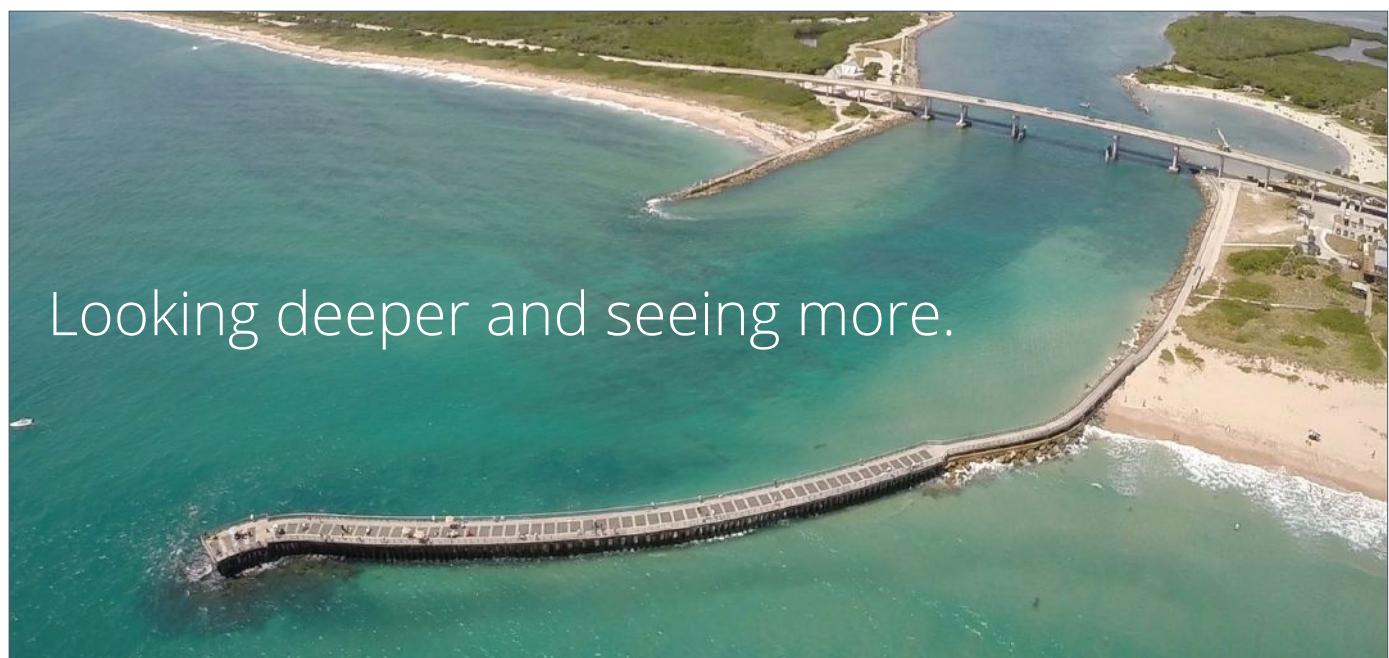
At peak production it is expected to produce the equivalent of supplying 1.5 million Danish homes with gas. The investment in this project is the largest of its kind within the Danish North Sea.

Oceaneering's Asset Integrity business provides integrity management capabilities,



conventional and advanced non-destructive testing (NDT) and specialist inspection solutions, with a team of over 2,100 technically focused people, servicing customers from 24 global locations.

**WWW.OCEANEERING.COM/
ASSET-INTEGRITY**



Morgan & Eklund Inc.

Morgan & Eklund, Inc. specializes in collecting data in the coastal zone providing bathymetric surveying services for project monitoring, beach restoration, dredging and offshore borrow area investigations.

For more information, visit www.morganeklund.com or call (772) 388-5364.

WHAT'S GOING ON AT OCEAN BUSINESS 2019?

MORE THAN 330 INTERNATIONAL EXHIBITORS, OVER 180 HOURS OF TRAINING AND DEMONSTRATION WORKSHOPS, A CUTTING-EDGE CONFERENCE, INDUSTRY LED ASSOCIATED MEETINGS, A CAREERS EVENT AND INNOVATIVE NETWORKING OPPORTUNITIES...



Whether you want to catch up with contacts, meet new people, or gain insights into the future of the industry, Ocean Business is a can't miss conference. Not surprisingly, exhibitor space is sold out, with many companies promising to unveil new technology during the conference and its surrounding events.

Come see us at Stand F13. We'll be there in full force, with editorial, sales, and marketing experts in attendance to help you get your company's message out. Of course, we'll be among friends, so we hope you get a chance to visit all of the exhibitors.

Interested in the OPENSEA operating platform? Greensea Systems will be there, at Stand L14. Or maybe oceanographic profilers, samplers, and flotation are what you need. McLane Research Labs will be at Stand A29. From France's iXblue to China's OceanAlpha, Russia's SeaTechrim to Egypt's MCS Free Zone, the over 360 exhibitors at this show make it one of the industry's premiere industry events. You can see a full list of exhibitors at www.oceanbusiness.com.

TRAINING AND DEMOS

More than just a static exhibition, Ocean Business really is a hands-on technology exhibition as it provides visitors with the opportunity to see the latest products and services first hand 'on-water' or 'in-classroom' at the training and demonstration sessions.

"Ocean Business: a place to discover new technologies, meet old and new friends and to design the future of the sea," says José Braga, Engineer, OceanScan-MST, Portugal.

He's right. Visitors can choose among 180 hours of live, free to attend demos being held in eleven parallel sessions. The training and demonstration program makes full use of the onsite facilities at the National Oceanography Centre by utilizing their classrooms, vessels, dockside waters and the test tank.

These workshops give buyers an ideal opportunity to test drive new equipment before purchasing plus providing an ideal opportunity to speak to the developers about latest developments and requirement.

BRINGING INDUSTRY TOGETHER

Ocean Business is also hosting a number of free to attend high profile meetings and industry events. A particular highlight is Enterprise Europe's B2B matchmaking event at the National Oceanography Centre (NOC), taking place on Wednesday 10 April. This is a free event designed to bring together potential business partners during pre-arranged 20-minute meetings. It provides business development opportunities for both exhibitors and visitors who are interested in marine engineering, maritime defense, environmental monitoring and pollution control, ports and harbors, and marine autonomous systems.

The National Oceanography Centre (NOC) is the UK's leading institution for integrated coastal and deep ocean research. In a series of interactive events held over the three days, the NOC will be reaching out to the community to understand the needs of the industry in terms of science and technology to support the future of the sector. Discussions will focus around ships and equipment chartering, official development assistance (ODA), marine science and technology, and marine data products. These free events provide the perfect opportunity to help steer the direction of science and technology for the good of the industry.

Another important event of particular interest for marine spatial planning (MSP), blue growth sectors, and policy and regulation, is the ATLAS workshop. ATLAS is a four-year EU project assessing Atlantic deep-sea ecosystems to create the integrated and adaptive planning products needed for sustainable blue growth, marine conservation and resource use in a changing climate. In a workshop on Wednesday 10 April, exhibitors and visitors are invited to hear about the latest project results and join the discussion over refreshments.

For those interested in driving innovation and competitiveness, Marine South East will be holding a workshop on Tuesday 9 April, focusing on how a number of key enabling technologies are driving innovation

and business in the maritime sector. Up for discussion will be technologies such as micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics and advanced manufacturing technologies. The workshop will help companies understand how these technologies can transform their business.

OFFSHORE SURVEY 2019 LAUNCHES TECHNOLOGY PACKED PROGRAM

Offshore Survey 2019 will deliver 35 top quality presentations from industry leaders and emerging technology companies, as well as world renowned academic and industry organizations.

Held in conjunction with the event, Offshore Survey 2019 is a two-day technical conference that focuses on the technology, operations and business issues in the global field of offshore surveying.

For those looking for a taste of what the future holds, there will be a fascinating session on 'Future Industry Perspective'. From handling data to remote management of technology, these presentations will share

knowledge to help plan the technologies of the future. Within this session, one of the biggest international projects of the moment, 'The Nippon Foundation GEBCO Seabed 2030 Project', which aims to map the seabed globally by 2030, will be sharing information about progress to date, how new and emerging technology is being utilized, and how the right mapping campaigns are in place to gather missing data.

With autonomous and unmanned vehicles being such a crucial part of offshore work right now, two sessions are being dedicated to the topic. These will include seven presentations over the two days of the conference from international organizations including: Omniaccess (Spain), Kietta (France), XOCEAN (Ireland), Subsea7 (UK), Sonardyne International (UK), Nortek (UK), and L3 ASV (UK).

More general issues of interest to the offshore industry will be addressed, such as the global problem of plastic waste. Other sessions will cover 'Coastal and Environment', 'Imagery and Visualization', 'Education and Competencies', 'Data and Digitalization', with

presentations that give a unique mix of technology and business.

Offshore Survey runs alongside Ocean Business, a high caliber three-day exhibition of technology and services, and this means that delegates can explore the exhibition and enjoy combined social and networking events, including welcome drinks the night before the Ocean Business show opens and a wine trail on the opening day of the show. Attendance to the Ocean Business show is free to attend. There is a fee to attend the Offshore Survey conference.

For full details about Offshore Survey 2019 or to register online for free, please visit: www.oceanbusiness.com.

This year's Ocean Business also offers career and recruitment advice, and a full line-up of enjoyable social events for informal networking. It takes place from 9-11 April 2019 at the National Oceanography Centre, Southampton, UK.

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NEC CORPORATION TO BUILD SUBMARINE CABLE SYSTEM IN JAPAN



NEC Corporation announces that a contract has been awarded by Okinawa Cellular Telephone Company for NEC to design, engineer, supply, install, test and implement an optical submarine cable system connecting Okinawa Prefecture and Kagoshima Prefecture in Japan. NEC will provide the optical submarine cable system as a turnkey solution. This cable system is scheduled to start operation in April 2020.

This cable system is connected to Nago City, Okinawa Prefecture, and Hioki City, Kagoshima Prefecture, with a total length of approximately 760 km and a maximum depth of approximately 1,200 m. The cable system employs the latest optical wavelength multiplex transmission method, and the maximum design transmission capacity is 80 Tbps per second.

By connecting the cable between Okinawa and Kagoshima via a different route from the existing cable, this cable can secure a backup line in the event of a large-scale disaster or other emergency. In addition, this cable system will respond

to the demand for communications between the Okinawa, Kyushu and Honshu regions of Japan, which is expected to continue growing in the future due to the construction of data centers in Okinawa and the launch of 5G services.

NEC has been a leading supplier of submarine cable systems for more than 50 years. It has built more than 300,000 km of cable, spanning the earth 7.5 times, and has strengths especially in the Asia-Pacific region, including Japan. NEC, as a system integrator, provides all aspects of submarine cable operations, including the production of optical transmission terminal stations, optical submarine repeaters, optical submarine cables, ocean surveys and route designs, installation of equipment and cable installation, and training and delivery testing. NEC's subsidiary, OCC Corporation, is responsible for the manufacture of this cable, which is the only company in Japan that can manufacture optical submarine cables capable of withstanding the water pressure from 8,000 m deep seas.

TELSTRA ADDS CAPACITY TO LARGEST SUBSEA CABLE NETWORK IN ASIA PACIFIC

Telstra has announced the addition of substantial capacity to its subsea cable infrastructure with its first large capacity purchase on the new-generation New Cross Pacific (NCP) cable, and a further investment in the Faster cable.

These investments strengthen Telstra's Japan to the US route and confirm Telstra's subsea cable network as the largest in the Asia Pacific.

In December, Telstra entered into agreed terms to purchase a 25 per cent stake in Southern Cross Cable Network (SCCN). Subject to approvals the agreement includes capacity on the existing Southern Cross network and new Southern Cross NEXT subsea cable - set to become the lowest latency path from Australia to the US. Telstra has also boosted its Asia to US operations over the last 12 months, with a half fiber pair investment in the Hong Kong Americas (HKA) cable and a 6Tb capacity purchase in the Pacific Light Cable Networks (PLCN) cable, both due to be completed in 2020.

These new-builds complement Telstra's major half fibre pair investment in the INDIGO cable system from South East Asia to Australia, which has reached a major milestone with the completion of the 4,600km Indigo West cable lay from Singapore to Perth just before Christmas. Today, Telstra's subsea cable network reaches more than 400,000km – enough to circle the world almost 10 times. Once completed, Telstra's investments in SCCN, HKA, PLCN and INDIGO, will grow Telstra's subsea cable network ownership by more than 25Tb.

For a third consecutive year, Telstra received the highest product scores for High Capacity Network and Low Latency Network in the Gartner Critical Capabilities 2018 report for Network Services, Asia Pacific.



SEAROBOTICS INTRODUCES NEW HYCAT ASV

SeaRobotics Corporation (SeaRobotics) completed the first production run of the HYCAT Autonomous Surface Vehicle (ASV) in partnership with XYLEM, USA. The HYCAT is a portable ASV with a small profile and shallow draft that allows deployment in the most challenging environments with minimal support. The successful production of the HYCAT is being followed by the development of a man portable addition to the SeaRobotics ASV family for bathymetric survey incorporating a multi-beam echosounder.

HYCAT is generously equipped with a full complement of water quality sensors including the SonTek M9, YSI EXO2 Multiparameter sonde, Hemisphere AtlasLink RTK GNSS, HYPACK Max onboard data acquisition and processing software residing on an onboard Windows 10 Data Acquisition Computer, as well as an Imagenex Side Scan Sonar system. The SonTek M9 Acoustic Doppler Profiler with Hydro Surveyor is fully integrated with HYPACK providing bathymetric data,

water column velocity data, and acoustic bottom tracking for hydrographic surveys. The YSI EXO2 multiparameter sonde provides an extremely flexible platform for the deployment of up to 7 discrete water quality sensors of the 23 available accessory sensors. The Imagenex 260/330/800 kHz Side scan sonar system and an integrated forward-looking camera rounds out the survey capability of the system. A single consolidated software interface has been developed by SeaRobotics and HYPACK making this small ASV the most fully integrated ASV on the market.

In the few months since introducing the prototype system into the market, HYCAT has performed at numerous trade shows and demonstrations, as well as completing a variety of commercial surveys. HYCAT performed a pipeline survey in international waters providing bathymetric data, side scan sonar data, and water column velocity studies in a high current environment. Other surveys utilized the side scan

sonar for search and rescue, and the EXO2 multiparameter sonde for sediment transport studies, and utilized several of the EXO2 sensors for water quality studies.

The system leverages SeaRobotics' extensive expertise delivering ASVs for high-precision bathymetric surveys, water quality analysis, and hydrographic surveys.

"SeaRobotics is pleased to provide the HYCAT ASV in partnership with XYLEM and its broad range of sensor and software support companies," stated Don Darling, president of SeaRobotics Corporation.

"We funneled 18 years of multidisciplinary ASV design & development experience into HYCAT. The end result is a leap forward for this technology and the marine survey industry. Our goal was to set the bar for safe, intuitive, autonomous survey systems. We did that with HYCAT. This is a product we and our strategic partners Xylem YSI, SonTek, & HYPACK are proud to offer," further

explained Geoff Douglass, ASV development manager at SeaRobotics.

SeaRobotics Corporation, headquartered in Stuart, Florida, specializes in smart survey vehicles that are manned/unmanned and autonomously operated. SeaRobotics clients include major military and commercial organizations, both U.S. and foreign. SeaRobotics' seasoned marine survey software interfaces with most data acquisition hardware, software and sensing systems to produce multi-spectral, georeferenced data for survey, research or surveillance efforts. Applications for SeaRobotics vehicles range from bathymetric and hydrographic surveys to coastal, harbor, and riverine surveillance. Many SeaRobotics vessels are small, modular and man-portable, allowing rapid deployment in remote areas or deployment by larger vessels; their command and control systems are user-friendly and compact allowing for safe efficient surveying.

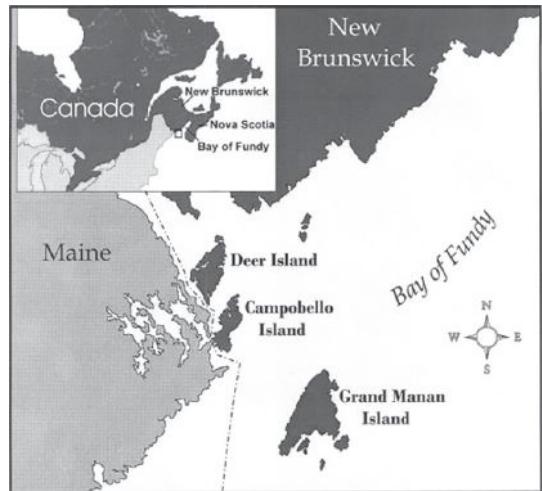
To learn more, visit
www.searobotics.com

PRYSMIAN DEVELOPING NEW SUBMARINE CABLE SYSTEM IN CANADA

Prysmian Group, a world leader in the energy and telecom cable systems industry, has been awarded a new contract worth €17 million by New Brunswick Power Corporation (NB Power), the largest electric utility in the Atlantic Canada based in the province of New Brunswick. The Fundy Isles Project involves the development of a new submarine cable link which will allow the upgrade of the capacity of the existing submarine transmission system in the Passamaquoddy Region of the Bay of Fundy.

The new power cable link will connect Deer Island, Campobello Island and Grand Manan Island to the mainland power grid in the Canadian province.

Prysmian Group will be responsible for the design, manufacture and installation of a 300 mm² 69 kV three-core submarine cable system with XLPE insulation for a total of 20 km. All submarine core cables will be produced at Prysmian's centre of excellence in Montereau (France), while the cable armoring will be manufactured at Prysmian's state-of-the-art factory in Nordenham (Germany), part of the Group after the merger with General Cable. Completion of the project is scheduled for October 2019.



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The first cable will run approximately for 3.5 km from the Cable Riser Station at Chocolate Cove, on the east side of Deer Island, to a Cable Riser Station at Wilson's Beach, on the west side of Campobello Island in Canada. The second cable will run approximately 16.5 km from the Cable Riser Station at Little Whale Cove, on the east side of Campobello Island to a Cable Riser Station at Long Eddy Point, on the north side of Grand Manan Island.

"This project is particularly challenging for Prysmian as the section where the installation activities will be performed presents the highest tides in the world, with very strong currents," stated Raul Gil, Prysmian Group Submarine Business Director. "Moreover, the submarine route crosses an extensive fishing area and this limits the time window that can be used for installation operations. Thanks to our technological and state-of-the-art products and solutions, we will ensure the safe and reliable energy supply to the communities of the area," concluded Gil.

This project further confirms the increasing dynamism of the North America market and the capability of Prysmian Group to leverage on its technological leadership in the submarine cable market.

WWW.PRYSMIANGROUP.COM

Prysmian
Group

HYDROMEA'S LUMA WIRELESS HIGH-SPEED UNDERWATER COMMUNICATION SYSTEM

Hydromea's LUMA, a wireless high-speed underwater communication system, was successfully deployed by a leading subsea operator, during a subsea manifold installation project in the North Sea in November 2018. LUMA was integrated with Ashtead Technology's AMS+ (Autonomous Monitoring System) to deliver fast and reliable remote communication of heading, pitch, roll and other essential data in real time via a work class ROV to the construction vessel.

Typically, wide band acoustics can provide 5 second data updates. With the LUMA optical modem the client obtained reliable data updates every 0.5 seconds without delay in what was deemed poor visibility by the ROV operators. Under these conditions reliable data throughput was achieved with the WROV monitoring from a distance of 3.5 meters from the AMS+ sensor package.

Ross McLeod, Technical Director, Ashtead Technology, said: "Conventionally underwater displays and/or acoustic modems are used to acquire the data from the AMS+. With the integration

of the Hydromea LUMA wireless optical modem, the data rate, immediate response and reliability of communication were significantly improved over acoustics."



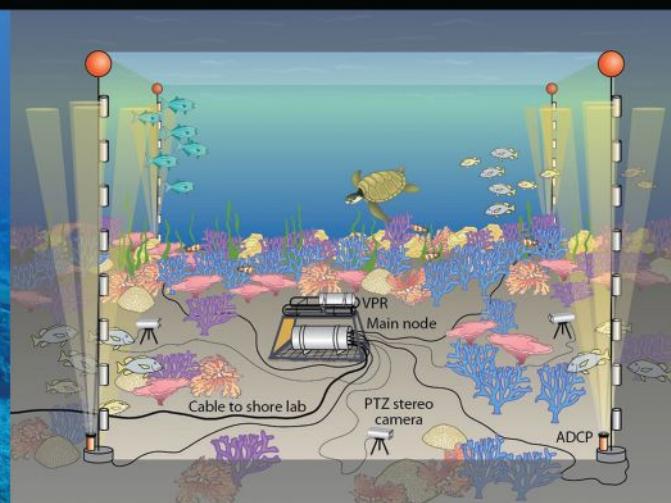
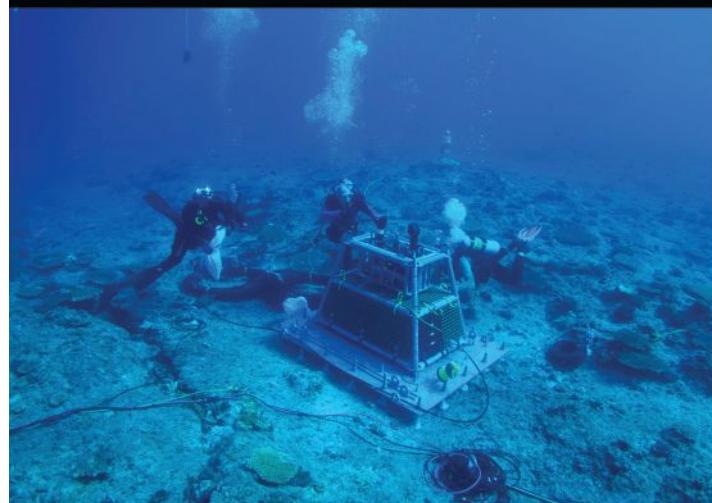
"This project has proven that Hydromea's LUMA wireless optical modems integrated with Ashtead's data management systems can reduce risk and add value on many subsea monitoring applications where real time data access is critical across subsea construction and life of asset support operation."

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SUBCOM RELIANCE COMPLETES SUCCESSFUL REPAIR OF TONGA CABLE SYSTEM



» Image credit: Tonga Cable Ltd.

SubCom, a leading global partner for undersea data transport, has announced that its cable ship SubCom Reliance successfully completed the repair of two Tongan submarine cables. The Tonga Cable and the Tonga Domestic Cable were damaged on January 20, 2019. Upon notification of the break, SubCom Reliance was mobilized and completed the necessary repairs to both cables within eight days of arrival on repair grounds. The repairs took place under the South Pacific Marine Maintenance Agreement (SPMMA), pursuant to which SubCom maintains over 69,000 km of cable consisting of 33 data and power cable systems in the Pacific Ocean.

"We salute SubCom and the entire SubCom Reliance team for a job well done," said CEO of Tonga Cable Ltd. Edwin Liava'a, who was aboard the ship during the cable repair process.

The Tonga Cable System is an international cable in the Pacific Ocean that spans 827 kilometers with landing points in Nuku'alofa, Tonga and Suva, Fiji. The Tonga Domestic Cable Extension is a 406-kilometer cable with three landing points in Tonga: Neiafu, Nukualofa and Pangai. SubCom maintains these two cables in addition to 31 other systems as part of the SPMMA, which was signed in 2017. The agreement covers the South Pacific region from Singapore in the west to Tahiti in the east and from the southernmost point of New Zealand to Hawaii.

SubCom Reliance is part of the company's world-class fleet, purpose-built for cable deployment and maintenance. The ship was on standby in the South Pacific at a port in Apia, Samoa. SubCom's highly trained crew of experienced merchant mariners, submersible engineers, and cable operations personnel loaded the ship with spare materials to expeditiously repair the Tongan cables.

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MARINE LAY FOR SUBSEA CABLE SYSTEM BETWEEN AUSTRALIA AND SOUTH EAST ASIA COMPLETED

On 25 January 2019, AARNet, Google, Indosat Ooredoo, Singtel, SubPartners and Telstra announced a significant milestone in the implementation of the INDIGO subsea cable system with the completion, on schedule, of the final splicing of both the INDIGO West cable and Indigo Central cable.

This marks the completion of the marine installation of both the 4600km Singapore to Perth INDIGO West submarine cable and 4600km Perth to Sydney INDIGO Central submarine cable. Commissioning of the submarine cable system has begun, with the INDIGO cable system on-schedule and on-track to be ready for service before mid-2019.

This milestone follows the announcement in April 2017 that the consortium had entered into an agreement with Alcatel Submarine Networks (ASN) to build the INDIGO cable system connecting Singapore, Perth and Sydney, with two additional fiber pairs connecting Singapore and Jakarta via a branching unit.

The 9,200km INDIGO cable system will strengthen links between Australia and the fast-growing South East Asian markets, providing lower latency and enhanced reliability. Using today's coherent optical technology, the cable's two-fibre pairs will be able to support up to 36 terabits per second, the equivalent of simultaneously streaming millions of movies a second.

The INDIGO cable system will utilize new spectrum sharing technology so each consortium member will have the ability to independently take advantage of technology advancements for future upgrades and capacity increases on demand.



» The INDIGO cable system on-schedule and on-track to be ready for service before mid-2019

POLE STAR LAUNCHES PSP TRACKING MOBILE APP

Pole Star announced the launch of their new mobile app, PSP Tracking for iOS. The app will provide Pole Star Platform customers with greater working flexibility by integrating vessel tracking services from their central desktop application on smartphones and tablet devices.

With this new app, Pole Star hope to continue helping their clients' operations run smoothly by delivering detailed actionable intelligence.

On the PSP Tracking app, users can:

- Easily log in using PSP platform credentials
- View ships under accounts or sub-accounts on a map or in list view
- Select a specific ship and view its movement history and details

- Change the device's reporting frequency (with relevant permissions)
- Choose from different map types as the base layer
- Enable weather layers in map view
- Display entire fleet in presentation view and mirror it on Apple TV
- Easily view SSAS/AIS non-reporting ships on a map or list
- Configure select features (eg. clustering, global ship trail length, vessel label)

The app is free of charge, and available on the Apple store under the name PSP Tracking.

While currently only available for iOS, updates regarding an Android version will be circulated accordingly.



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ADMIRAL RICHARDSON COMMENTS ON NAVY'S ELECTROMAGNETIC RAILGUN TECHNOLOGY



» The Office of Naval Research (ONR)-sponsored Electromagnetic Railgun (EMRG) at terminal range located at Naval Surface Warfare Center Dahlgren Division (NSWCDD). (U.S. Navy/John F. Williams).

The Navy's \$500 Million investment in railgun technology was part of a discussion during a 6 February 2019 Atlantic Council event that included a discussion with the U.S. Navy's top officer. Railguns use electromagnetic energy instead of gunpowder to propel rounds, and can strike at speeds of up to 1.6 miles per second, at targets over 120 miles away.

Admiral John M. Richardson, Chief of Naval Operations, United States Navy, stressed the need for rapid prototyping to maintain maritime superiority, and added, "I would say that rail gun is the case study that would say, this is how innovation maybe shouldn't happen."

"[The rail gun project] has been around 15 years, maybe 20; 'rapid' doesn't come to mind in a time frame like that . . . Now we've learned a lot [from the project],

and the engineering of building something like that that can handle that much electromagnetic energy and not just explode is challenging. So, we're going to continue after this — we're going to install this thing, we're going to continue to develop it, test it. It's too great a weapon system so it's going somewhere, hopefully."

He added that "The high-velocity projectile is also usable in just about every gun we have. It can be out in the fleet very, very quickly independent of the railgun," he said. "So, this effort is breeding all sorts of advances. We just need to get the clock sped up with respect to the railgun."

Meanwhile, multiple reports claim that China tested its version of the railgun in January, and it is expected to be ready for warfare by 2025.

NAVY AWARDS BOEING \$43 MILLION TO BUILD FOUR ORCA XLUUVS

According to Ben Werner at USNI News, the U.S. Navy has awarded Boeing a \$43-million contract to build four Orca Extra Large Unmanned Undersea Vehicles (XLUUVs) that will become multi-mission for the service, according to a Wednesday Pentagon contract announcement.

Boeing based its winning Orca XLUUV design on its Echo Voyager unmanned diesel-electric submersible. The 51-foot-long submersible is launched from a pier and can operate autonomously while sailing up to 6,500 nautical miles without being connected to a manned mother ship, according to the Navy. Eventually, the Navy could also use the Orca XLUUV for mine countermeasures, anti-submarine warfare, anti-surface warfare, electronic warfare and strike missions, according to a Navy outline of the system's capability development.

"We are pleased with the Navy's decision to award Boeing a contract to build and deliver four Orca Extra Large Unmanned Undersea Vehicles, and are committed to providing this important autonomous undersea capability to meet the Navy's unique mission needs," the company said in a statement to USNI News.

The Navy also considered the Lockheed Martin Autonomous Underwater Vehicle system. In October 2017, both companies received design phase awards – \$43.2 million to Lockheed Martin, \$42.3 million to Boeing.

Werner notes that the Navy is also exploring the possible use of Large Diameter Unmanned Underwater Vehicles (LDUUVs) as another rapid acquisition program. The LDUUV would be a vehicle launched from either a Virginia-class fast attack submarine or from a surface ship. LDUUVs could perform similar missions as the XLUUV, however, the LDUUV would need to remain relatively close to the mother ship instead of operating autonomously like the XLUUV.



ON SCENE AND UNSEEN: USS SOUTH DAKOTA (SSN 790) COMMISSIONED



Patrolling the seas with silence and stealth, the 17th Virginia Class nuclear submarine, The USS South Dakota (SSN 790), is the newest, most innovative fast-attack submarine in the United States Navy's fleet. Her commissioning ceremony took place at Naval Submarine Base New London, Connecticut on 2 February 2019.

The U.S. Navy, with assistance from Mrs. Deanie Dempsey, the ship's sponsor, gave the command, "Man our ship and bring her to life!" spurring the crew into action and all ship's systems to be tested, including alarms, bells, radars, and scopes.

South Dakota is a flexible, multi-mission platform designed to carry out the seven core competencies of the submarine force: anti-submarine warfare; anti-surface warfare; delivery of special operations forces; strike warfare; irregular warfare; intelligence, surveillance and reconnaissance; and mine warfare. The submarine is 377 feet long, has a 34-foot beam, and will be able to dive to depths greater than 800 feet and operate at speeds in excess of 25 knots submerged. It will operate for over 30 years without ever refueling.

USS South Dakota's Commanding Officer, Cmdr. Craig Litty, highlighted South Dakota's capability to dominate the undersea domain and enable military success in any engagement, "South Dakota was built to be on

scene and unseen, forward deployed and ready to take the fight to our adversaries and protect our shores here."

Commander of the Submarine Forces, Vice Adm. Chas Richard added, "South Dakota will soon enter the fleet with stealth, flexibility and endurance. Traveling silently through the world's oceans undetected, collecting information, preparing for battle, and if necessary, striking from the deep swiftly without warning; answering the nation's call. To the South Dakota crew, as your motto attests, 'Under the Sea, We Rule' because the Nation, the Navy, and the Mt. Rushmore state are depending on you."

The first South Dakota (ACR 9) a United States Navy Pennsylvania-class armored cruiser launched on 21 July 1904.

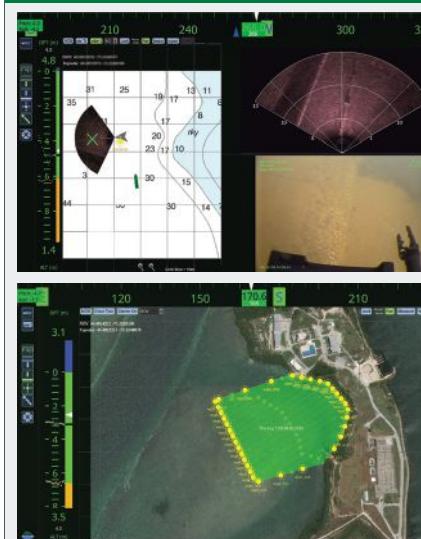
The second South Dakota's (BB 57) was launched on 7 June 1941. The lead ship of her class, South Dakota was considered to be the most efficient battleship designed under the limitations of the Washington Naval Treaty during World War II. Though in their nineties, some of the Sailors from the submarine's namesake made it out to the event to see that the history and traditions were passed on to the next generation.

South Dakota is the seventh of eight Block III Virginia-class submarines to be built. The Block III submarines are made with the new Virginia Payload Tubes designed to lower costs and increase missile-firing payload possibilities. The first 10 Block I and Block II Virginia-class submarines have 12 individual 21-inch diameter vertical launch tubes able to fire Tomahawk Land Attack Missiles (TLAMs). The Block III submarines are built with two-larger 87-inch diameter tubes able to house six TLAMs each.

Construction on South Dakota began 2013; the submarine's keel was authenticated on 4 April 2016; and the submarine was christened 14 October 2017.



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WRECKAGE OF WORLD WAR II AIRCRAFT CARRIER LOCATED IN SOUTH PACIFIC

One of the most important aircraft carriers in WWII history has been located thanks to efforts from the crew of Paul Allen's R/V Petrel. The discovery of the USS Hornet was made during Petrel's first mission of 2019.

Wreckage of the World War II aircraft carrier USS Hornet rests on the floor of the South Pacific Ocean around the Solomon Islands, 5,400 meters (nearly 17,500 feet) below the surface. Hornet was best known for its part in the fateful Doolittle Raid that was launched in April of 1942, which was the first airborne attack of Japanese homeland targets including Tokyo. Led by U.S. Army Lt. Col. James Doolittle, all of the 16 B-25 planes that were launched from Hornet were unable to land at their designated airstrip in China, but the raid provided a boost to American morale, and put Japan on alert about our covert air capabilities.

In June, Hornet was one of three American carriers that surprised and sunk four Japanese carriers at Midway, turning the tide of war in the Pacific.

The ship was sunk during the exceptionally vicious Battle of Santa Cruz Island that started Oct. 25, 1943. Hornet proved an especially



» Inside the control room for the ROV used to explore the wreck where it rests 5,000 m below the surface. Photo courtesy of Paul Allen's Exploration Team.

determined ship over the next 24 hours. Enduring a relentless, coordinated attack by Japanese dive-bombers and torpedo planes, her crew was ultimately forced to abandon the ship due to damage and resulting fires. She then defied American efforts to scuttle her with 16 torpedoes and 369 rounds of 5-inch shells. When Japanese forces approached shortly thereafter and fired four torpedoes from two Japanese destroyers late in the evening of Oct. 26, Hornet finally succumbed and slipped beneath the surface. She lost 111 Sailors from her crew of nearly 2,200.

"With the loss of Hornet and serious damage to Enterprise, the Battle of Santa Cruz was a Japanese victory, but at an extremely high cost," said retired Rear Admiral Samuel Cox, director of Naval History and Heritage Command. "About half the Japanese aircraft engaged were shot down by greatly improved U.S. Navy anti-aircraft defenses. As a result, the Japanese carriers did not engage again in battle for almost another two years."

"Naval aviation came of age in World War II and American Sailors today continue to look to and draw inspiration from the fighting spirit of ships and crews like USS Hornet (CV 8)," Vice Chief of Naval Operations Adm. Bill Moran added.

"Although her service was short-lived, it was meteoric. In the dark days following the Japanese surprise attack on Pearl Harbor, she and the Doolittle Raiders were the first Americans to punch back at Japan, giving hope to the nation and the world when things looked bleakest," Moran said.

"She was there when the American Navy turned the tide in the Pacific at the Battle of Midway, and she was there when America started the long drive to Tokyo in the Solomon Islands. Mortally wounded during the vicious campaign at Guadalcanal and abandoned after all attempts to save her failed, she was finally sent below by the Japanese destroyers Akigumo and Makigumo.

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As America's Navy once again takes to the sea in an uncertain world, Hornet's discovery offers the American Sailor a timeless reminder of what courage, grit and commitment truly look like," Moran continued. "We'd be wise as a nation to take a long, hard look. I'd also like to thank the crew of Petrel for their dedication in finding and honoring her sacrifice."

The discovery of Hornet was made during R/V Petrel's first mission of 2019 after relocating from the Philippine Sea to the Solomon Islands to spend winter months in this arena. Operating out of Guadalcanal, the area is rich in history and prominence in terms of naval engagements.

"We had Hornet on our list of WWII warships that we wanted to locate because of its place in history as an aircraft carrier that saw many pivotal moments in naval battles," said Robert Kraft, director of subsea operations for Vulcan. "Paul Allen was particularly interested in historically significant and capital ships, so this mission and discovery honor his legacy."

The 10-person expedition team on the 250-foot R/V Petrel was able to locate Hornet's position by piecing together data from national and naval archives that included official deck logs and action reports from other ships engaged in the battle. Positions and sightings from nine other U.S. warships in the area were plotted on a chart to generate the starting point for the search grid.

In the case of Hornet, she was discovered on the first dive mission of Petrel's autonomous underwater vehicle, and confirmed by video footage from the remotely operated vehicle, both pieces of equipment rated to dive down to 6,000 meters.



» A F4F Wildcat from the debris field. Photo courtesy of Paul Allen's Exploration Team.



» 5-inch guns of the USS Hornet. Photo courtesy of Paul Allen's Exploration Team.

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FOR HYDROCARBONS, THE OIL AND GAS MARKETS NOTABLY DIVERGE

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

NATURAL GAS

Punxsutawney Phil was rudely pulled from his hole by his handlers before dawn on Groundhog Day, but he failed to see his shadow on that February 2nd morning. Tradition says we are headed for an early end to winter. For those Americans in the Midwest and Northeast who had just suffered through their second Polar Vortex bone-chilling cold spell, Phil's pronouncement was heartily welcomed. For natural gas prices, the second Polar Vortex in January had failed to boost them, as they further declined to unseasonably low levels, possibly in anticipation of Phil's gray-morning debut.

The early spring prediction weighed down gas prices despite several weeks of record gas withdrawals from storage required to help meet demand. Based on the latest gas storage data for the week ending February 15, there was 1,705 billion cubic feet of gas in storage, down 177 Bcf from the prior week. Storage volumes are 4.1 percent below a year ago and 17.9 percent below the 5-year average of 2,067 Bcf. As the chart shows, the current gas storage volumes have been tracking the 5-year average for the past few weeks, and is now within the range of maximum and minimum volumes over that period.

The latest data shows domestic natural gas production continuing to set new monthly records, reaching total gross production of 107.4 Bcf per day, an 11.7 percent increase over the last 12 months. The government is forecasting growth over the next 12 months of 3.7 percent, followed by a 1.5 percent increase the following 12 months. The problem with these forecasts is that the same agency predicted a 5.5 percent hike in output, when actual production grew 11.7 percent between November 2017 and the same month in 2018. This rapid supply growth, especially given the inability of the government experts to anticipate it, has convinced gas traders

there will be no problem finding sufficient gas supply to rebuild storage volumes this summer in preparation for the winter of 2019-2020.

The confidence the gas market has about future supply is reflected in current gas futures prices. At \$2.70 to \$2.80 per thousand cubic feet, gas prices appear high enough to bring new supply on line to meet increased power consumption, satisfy residential and commercial demand, as well as deliver increasing volumes to LNG export terminals.

The increase in domestic gas output continues to confound experts who have predicted a slowing in supply growth due to the oil well drilling slowdown in regions with high associated gas volumes. While the supply and demand outlook will change one day, for the foreseeable future it looks as if natural gas prices will languish well below the magical \$3 per thousand cubic feet price level, and may even fall below the 2019 consensus expectation of \$2.82 per Mcf.

CRUDE OIL

In contrast to the natural gas market, crude oil prices have been rallying since their recent low established on Christmas Eve. As WTI prices flirt with \$57 a barrel, up over 20 percent since year-end, a degree of optimism has crept back into the oil community. Although oil-focused E&P company capital spending is projected to decline modestly in 2019 (-9 percent) from spending levels of 2018, current producer cash flows are higher than anticipated when managers planned their budgets during the fourth quarter.

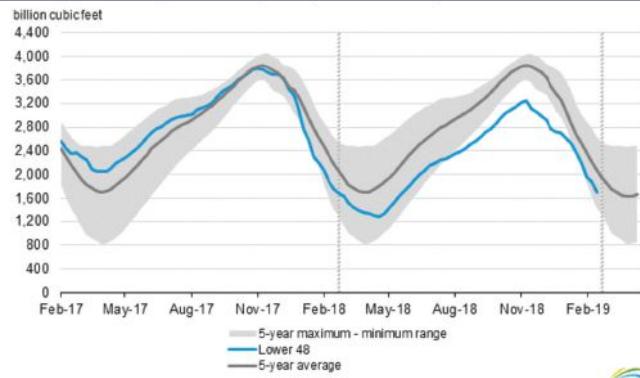
Mid-February is too early to speculate on exactly how much of any additional cash flows may wind up drilling and completing more wells this year, as opposed to being returned to shareholders in the form of

increased dividends and share buybacks. Preliminary indications by E&P companies who have reported 2018 year-end results and 2019 spending and production plans show a modest reduction in spending. But those declines were from budgets approved when the oil price outlook was questionable. A survey of E&P company executives attending the recent NAPE conference in Houston indicated that about 60 percent of them plan to spend all or more than their projected cash flow this year. So much for the fear of "capital discipline" restraining activity. The survey results are welcome news for oilfield service company execs who are fighting for business, which is needed to boost service prices.

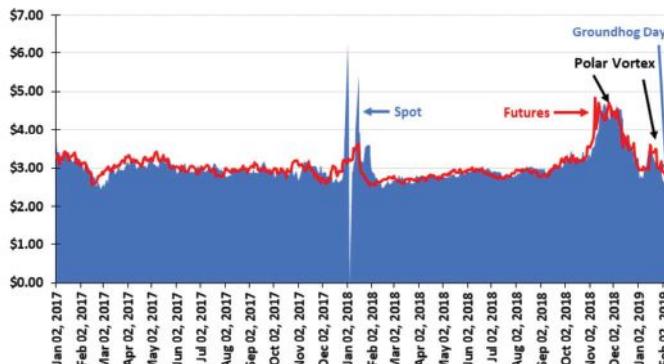
The worrying issue for oil execs is that the current balanced oil market, which has aided the oil price rally, has been achieved primarily by supply cuts rather than rising demand. In fact, world financial organizations have revised their near-term economic outlooks downward, cutting demand and putting pressure on OPEC to renew its supply cut agreement with Russia for another six months following the June expiration. That supply cut has been helped by Canada's mandatory production reduction, along with Venezuela's continuing oil output contraction, and now U.S. economic sanctions. Without these cuts, and their likely extension through year-end 2019, oil prices would not be where they are currently.

For a sign of where crude oil prices may go in the future, watch the negotiations between Saudi Arabia and Russia. What those countries decide about their oil output will move oil prices. In turn, those countries are closely monitoring the health of U.S. oil shale production. Yes, there are lots of moving parts to track, but it is necessary in order to understand oil price trends!

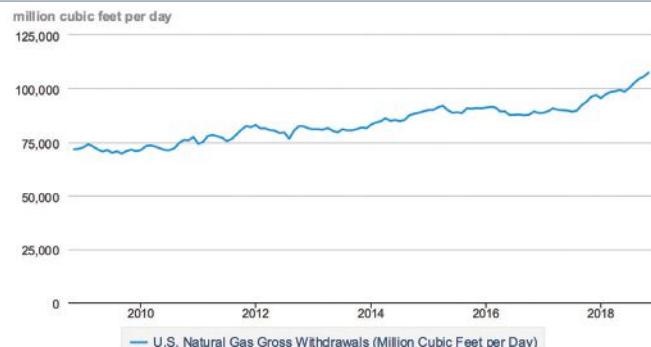
Working Gas in Underground Storage Compared with the 5-year Maximum and Minimum.



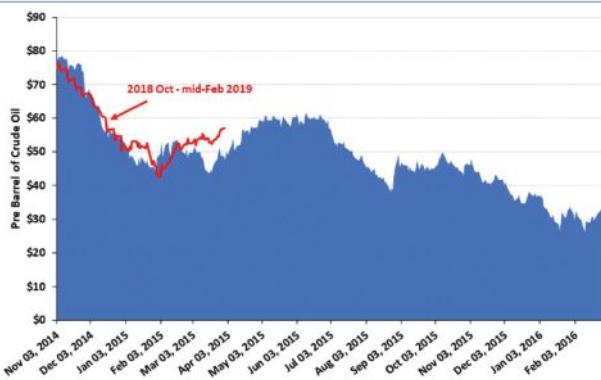
Futures and Spot Gas Prices Predicted Early Spring Groundhog Call



U.S. Natural Gas Production (gross withdrawals)



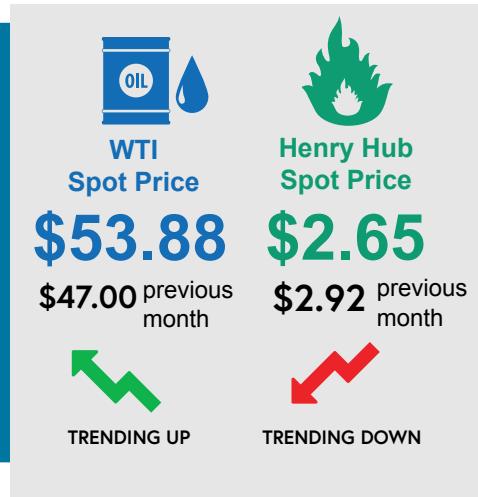
Is 2018-2019 Going to be a Repeat of 2014-2016?



CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF FEBRUARY 18, 2019

Oil prices rebounded in the first weeks of 2019 after dropping from about \$75.00 per barrel in October to a low of about \$45.00 per barrel at the end of December. In the first seven weeks of 2019, however, prices gained steadily to reach nearly \$59.00 per barrel on February 18. The relaxation of trade tensions between the United States and China and ongoing OPEC supply cuts were cited by CNBC as the driver for the price gains.



KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF FEBRUARY 18, 2019

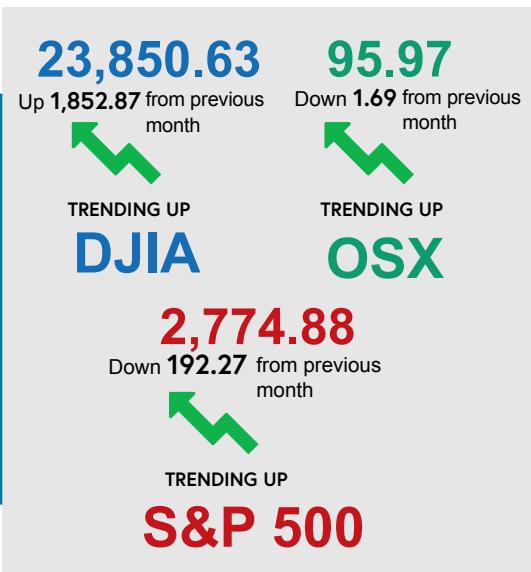
THE DOW JONES INDUSTRIAL AVERAGE AND S&P 500
have fallen significantly in the past month

Equity market, which ended 2018 with high levels of turbulence, have steadily advanced in the first weeks of 2019.

By mid-February, the Dow Jones index had advanced by more than 2,000 points since the end of 2018 to near the 26,000-point mark, making up for some of the losses experienced last fall. The S&P500 saw a similar trend, advancing more than 200 points in the same period. The advances have been widely attributed to a lessening of trade tensions between the United States and China.

PHXL Oil Services Index (OSX) has stabilized after an 11-week stretch last fall when it lost more than half its value and bottomed out at about 77 points in mid-December. Since then, the OSX has risen slowly and neared the 100-point mark in mid-February. The OSX was over 150 points on October 8, 2018.

SELECTED EQUITY INDEXES





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www.2019.otcnet.org/

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US Offshore Wind

Boston, MA » June 10-11
events.newenergyupdate.com/offshore-wind

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<https://interventioneu.offsnetevents.com>

Deepsea Mining Summit

London, UK » April 29-30
www.deepsea-mining-summit.com

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Aberdeen, UK » May 7-8
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Stockholmsmassan, Sweden
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Glasgow, UK » June 9-14
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Napoli, Italy » September 1-6
www.ewtec.org/conferences/ewtec-2019

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Bangkok, Thailand » March 25-27
www.terrapinn.com/conference/telecoms-world-asia/index.stm

Unmanned Systems Asia

Singapore » April 9-11
www.unmannedsystems-asia.com

Underwater Technology

Kaohsiung, Taiwan » April 16-19
ut19.tori.org.tw

ICCOE

Bangkok, Thailand » April 25-28
www.iccoe.org

Offshore Well Intervention Asia Pacific

Kuala Lumpur, Malaysia » May 2-3
interventionasiapac.offsnetevents.com/

MAST

Tokyo, Japan » June 17-19
www.mastconfex.com/asia2019

Submarine Networks World

Singapore » September 17-19
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» Offshore Technology » Maritime Security & Ocean Intelligence	Testing Facilities; Military Tech and Contractors	OTC » May 6-9 UDT » May 13-15
MAY		
» Surface Vehicles » Tracking & Positioning	Transponders / AIS; S/P Power Systems; Dredging	TBD
JUNE		
» Offshore Energy Exploration » Ocean Sound	Sonar Systems and Vessels; Imaging & GIS; Magnetometers	TBD
JULY		
» Unmanned Vehicles Buyers' Guide	ROV, AUV, USV, Glider, Towed Vehicles	TBD
AUGUST		
» Submersibles (AUV, ROV, UUV)	Cranes, Winches, LARS & Control Systems; Sensor, Profilers, Measurement; Thrusters; Umbilical, Tether, Cables, and Connectors	Teledyne Marine Tech » October 6-9
SEPTEMBER		
» Renewables » Offshore Energy Installation & Maintenance	Energy Storage Devices; Inspection Drones; Current Meters	Offshore Energy » October 8-9
OCTOBER		
» Ocean Science & Technology	Acoustic Modems; Acoustic Releases, Transponders, Command & Control Systems; Technical Schools, Training Programs	TBD
NOVEMBER		
» Oil Spill Prevention & Response » Ocean Archaeology & Salvage » Executive Profile	Buoyancy Materials; Pressure/Watertight Housing; Well Control Equipment	TBD
DECEMBER		
» Upper Deck Equipment Guide	LARS, Winches, Cranes, A-Frames, and Buoys	TBD



HAROLD ORLINSKY JOINS CHESAPEAKE TECHNOLOGY AS GENERAL MANAGER

Chesapeake Technology, Inc. (CTI) announces the appointment of Harold Orlinsky as General Manager. Harold brings 25 years of experience in the hydrographic field to lead Chesapeake, as they continue to build on SonarWiz their world class software for sidescan, sub bottom and multibeam applications. Under Harold's direction, CTI will provide additional software solutions to users as expand into new areas. In 2019, Harold will be travelling around the world to meet CTI clients, agents and manufacturers

Harold began his career as a NOAA Corps officer, and afterwards, spent his career in the hydrographic field, most recently as GM of HYPACK. He is active in the hydrographic community, serving as Treasurer for The Hydrographic Society of America, has published articles in trade magazines, and provides training for new students in the field of hydrography and surveying. Harold has an engineering degree from the University of Rochester and completed his MBA at the University of Maryland.

www.chesapeaketech.com



BOEM'S NATIONAL MARINE MINERALS INFORMATION SYSTEM LAUNCHED

The Bureau of Ocean Energy Management (BOEM) has launched the Marine Minerals Information System (MMIS): a state-of-the-art tool to assist decision-makers in managing coastal recovery and planning coastal resilience projects.

The release of the MMIS marks a step forward in BOEM's efforts to build a National Offshore Sand Inventory, providing offshore sediment data including data and information from 30 years of BOEM-funded research and data from more than 40 partner organizations. The information on offshore sand and gravel covers resources throughout the U.S. Atlantic, Gulf of Mexico and Pacific outer continental shelf (OCS). The MMIS is accessible at <https://mmis.doi.gov/BOEMMMIS>.

The goal of the National Offshore Sand Inventory and MMIS is to help to reduce response time in disaster recovery and facilitate long-term planning to strengthen the resilience of coastal communities and infrastructure. Ensuring all parties have access to detailed offshore information is critical to responsible decision-making.

OCS sand and gravel resources are vital sources of material for the construction of coastal protection and restoration projects, including efforts to protect coastal communities, national defense facilities, and federal and state infrastructure. In recent years, there has been a growing demand for OCS sediment for planned projects, as well as for emergency needs to restore areas damaged by natural disasters. On a national scale, little is known about the character, quantity, and location of sand resources on the OCS and the habitat it provides for biological communities.

Proponents of planned infrastructure projects are requesting higher volumes of OCS sediment, driven by diminishing resources in state waters and a high frequency of recent storms along the Atlantic and Gulf of Mexico coasts. Further, given the significant

N-SEA ANNOUNCES MAJOR NORTH SEA CONTRACT WINS

UK and Netherlands-based subsea provider N-Sea has announced that it has been awarded two £multi-million contracts.

Managed and supported by N-Sea's Aberdeen base, the first is a three-year contract, awarded by an international operator. The workscope will take place across a number of the operator's UK North Sea assets and includes air diving inspection, repair and maintenance, in addition to light construction requirements from its diving support vessels and dive daughter craft.



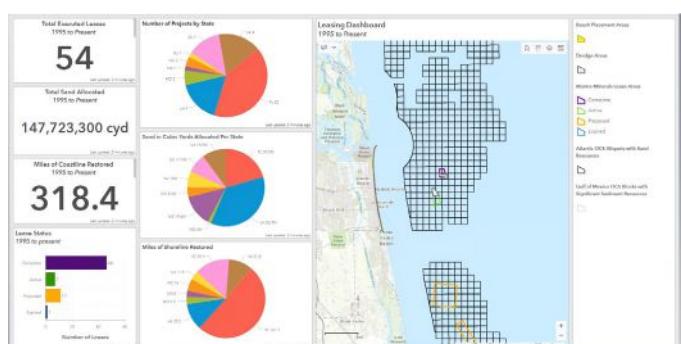
» Roddy James, N-Sea Chief Operating Officer

Additionally, and following an initial framework contract award in 2018, N-Sea will also undertake a two-year project for another North Sea operator, comprising inspection, repair and maintenance on two of its North Sea assets. The project will see N-Sea provide its client with a variety of services similar to the highly successful scopes already provided in 2018.

www.n-sea.com

MMIS MARINE MINERALS INFORMATION SYSTEM LAUNCHED

The Bureau of Ocean Energy Management (BOEM) has launched the Marine Minerals Information System (MMIS): a state-of-the-art tool to assist decision-makers in managing coastal recovery and planning coastal resilience projects. This can make it challenging to identify new potential areas from which to borrow or dredge sediment. As the system continues to grow and mature, BOEM plans to add more features and data sets.



OCEAN CAREERS 2019 LAUNCHES INSPIRING PROGRAM

Ocean Careers held alongside Ocean Business 2019, at the National Oceanography Centre in Southampton from 9-11 April 2019, is providing an opportunity for students to discover job opportunities in the ocean technology sector and get careers advice from key industry professionals at its free Ocean Careers event. Running for the three days of the show, Ocean Careers' program has been launched online at: www.oceanbusiness.com.

This year's Ocean Careers includes 16 workshops hosted by some of the biggest names in the industry, such as Fugro and Teledyne. These presentations will provide information on careers in ocean technology, marine science and the offshore industries, and different study options and routes into careers. As well as this, there will be one-to-one sessions for students offering the chance to explore careers in depth with a choice of 20 industry professionals, all from different career backgrounds.

A special attraction of Ocean Careers 2019 will be the RBR Ocean Science Slam, which is a competition open to early career scientists, with a £500 prize. The competition offers the chance for graduate students to share their research to potential employers in a creative, engaging and non-traditional presentation. The audience will form the jury and vote on the winner. The RBR Ocean Science Slam is intended for graduate students engaged in ocean science and technology and the event will connect early



career scientists with prospective employers, a leading research faculty, and innovative ocean technology companies. Full details of entry criteria are available online at www.oceanbusiness.com in the Ocean Careers section. The closing date for entries is Monday, 25 March 2019.

Visitors will also benefit from the full range of activities at Ocean Business with over 330 exhibitors, as well as free training and demonstration sessions. Social events also enable students to network with potential employers. The event takes place from 9-11 April 2019 at the National Oceanography Centre, Southampton, UK. To attend, register online for free at: www.oceanbusiness.com.

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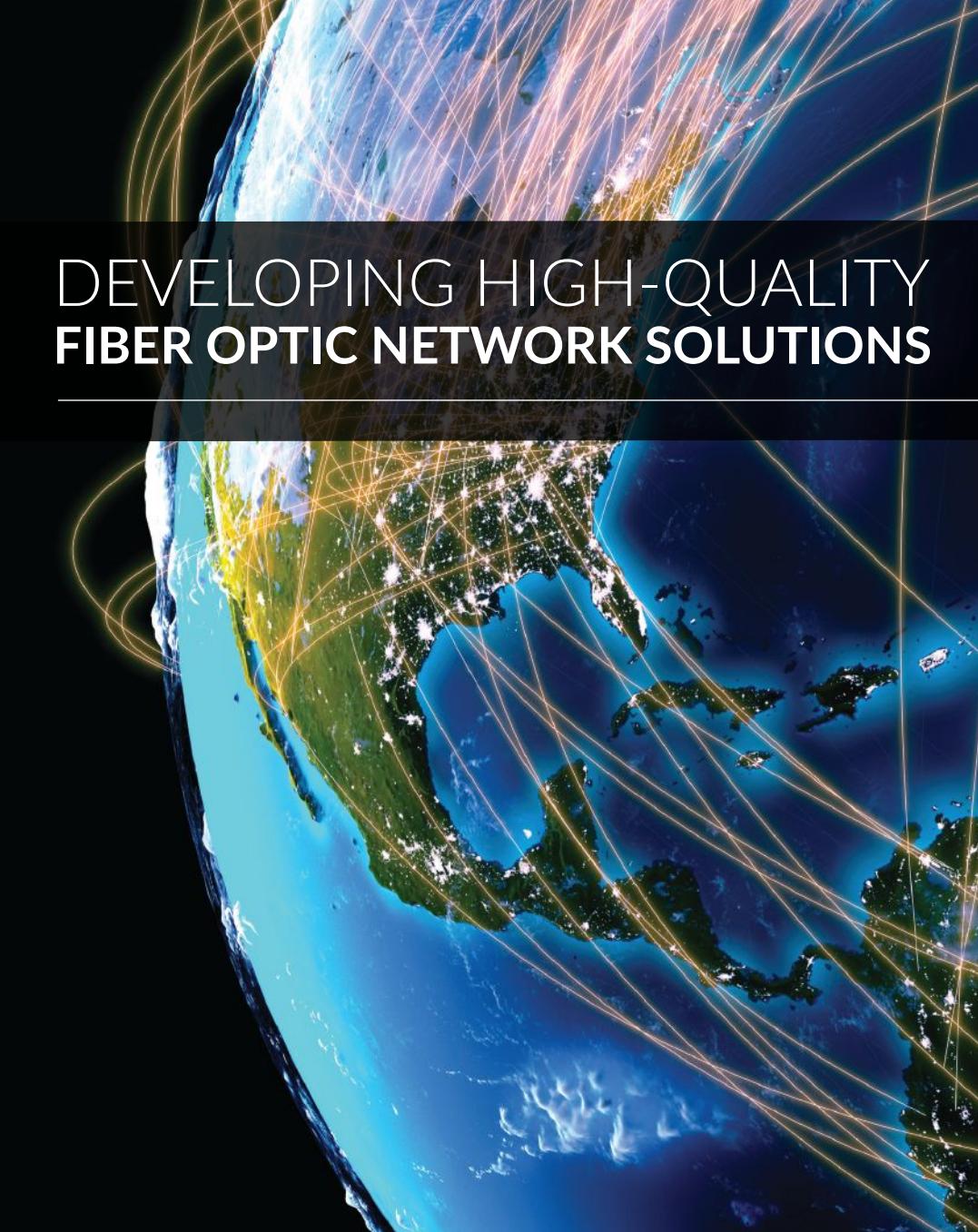
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Manufacturer of fully integrated USBL acoustic tracking systems, both portable and vessel based, high quality multi-system compatible beacons for acoustic positioning and release, and seismic sub-bottom profiling systems for coastal, offshore or geohazard surveys. All products are supported by a network of overseas representatives providing a first class service on a global scale.

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Experts in rugged marine sensor systems utilized in geophysical surveys, anti-submarine warfare, marine mammal monitoring and downhole applications. Products include data acquisition systems, hydrophones, array cables, pressure vessels and peripherals related to marine systems.

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Ocean Sonics designs and manufactures icListen, the world's first smart digital hydrophone. Compact and easy to use, its small size makes it the perfect tool for sound data collection. Listen in real-time and improve decision making, or use as an acoustic recorder for long term deployments. The best data is collected by the best tools. icListens internal processing saves time. Digital sound is streamed live.

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RTSYS designs and manufactures Real-Time Acoustic Systems (Underwater Recorders and Buoys), Sonar Systems (analog sonar retrofit, portable sonars for divers) and Autonomous Underwater Vehicles.

Our Synchronized Multichannel Acquisition Core System (SDA) can handle various Acoustic Transducers and Hydrophones from 3Hz to more than 1MHz and allows a broad range of applications such as noise impact studies, sediment characterization, or cetacean research.

RTSYS products are used all over the world by Navies, Scientific Research Institutes and Offshore Fields Engineers. Flexibility, passion and innovation guide our daily decisions.

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Teledyne RESON together with Teledyne BlueView and Teledyne Odom provides a range of high quality underwater acoustic hardware and software solutions for underwater imaging within Teledyne Marine. These solutions are delivered through recognized brands such as SeaBat, BlueView, Odom, HydroSweep and ParaSound Multibeam Echosounder and Teledyne PDS software suite.

Teledyne Marine is a group of leading-edge subsea technology companies that are part of Teledyne Technologies Incorporated. Through acquisitions and collaboration over the past ten years, Teledyne Marine has evolved into an industry powerhouse, bringing Imaging, Instruments, Interconnect, Seismic, and Vehicle technology together to provide total solutions to our customers.

ADCP/DVL

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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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TELEDYNE
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Teledyne RD Instruments, Inc., located in Poway, CA USA, specializes in the design and manufacture of underwater acoustic Doppler products and oceanographic sensors for a wide array of commercial, academic, and defense applications.

Originally founded in 1982, RD Instruments developed the industry's first Acoustic Doppler Current Profiler (ADCP). Through the years, this innovation has spawned a full line of ADCPs for current profiling in environments ranging from the shallowest stream to the deepest ocean. Expanding on this technology, the company also offers their industry-leading Doppler Velocity Logs (DVLs) for precision underwater navigation onboard manned and unmanned submersibles.

BUOYS

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BUOYANCY PRODUCTS

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Contact: Dan Cote, Sales Manager



DeepWater Buoyancy Inc. is the world's largest producer of subsea buoyancy products for the oceanographic community and has a vast product line of buoyancy solutions for offshore oil & gas, energy and technology companies. This product portfolio has been built over the course of 35 years serving these industries. Though products are offered for shallow water applications, the company specializes in deepwater, providing solutions to depths of 6000 meters and beyond.

NAUTILUS MARINE SERVICE GMBH

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Arctic Rays LLC is a specialist in the design and manufacture of deep sea lighting and imaging products specifically for use on AUVs, but also prove ideal for manned vehicles and all other underwater, surface vehicles or platforms. Our designs feature the smallest possible size and lowest power consumption available.

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Contact: Alberto Lopez Pastor
Cathx Ocean design and manufacture advanced subsea imaging and precision measurement systems for subsea operations.



Designed to meet stringent technical, operational and integration requirements associated with various subsea applications and vehicle types, Cathx Ocean's systems offer precision, reliability and peace of mind. Products include advanced still imaging, colour laser point cloud and video systems, designed to deliver precision subsea data in a way that allows automation for subsea vehicle operations.

The range includes the Hunter system (AUV Imaging and Laser), the Scout system (Observation Class ROV Imaging and Laser Profiling), the Pathfinder system (Work Class ROV Imaging and Laser Profiling) and the Prowler I & II systems (Towed Vehicle Imaging Range and Scale Measurement).

DEEPSEA POWER & LIGHT

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For over 30 years, DeepSea Power & Light has provided high-quality and innovative products to the oceanographic community. The company's expertise and product line has grown to include underwater video systems, lighting solutions, pressure relief valves, and lasers.

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SIDUS Solutions LLC, 'SIDUS' is a worldwide company that designs, manufactures and installs systems in the most extreme of environments. SIDUS products include Cameras, Pan & Tilts, Lights and Lasers for use in hazardous areas and for SUBSEA, serving the, energy, scientific, military, nuclear, and shipping industries. Engineering experience makes us the perfect choice for application specific surveillance systems to provide end to end safety and security. SIDUS provides complete integration, design, documentation, and commissioning for all systems. From sea-floor observation platforms, to surveillance systems on drilling rigs, or sonar deployment systems - SIDUS is a field proven solution.

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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.

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BIRNS has served the subsea industry since 1954, and is an ISO 9001:2015 certified global leader in the design and manufacturing of high performance connectors, cable assemblies and lighting systems. With a NAVSEA PRO-020 certified molding facility, it offers sophisticated connector lines, including 6km-rated electrical, electromechanical, coaxial, electro-coax, optical, electro-optical and electro-opto-mechanical hybrids. 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' LED and tungsten-halogen marine, chamber, security and commercial diving lights are trusted in the world's most extreme environments.

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Birns Aquamate design and manufacture underwater electrical connectors, cable assemblies, and cable terminations. The company produces a wide range of standard industry products such as the 5500 Series, SC, MC, LP, FAWL/FAWM, NANO, TC, Rubber Molded, etc. Birns Aquamate is the only manufacturer to guarantee compatibility with other uw connectors. Birns Aquamate also specializes in fast turn-around for custom design of special connector solutions. All connectors are manufactured under DNV ISO 9001:2000 certification. Dealers in Canada, Brazil, UK, Belgium, Holland, Norway, Germany, South Africa, Holland, Italy, and China.

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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.

DESIGN & ENGINEERING

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 Website: www.hydroleduc.com



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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 Contact: John Benson



The EdgeDVR is currently used worldwide by most of the major ROV and Diving contractors. With our present Version 4 software, we have 6 models. The EdgeDVR has become an essential part of any ROV and Diving system offshore, easy to use and reliable. The system is capable of recording simultaneous High Definition and Standard Definition video, together with auto creation of Dive, Video, Photo and Anomaly logs. Multi channel digital overlay is also available for all recorded channels, logos and real-time survey data can be displayed. With around 500 systems now offshore, we have a proven record of reliability.

Our version 5 software is currently in development and full details will be released soon....

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Okeanus is the premier rental provider for oceanographic and marine scientific research equipment utilized in nearshore and offshore projects around the world. Focused on providing industry-leading customer service, Okeanus offers advanced, high-quality technology coupled with knowledgeable and experienced staff that can deliver dedicated support regardless of a project's location.



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Ocean Specialists, Inc. (OSI) is a system development and advisory firm for undersea cable projects and technology with global 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.

GYRO COMPASSES

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KONGSBERG

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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ATL specializes in the design/manufacture of custom bladder-type fluid containment systems, including tanks, inflatables, pillows and bellows for surface and subsea. ATL's flexible fluid containers boast unparalleled chemical tolerance, abrasion resistance, and remarkable durability - used with methanol, diesel fuel, gases, ethylene glycol, hydraulic fluids and chemical cleaning cocktails. Expedited deliveries are also available.

MARINE ENVIRONMENTAL CONSULTING SERVICES

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CSA Ocean Sciences Inc. (CSA) is a marine environmental consulting firm specializing in multidisciplinary projects concerning potential environmental impacts of activities throughout the world. With extensive experience in environmental sciences and technical field operations, CSA is staffed and equipped to offer a complete range of services for projects in offshore, nearshore, estuarine, wetland, and freshwater environments.

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Marine Ventures International, Inc. (MVI) provides high quality, marine environmental and technical experts to conduct coastal and offshore field operations worldwide. We leverage our wealth of talent and resources to bring you a customized team of independent contractors, subject matter experts and specialized equipment to get the job done. Our professionals work in a variety of sectors from submarine cable projects and engineering services to protected species observation and environmental consulting.

MOTION SENSING EQUIPMENT

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Contact: Finn Otto Sanne at finn.otto.sanne@kongsberg.com



KONGSBERG

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.

NAVIGATION & POSITIONING SYSTEMS

ADVANCED NAVIGATION

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Tel: +61 2 9099 3800
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Website: go.advancednavigation.com/ONT



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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E-mail: sales@evologics.de
Website: www.evologics.de



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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RJE International offers product design, development, evaluation and marketing for military divers, offshore and marine scientific communities, search and rescue teams, and more. RJE has become the industry leader in diver navigation and acoustic relocation. Our team has an extensive background in developing, manufacturing, and supplying underwater acoustic marking and relocation systems, diver navigation platforms, and other subsea equipment.

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- **Consulting:** Field work, data collection, analyses, numerical modelling, acoustics, remote sensing, oceanographic mooring design and system integration.
- **Manufacturer's Representative:** Teledyne RD Instruments, Deep Water Buoyancy, WERA Northern Radar.

NKE INSTRUMENTATION

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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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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.

SONAR SYSTEMS

ECHOLOGGER

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Website: www.echologger.com
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Echologger represents the best quality sonar products in the market. We are a leading developer/manufacturer of high-end ultracompact echosounders and high resolution scanning sonar that are equipped with state-of-the-art features and essential functionalities to match customers' needs in affordable price.

Founded in 2009 and a company located in South Korea, and with a brand name Echologger, EoFE Ultrasonics Ltd. is a knowledge-based company that continuously designs, develops and manufactures high technology sonar devices and solutions to meet the changing needs of the customers. Having been in the industry for years, the company understands how the industry operates and what works best for the benefit of our valued customers.

EDGETECH

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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.

KLEIN MARINE SYSTEMS, INC.

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International: 603 893 6131
E-mail: sales@kleinmarinesystems.com
Website: www.kleinmarinesystems.com



Celebrating over 50 years in the marine technology industry, Klein Marine Systems continues to be a world leading sensor technology manufacturer of high-resolution side scan sonar equipment and radar-based security and surveillance systems. Klein Marine Systems has developed a worldwide reputation of excellence in the industry by providing quality products and excellent customer service. Klein sonar systems are deployed by government agencies, navies, port authorities, surveyors, oil companies and universities worldwide. Visit our web site at www.KleinMarineSystems.com and discover how Klein is Making the Oceans Transparent!

MARINE SONIC TECHNOLOGY

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Toll Free: +1 800 447 4804
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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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SUBSEA FABRICATION

NEW INDUSTRIES

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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.

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KONGSBERG

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 Elume vehicle.

UNMANNED MARITIME VEHICLES

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Contact: Adam Mara



General Dynamics Mission Systems' Bluefin Robotics products provide undersea capabilities for defense, scientific and maritime customers worldwide. Bluefin Robotics products offer a range of systems and configurations that can operate in the open ocean and in constrained waterways. Our core autonomous product line includes Bluefin SandShark, Bluefin-9, Bluefin-12, and Bluefin-21, Hovering Autonomous Underwater Vehicle (HAUV), and Subsea Power technologies.

The Bluefin Robotics AUV family shares a free-flooded, modular, and open architecture backbone that has enabled the integration of 70+ sensors. We have developed and delivered AUVs worldwide to research institutes and industry and have provided AUVs to the United States' and International Navies.

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International Submarine Engineering Ltd. (ISE) is a world leader in the design and integration of autonomous and remotely operated robotic vehicles and terrestrial robotics. Over our 40+ years in business, we have accumulated a great deal of expertise in the design, manufacture, and maintenance of:

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**L3 OCEANSERVER, INC.**

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Teledyne Oceanscience manufactures unmanned deployment platforms for echosounders and environmental monitoring instrumentation. Our major products are remotely-controlled Q-Boats and tethered instrumentation deployment Riverboats for echosounders and ADCPs, remotely-controlled Z-Boats for hydrographic surveys in shallow or hard to access areas, the Underway CTD that provide affordable and compact profiling from a moving vessel, and the popular Sea Spider and Barnacle seafloor platforms.

TELEDYNE SEABOTIX

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Contact: Jamie Carrig



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.

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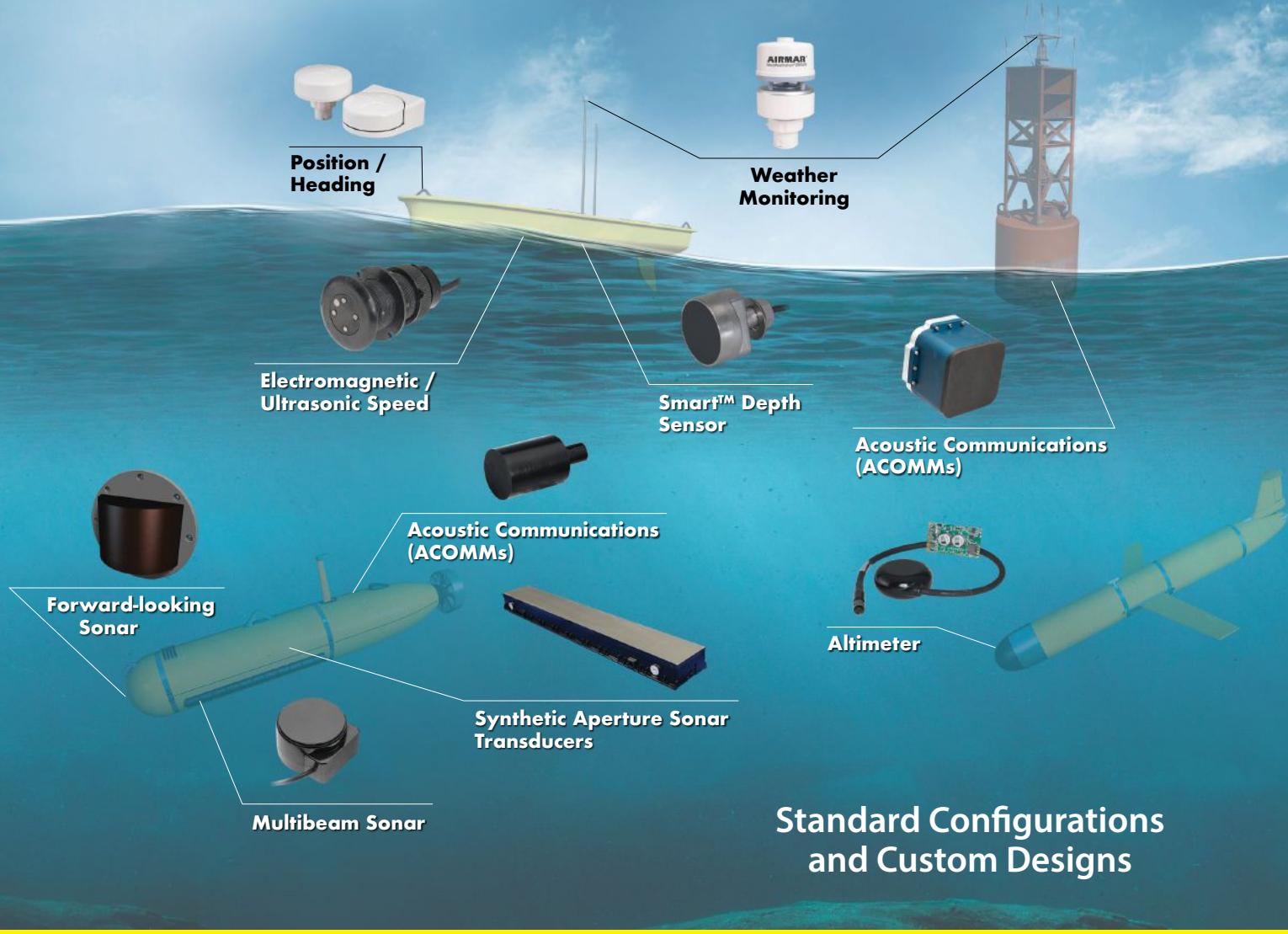
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