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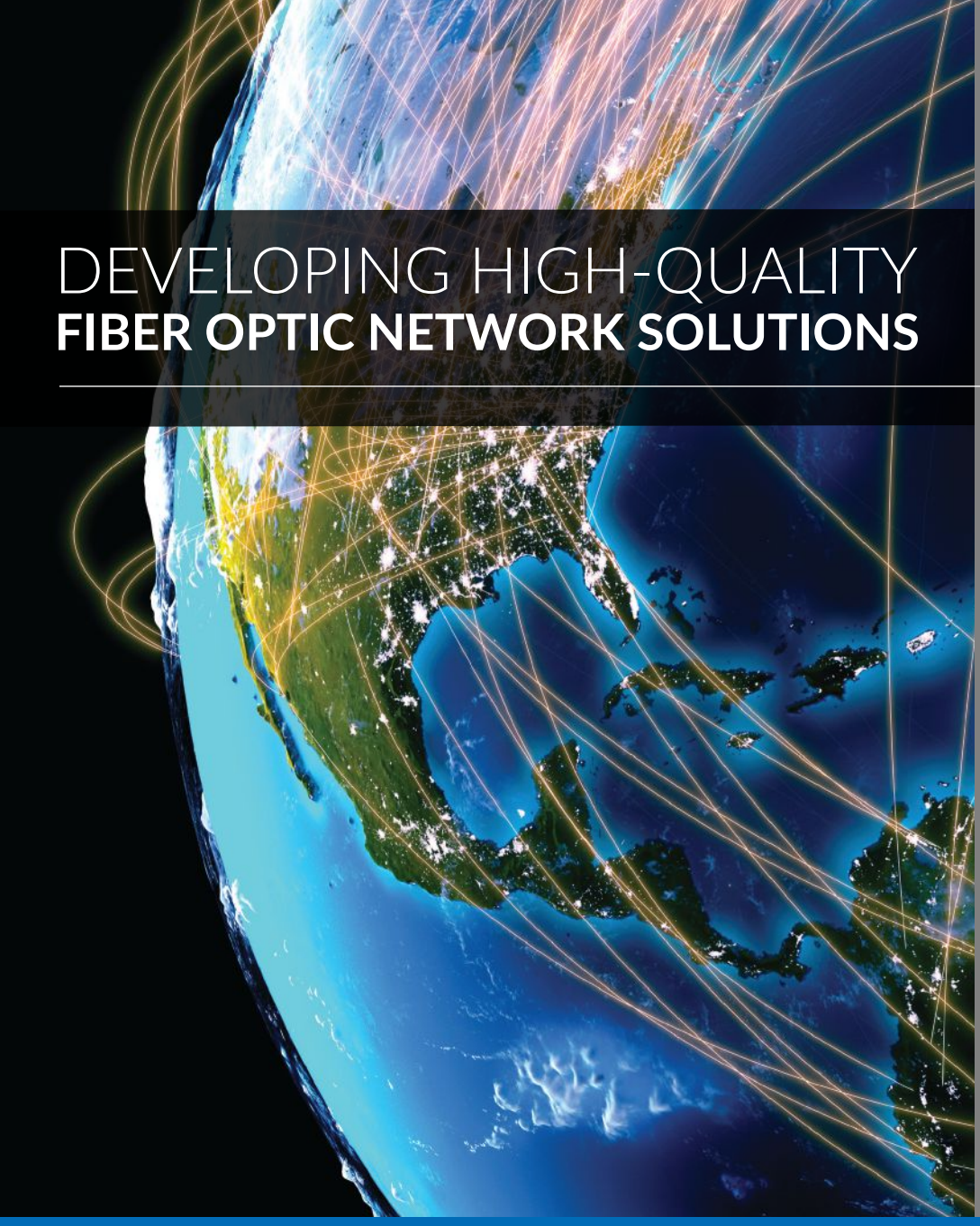

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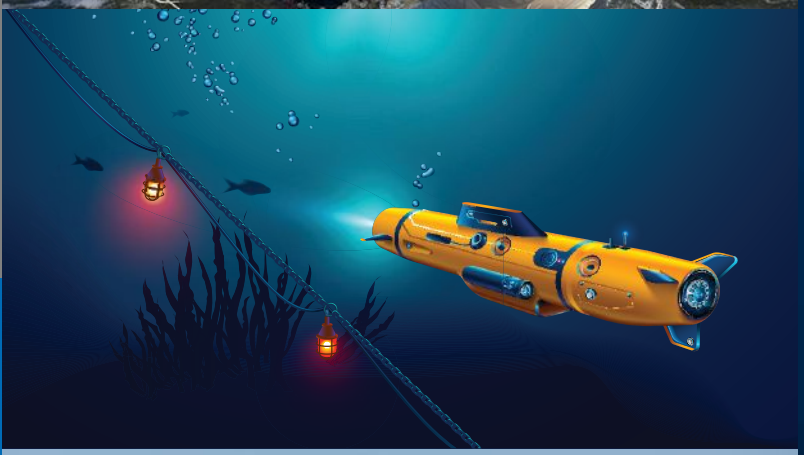

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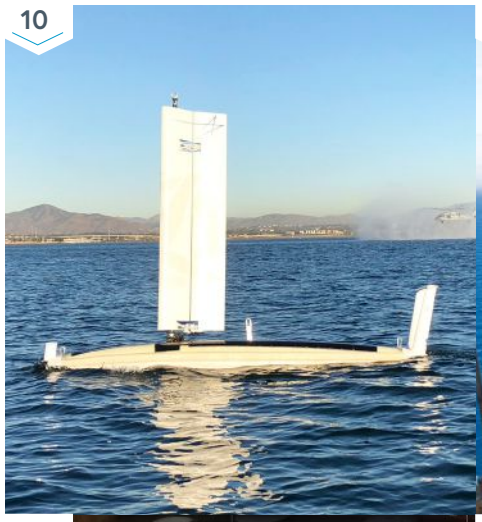

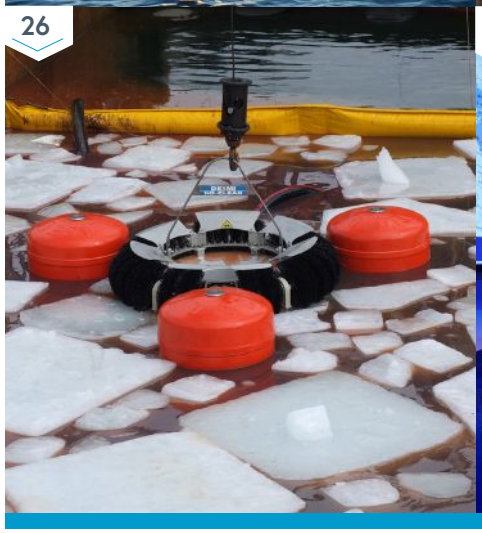

FEATURES

DEPARTMENTS

IN EVERY ISSUE

ON THE COVER:
USCG Air Station Cape Cod helicopter crew works with USCG Cutter Seneca crew to conduct hoists during Operation Orange Flag in Rhode Island Sound (April 2015). Photo credit: Petty Officer 3rd Class Jimmy Clay, USCG.

A NEW TELEDYNE
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OVERCOMING THE CHALLENGES OF BRINGING OFFSHORE WIND TO THE U.S.

BY MATTHEW PALMER

Since 2001, Europe has installed over 16,000 megawatts (MW) of offshore wind, enough power to supply approximately 8 million homes with clean, renewable energy. In that same time, the U.S. has installed 30 MW. While that is a great start, what challenges cause the U.S. to be so far behind?

The key challenge in the U.S. is to balance the local supply chain and the jobs that will create with the need to provide customers with affordable electricity. On the local supply chain side, one of the associated challenges is the fabrication and installation of foundations. The most cost-effective offshore wind turbine foundations for the East Coast are monopiles—large tubes driven into the ocean floor weighing more than 1,000 tons.

Because of their diameter and thickness, few facilities can manufacture these monopiles. The only facilities with that capacity are in Europe, and it would require investment exceeding $100 million to build one in the U.S.

The same problems exist with the manufacture of wind turbine components, vessels with the capacity to install these components, and ports to receive and store components prior to installation. The U.S. workforce will need to be trained to staff these facilities.

These problems can be solved with investment. The cost of the investment will need to be recovered, of course, and that creates the tension between local job creation and the cost of electricity to consumers.

Fortunately, technology advancement is creating the overall solution. The offshore turbines are getting significantly larger very quickly. In 2015, Cape Wind was using a state-of-the-art 3.6MW turbine. Now, Vineyard Wind will use an 9.5MW turbine, and GE is developing a 12MW unit to be available in 2021. That is a three-times increase in six years. The resulting decrease in cost has made offshore wind potentially competitive with fossil fuel-generated electricity.

Improvements in battery storage technology will allow integration of these intermittent renewable resources into our electric grid and still maintain reliability. The power of offshore wind will allow us to transform the way we generate electricity to the tremendous benefit of our planet and future generations.

Matthew Palmer is Vice President, Offshore Wind Manager, at WSP USA, a leading engineering and professional services consultancy. The firm is partnering with Wood Thilsted, a specialist structural and geotechnical engineering consultancy with extensive experience in wind turbine monopile design, to offer a full suite of technical, project management and regulatory support services to the Vineyard Wind project. In February 2019, he was elected to the Board of Directors of the Business Network for Offshore Wind.

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MISSION **POSSIBLE**

OCEAN AERO & LOCKHEED MARTIN TACKLE SOME OF THE TOUGHEST TASKS ON AND IN THE OCEANS

By Duane Baker, Lockheed Martin,
Business Development Analyst Principal

Transformers aren't just in the movies anymore. San Diego-based company Ocean Aero has developed an autonomous ocean-going unmanned vehicle that can morph from a surface-sailing vehicle that relies on a futuristic wing-foil sail for propulsion—into a self-navigating submersible powered by thrusters energized by a battery charged with solar energy.

Ocean Aero's complex engineering effort created a new class of vehicle—the autonomous underwater and surface vehicle (AUSV). Until Ocean Aero's breakthrough technology, there were just two distinct classes of autonomous marine vehicles—autonomous unmanned surface vehicles (USV/ASV) and autonomous underwater vehicles (UUV/AUV). Missions previously reserved for only a USV or UUV are now accomplished with a single vehicle: Ocean Aero's Generation III AUSV. Ocean Aero has developed a true hybrid that enables operation in either environment. Ocean Aero's AUSVs enable challenging cross-domain missions.

LOCKHEED MARTIN

» *Ocean Aero manufactures its AUSVs in a state-of-the-art facility with capabilities that enable the company to complete all custom hull and deck fabrication, electronics assembly, mechanical engineering, and software development. Photo courtesy of Ocean Aero.*

» *The vehicles can morph from a surface-sailing vehicle that relies on a futuristic wing-foil sail for propulsion—into a self-navigating submersible powered by thrusters energized by a battery charged with solar energy. Photo courtesy of Ocean Aero.*

In 2017, Lockheed Martin made a strategic investment that funded the development of three Ocean Aero AUSV models: Navigator, Discovery, and Scout. All models are now third generation, Technical Readiness Level (TRL) 7, designs that have unique capabilities that enable the sensor platforms to operate both surfaced and submerged.

Navigator will dive to a depth of 200 meters and navigate using autonomous operation mission criteria for up to four days before returning to the surface to recharge batteries using the solar paneled deck.

Discovery dives to 100 meters and remains submerged for up to three days while drifting in ocean currents before returning to the surface to recharge batteries using the solar paneled deck.

Scout primarily operates on the surface but is also capable of folding the wing-foil sail and submerging to "decks-awash" to avoid detection and rough weather conditions.

Imagine Scout in a role to gather meteorological and hydrographic information. Discovery and Navigator might serve in these and varying security missions.

Ocean Aero manufactures its AUSVs in a state-of-the-art facility that has capabilities that enable the company to complete all custom hull and deck fabrication, electronics assembly, mechanical engineering, and software development. Ocean Aero has also built a specialized component testing space that has been designed to better-than-industry standards. Once a vehicle is complete, Lockheed Martin is positioned to acquire and integrate sensors beyond those integral to the vehicle to meet security customers' needs and budget.

The U.S. Navy is making a strong push to exploit unmanned maritime vehicles and autonomous capabilities. Similar interests are being undertaken by the U.S. Department of Homeland Security, via the U.S. Coast Guard and U.S. Customs & Border Patrol. Ocean Aero is poised to play a big role in their efforts. Lockheed Martin and Ocean Aero have already teamed on exercises with the U.S. Navy, demonstrating the integration of autonomous underwater, surface, and aerial vehicles using cross-domain communications, and command and control via underwater acoustic and above-surface radio links. Ocean Aero vehicles have been equipped with an acoustic multi-beam sonar to collect high-definition imagery of the seabed.

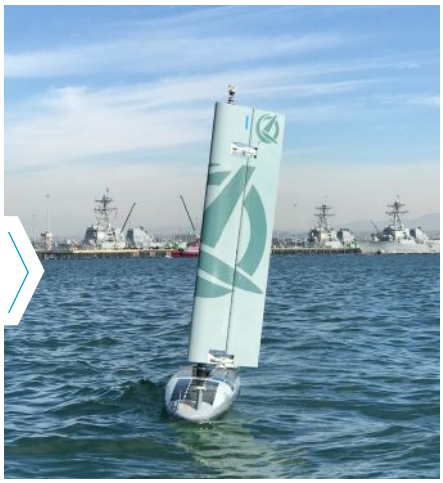
Ocean Aero's AUSVs are potentially a key component of a "system of systems," performing a diverse assortment of potential missions, including those that require a covert platform. These missions include: 1) Persistent Intelligence, Surveillance, and Reconnaissance (ISR); 2) Cross domain communications gateway; 3) Critical infrastructure

monitoring; 4) Special Operations support; 5) Payload delivery; 6) Ocean observation; and 7) Law Enforcement/Transnational Organized Crime prevention.

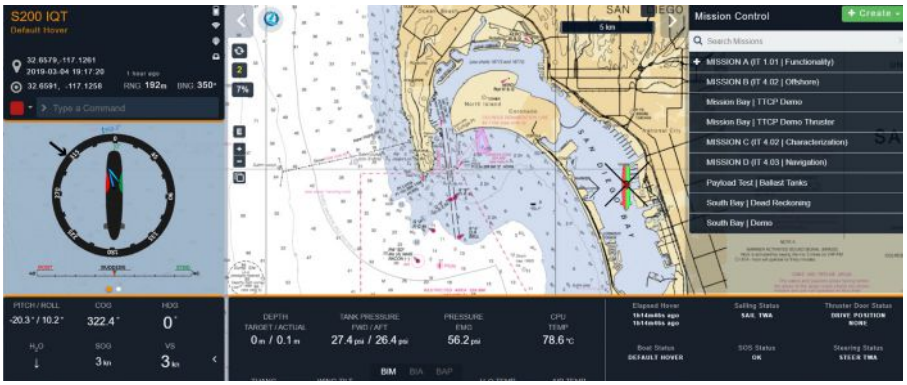
Scout, Discovery, and Navigator all use a multi-platform-compatible operating system that works seamlessly with other command and control systems. Users can monitor all vital functions of an Ocean Aero AUSV through a dynamic interface that provides information in real time. Pre-programmed missions, using GPS waypoints, are easily inserted into the interface and enable the vehicle to function with complete autonomy.

Relying on a wind and solar-powered, hybrid design that includes wing sail and lithium-ion batteries charged from solar panels, Ocean Aero AUSVs are ideally suited for autonomous missions that require speed, stealth, endurance, and persistence under demanding ocean conditions. A launch and recovery system (LARS) can have Ocean Aero's vehicles in and out of the water in a matter of minutes from a ramp, dockside, or from a ship with nothing more than a davit.

The ability to submerge enables Navigator, Discovery, and Scout to ride out extreme weather conditions, avoid collision, and reduce counter-detection. Whether submerging to decks awash, 100 meters, or 200 meters, these vehicles with their wing-sail lowered become virtually invisible. Making no noise, surfaced, or submerged, the vehicles cannot be found with existing search systems. With increasing demand for autonomous marine vehicle capabilities, Ocean Aero's AUSVs provide a persistent, cost-effective solution and increased operational efficiency to current maritime efforts. When equipped with Lockheed Martin provided and integrated sensors, the system can be employed in a wide variety of settings for a wide variety of missions.



» *Lockheed Martin and Ocean Aero have already teamed on exercises with the U.S. Navy, demonstrating the integration of autonomous underwater, surface, and aerial vehicles using cross-domain communications, and command and control via underwater acoustic and above-surface radio links. Photo courtesy of Ocean Aero.*

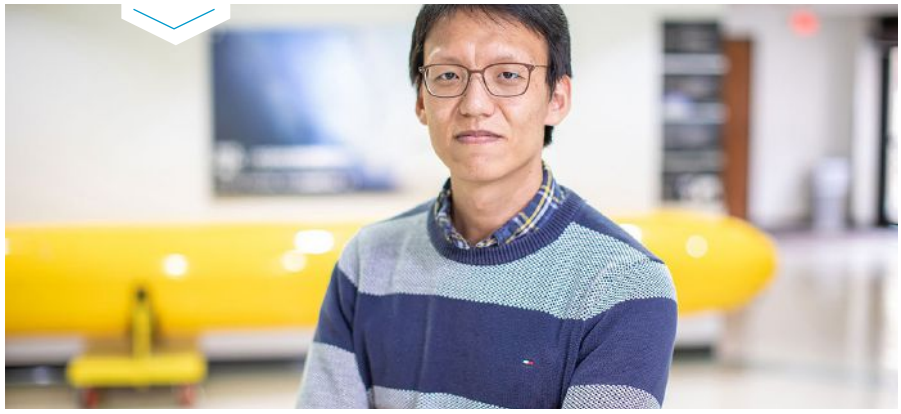


» *Scout, Discovery, and Navigator all use a multi-platform-compatible operating system that works seamlessly with other command and control systems. Photo courtesy of Ocean Aero.*

» *Navigator descending to 200m. The ability to submerge enables Navigator, Discovery, and Scout to ride out extreme weather conditions, avoid collision, and reduce counter-detection. Photo courtesy of Ocean Aero.*

» *A launch and recovery system (LARS) can have the vehicles in and out of the water in a matter of minutes from a ramp, dockside, or from a ship with nothing more than a davit. Photo courtesy of Ocean Aero.*

COULD HARNESSING OCEAN WAVES PROVIDE ACCESS TO CLEAN ENERGY



» *Kang stands in the Haynes Engineering Building lobby, home to the Department of Ocean Engineering. Photo credit: Texas A&M Engineering.*

The quest for clean energy sources has been ongoing for many years, with minimal results. This could all change with the development of a single device that will lie on the water's surface and utilize the ocean waves to generate electrical power.

HeonYong Kang, a research assistant professor in the Department of Ocean Engineering, first began working on this idea in 2015 as the result of the U.S. Department of Energy's (DOE) Wave Energy Prize Competition.

Kang's project is the development of a surface riding wave energy converter (SR-WEC). While the initial applications will be a stepping stone to eventually utilizing the renewable and clean ocean energy in the commercial sector, the SR-WEC will be further developed to be a competitive power supply for the large-scale grid connected system. The first goal is to supply maritime markets, then supply the large-scale connected system.

"In this project, we develop and test the SR-WEC in a form of scaled prototype, which can eventually supply electricity to various maritime markets at a competitive cost," said Kang, lead principal investigator on the project. "The maritime markets to benefit from this technology include ocean observation and navigation, underwater vehicle charging, desalination, marine aquaculture, marine algal biofuels, seawater mining, offshore data center, disaster resiliency and recovery, and isolated power systems."

Kang and his team of interdisciplinary researchers will be faced with some limitations regarding the development of the scaled prototype of the SR-WEC due to being in the early stages of developing the technology required for wave energy conversion into electrical power.

"There are multiple aspects we need to make efforts along the technical development," Kang said. "It spans from fabricating the scaled prototype out of limited suppliers and building connections in the industry, to educating the public of the SR-WEC and its potential impact on society."

The most challenging aspect of the project has been to develop the preliminary system with minimal support. The DOE identified $23 million for projects in next-generation marine energy devices and selected 12 research projects, including Kang's project. The grant will help to further develop and test the prototype and prepare it for open-sea testing by the end of the project in 2022.

"I am most excited to unlock the renewable ocean wave energy and eventually resolve energy challenges in the various maritime markets," Kang said.

Learn more about Texas A&M Engineering at ***https://engineering.tamu.edu***.

PROVEN SURFACE AUTONOMY AND SUBSEA SENSOR TECHNOLOGY COMBINED

L3 Technologies announces that together with Sonardyne International Ltd. it will offer 6G-enabled capability across its commercial autonomous vessel product range.

L3's C-Stat 2 and C-Cat 3 autonomous vessels will be offered factory-fitted with Sonardyne's 6G range of Ranger 2 Ultra-Short BaseLine (USBL) tracking and communications systems. These unique platforms and sensor combinations have been proven to deliver optimised solutions for data gathering and subsea positioning tasks during inshore and offshore operational scenarios.

The C-Stat 2, equipped with Sonardyne's Ranger 2 Gyro USBL model, is designed for operators needing to position underwater assets with high levels of precision. The platform will enable a range of tasks, such as touchdown monitoring, seismic cable lay operations, Compatt 6 Long BaseLine (LBL) array box-in and remote LBL baseline calibration, vehicle tracking and subsea sensor data collecting.

The C-Cat 3, equipped with Mini-Ranger 2, will be able to operate as a gateway for Autonomous Underwater Vehicle (AUV) operations, enabling tracking and communications with up to 10 AUVs at the same time.

"Combining our unrivalled autonomous vessel technology with Sonardyne's industry-standard communication and positioning systems will enable us to provide end users with a fully integrated solution," said James Cowles, Commercial Technical Sales Manager, L3 UK.

WWW.L3T.COM/BUSINESS-SEGMENTS/COMMUNICATIONS-NETWORKED-SYSTEMS

» *L3 Technologies C-Cat*

ROBOTS MAY REVOLUTIONIZE MARINE ENVIRONMENTAL MONITORING

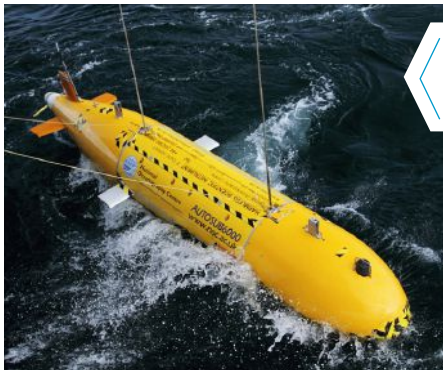
Scientists at the NOC have released a forward-looking review of how marine robotic capabilities can support the environmental monitoring needed for decommissioning oil and gas installations.

This review shows how already-existing sensors and autonomous platforms could be used to assess all the types of marine environment encountered during decommissioning monitoring. The approach was tested and refined in consultation with representatives from industry, environmental managers and regulators.

Decommissioning of oil and gas installations is big business, with the estimated costs exceeding 50 billion pounds in the UK alone. It also has the potential to impact the marine environment. To try to safeguard against these impacts it is important that regular monitoring is carried out to check for potential pollutants and their effects to marine life. This assessment represents a major challenge, with over 400 decommissioning programs in the British part of North Sea alone. The potential costs of this are large, which will likely limit the regularity of monitoring, running the risk of missing impacts to the marine environment when there is still time to deal with them.

Autonomous systems are already making step-changes in the way that marine survey and scientific investigations are being done, allowing high-resolution information on large areas of the marine environment to be collected much more quickly and frequently than before. The costs of these systems are decreasing all the time.

NOC scientist, Dr. Daniel Jones, the lead author of this review said "Industry and the government regulators are taking note of these new technologies. Expert syntheses, such as this, will be helpful in developing a more cost-effective but still rigorous approach for the future."



» *Autosub launch. Photo credit: NOC*

The review was the key output from the "advanced monitoring of marine infrastructure for decommissioning" project funded by the UK Natural Environment Research Council (NERC).

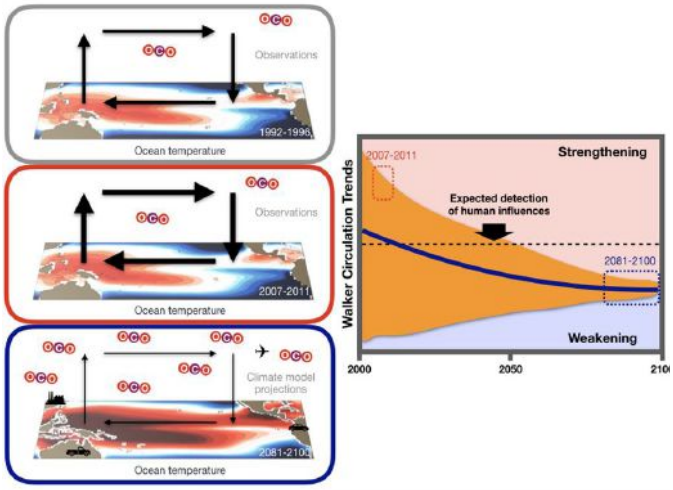
WWW.NOC.AC.UK

STUDY: HUMANS ARE NOT INFLUENCING PACIFIC EQUATORIAL WINDS

A new study published in the journal Nature Climate Change shows that the recent intensification of the equatorial Pacific wind system, known as Walker Circulation, is unrelated to human influences and can be explained by natural processes. This result ends a long-standing debate on the drivers of an unprecedented atmospheric trend, which contributed to a three-fold acceleration of sea-level rise in the western tropical Pacific, as well as to the global warming hiatus.

Driven by the east-west sea surface temperature difference across the equatorial Pacific, the Walker circulation is one of the key features of the global atmospheric circulation. It is characterized by ascending motion over the Western Pacific and descending motion in the eastern equatorial Pacific.

At the surface, trade winds blow from east to west, causing upwelling of cold water along the equator. From the early 1990s to about 2013, this circulation has intensified dramatically, cooling the eastern equatorial Pacific and triggering shifts in global winds and rainfall (see Figure 1). These conditions further contributed to drying in California, exacerbating mega-drought conditions and impacting agriculture, water resources and wild



» *(Left) Schematic of Pacific Walker circulation changes due to natural processes and human-induced climate change: Normal conditions (top), strengthening due to natural variability (middle) and weakening due to greenhouse warming (bottom). Black arrows represent horizontal and vertical winds with the shading on the background map illustrating ocean temperatures. Over the past few decades, natural variability has strengthened the Pacific Walker circulation leading to enhanced cooling in the equatorial central-to-eastern Pacific (middle). Climate models forced by increasing greenhouse gas concentrations simulate weakening of the Walker circulation (bottom). (Right) Temporal evolution of model-simulated Walker circulation trends, with the dark blue line and orange shading denoting anthropogenically-induced changes and the impact of natural processes, respectively.*

fires. Given these widespread impacts on ecosystems and society, the recent Walker circulation trends have become subject of intense research.

In contrast to the observed strengthening, the majority of climate computer models simulates a gradual weakening of the Walker Circulation when forced by increasing greenhouse gas concentrations (see Figure 1).

"The discrepancy between climate model projections and observed trends has led to speculations about the fidelity of the current generation of climate models and their representation of tropical climate processes," said Eui-Seok Chung, researcher from the Center for Climate Physics, Institute for Basic Science, South Korea, and lead-author of the study.

To determine whether the observed changes in the tropical atmospheric circulation are due to natural climate processes or caused by human-induced climate change, scientists from South Korea, the United States and Germany came together to conduct one of the most comprehensive big-data analyses of recent atmospheric trends to date.

"Using satellite data, improved surface observations and a large ensemble of climate model simulations, our results demonstrate that natural variability, rather than anthropogenic effects, were responsible for the recent strengthening of the Walker circulation," said Prof. Axel Timmermann, Director of the IBS Center for Climate Physics at Pusan National University and co-author of this study.

Reference:
Eui-Seok Chung, Axel Timmermann, Brian J. Soden, Kyung-Ja Ha, Lei Shi, Viju O. John. Reconciling opposing Walker circulation trends in observations and model projections. Nature Climate Change. DOI: 10.1038/s41558-019-0446-4.

PROPELLER TECHNOLOGY REDUCES UNDERWATER RADIATED NOISE

A revolutionary new technology capable of reducing the underwater radiated noise (URN) generated by ships' propeller cavitation has been developed by Strathclyde University and Oscar Propulsion, a UK-based innovation and technology transfer company.

The patented Oscar PressurePores™ system reduces propeller tip vortex cavitation by applying a small number of strategically bored holes in the propeller blades. The addition of these pressure-relieving holes now allows ships to operate with a more silent propeller with a minimum of compromise on its efficiency or having to slow steam. Reducing cavitation also reduces its associated erosive effect.

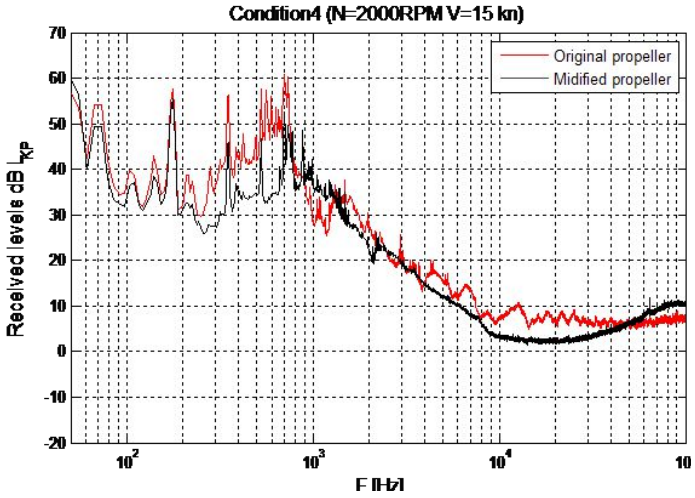
David Taylor, CEO, Oscar Propulsion, said, "Introducing holes in propeller blades to reduce root cavitation, for example, is not in itself new, but achieving high levels of noise reduction by strategically placing relatively few holes, while maintaining efficiency, is new."

During the development of this technology at Strathclyde using comprehensive computational fluid dynamics (CFD) modelling and cavitation tunnel tests, it was demonstrated that the PressurePores system can reduce cavitation volume by almost 14% and underwater radiated noise (URN) by up to 21dB.

The results were further verified in separate tests on the sub-cavitating propellers used by the Princess Royal, a 19m research catamaran operated by Newcastle University. The original, unmodified model propeller was tested and used as a reference. Then CFD analysis and model tests were carried out on two propellers of the same design, one with 33 strategically-introduced holes in each blade, another with 17 holes.

The outcome showed that PressurePores technology substantially reduced tip vortex cavitation and URN. "Remarkably, it was found that the optimum number of holes could be as few as 17 per blade tip so long as they were placed in the most effective positions," said Taylor.

"It's not a case of simply drilling holes into the blades, as this will affect the propeller's thrust capability. CFD modelling at Strathclyde allows us to know exactly where to place the holes for maximum efficiency and optimum noise reduction." Taylor added.



» *Propeller noise reduction achieved with PressurePores.*

Oscar Propulsion is now looking to partner with shipping companies and propeller designers or manufacturers to commercialize the PressurePores concept and to help the shipping industry operate in an environmentally safer way.

WWW.OSCARPROPULSION.CO.UK

| FEATURE |

A LIFE SAVING TECHNOLOGY:

HOW METOCEAN TELEMATICS SATELLITE-ENABLED BUOY ASSISTS THE WORLD'S COAST GUARDS IN SEARCH AND RESCUE OPERATIONS

By Greg Leatherman, ON&T Editor

The average person does not think about the daunting challenge of Search and Rescue (SAR) at sea unless we, or someone we know, need it. However, for the coast guards responsible for saving lives and protecting assets, preparing for such scenarios is critical.

In fact, SAR is the primary mission of the world's coast guards. When you are leaders in SAR response, nothing you do happens by accident, which is why the world's coast guards put thoroughly vetted policies, procedures, and plans in place. They also undergo intense training, maintain robust facilities, and utilize advanced life-saving technology.

You may already know that coast guard SAR response involves multi-mission stations, cutters, aircraft, and boats linked by communications networks. What you may not know, however, is the crucial role of a device called the Iridium Self Locating Datum Marker Buoy (iSLDMB).

According to their own numbers, the U.S. Coast Guard (USCG) conducts 20,000 search and rescue cases a year, with 4,000 lives saved, on average. USCG policy mandates the use of SLDMBs during all significant SAR case operations. Consequently, they maintain a large inventory of iSLDMBs, ready for deployment. They are not alone. The Canadian Coast Guard, the Australian Maritime Safety Authority, and many others around the globe also utilize this cutting edge SAR tool.

MetOcean Telematics First Generation SLDMB

The Self Locating Datum Marker Buoy (SLDMB) is a drifting, search and rescue surface buoy designed to meet the stringent performance requirements of SAR operations in the open ocean. MetOcean Telematics developed the first-generation SLDMB more than two decades ago, and their product remains the top choice for SAR organizations.

The design is based on the Coastal Ocean Dynamics Experiment (CODE) and Davis-style oceanographic Surface drifters. However, there is one key difference. The SLDMB is designed for deployment by USCG vessels; equipped with a Global Positioning Satellite (GPS) sensor that, upon deployment transmits its data set continuously to the USCG.

The SLDMB achieves this by communicating its GPS position, via satellite, to a Rescue Coordination Centre. By ingesting the SLDMBs data set into SAR software, the predictive models become refined and highly accurate. This combination of measurement, tracking, and real-time communication means that SLDMBs can help minimize loss of life, injury, and property loss.

Iridium the only Truly Global Satellite Network

The original SLDMBs relied on the ARGOS satellite system for data telemetry, resulting in long and variable latencies in message arrival. This limitation was addressed with the introduction of the iSLDMB, which uses Iridium satellite communications.

The Iridium satellite constellation is the only communications network with pole-to-pole coverage over the entire planet. It is comprised of 66 satellites in the operational constellation, creating a web of coverage around the Earth. This reliability and truly global coverage are essential for SAR operations.

The iSLDMB: Powered by the Iridium Global Satellite Network

MetOcean Telematics Iridium equipped iSLDMB is a patented design, which features a universally recognized NATO A-sized sonobuoy form factor. It is the most advanced version of this critical SAR tool and the next evolutionary step for the technology. That data includes GPS positioning, sea surface temperature (SST) to assist in understanding the probability of survival.

iSLDMBs are deployed via aircraft or ship to mark critical points of interest. As they drift away from the originating location of the incident, the iSLDMB provides real-time information to the Coast Guard/Navy.

"All major coast guards around the world have adopted the iSLDMB as the preferred drifter for search and rescue response," says Clifton Flint, Business Development Manager at MetOcean Telematics.

They have adopted it because it is a proven technology. When lives are on the line and time is of the essence, coast guards trust MetOcean Telematics Search & Rescue products.

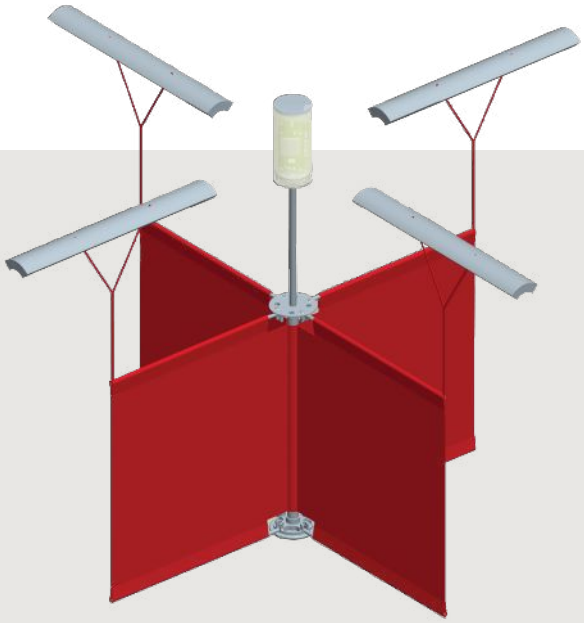
Wider Applications

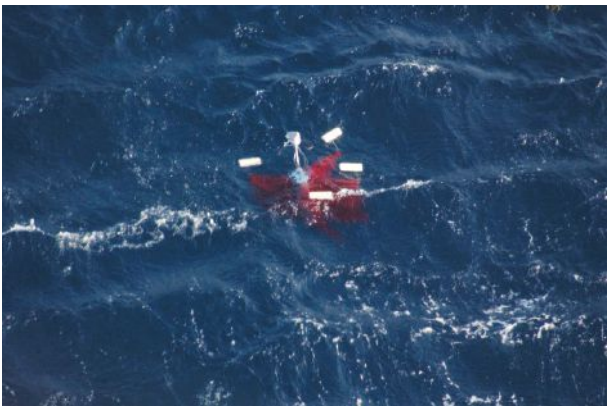
This technology is not only applicable during SAR emergencies, but it can be used for refining and calibrating predictive current models, tracking the flow of hazardous materials, and various maritime domain awareness applications. For example, in 2008, the USCG Research and Development Center (R&DC) and the Canadian Coast Guard (CCG) used multiple satellite enabled SLDMBs in studies of various drift targets such as life rafts, evacuation vessels, sailboats, and others. The leeway coefficients computed generated from these studies were then used in SAR planning software to define potential search areas during SAR operations. A more recent project utilized multiple iSLDMBs to assess the impact of currents, waves and wind in modelling surface drifters and oil spills.

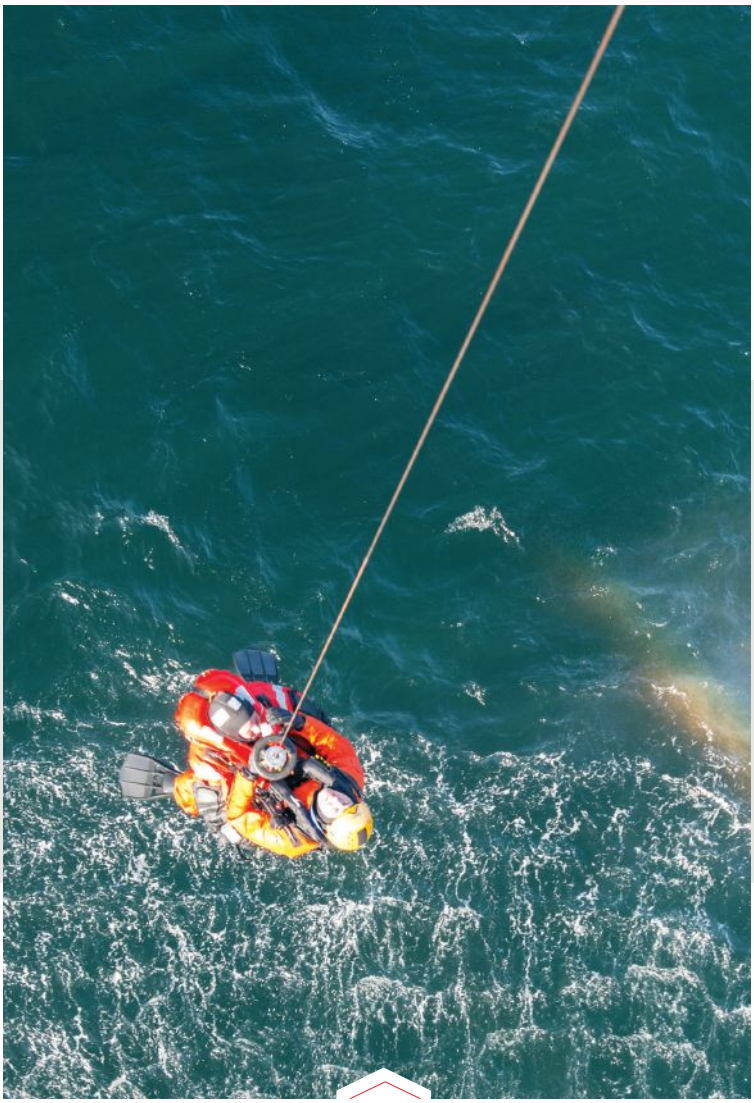
Semper Paratus – Always Ready

For the vast majority of coast guard personel, the SAR mission was what inspired them to serve. Luckily, we've come a long way in determining the exact location of a distressed mariner. The expanded use of advanced technology, such as the MetOcean Telematics iSLDMB, contributes to greater numbers of lives being saved in emergency situations. MetOcean Telematics takes this responsibility seriously and remains committed to advancing the state of technology in support of the primary mission of the world's coast guards.

To learn more, visit
www.metocean.com







» *A Baltic Sea "victim" winched on the Danish Search and Rescue helicopter Merlin during NATO's 2015 Dynamic Mercy SAR exercise designed to test collaboration procedures with neighboring countries (NATO and non-NATO) and to test the means of communication between Rescue Coordination Centers. Photo credit. W.O. C. Artigues, NATO HQ MARCOM.*

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[iii] Morris, J.T. et al., *Analytical techniques for the calculation of leeway as a basis for search and rescue planning, Oceans 2008,* https://apps.dtic.mil/dtic/tr/fulltext/u2/a502061.pdf. Retrieved 28 March 2019.

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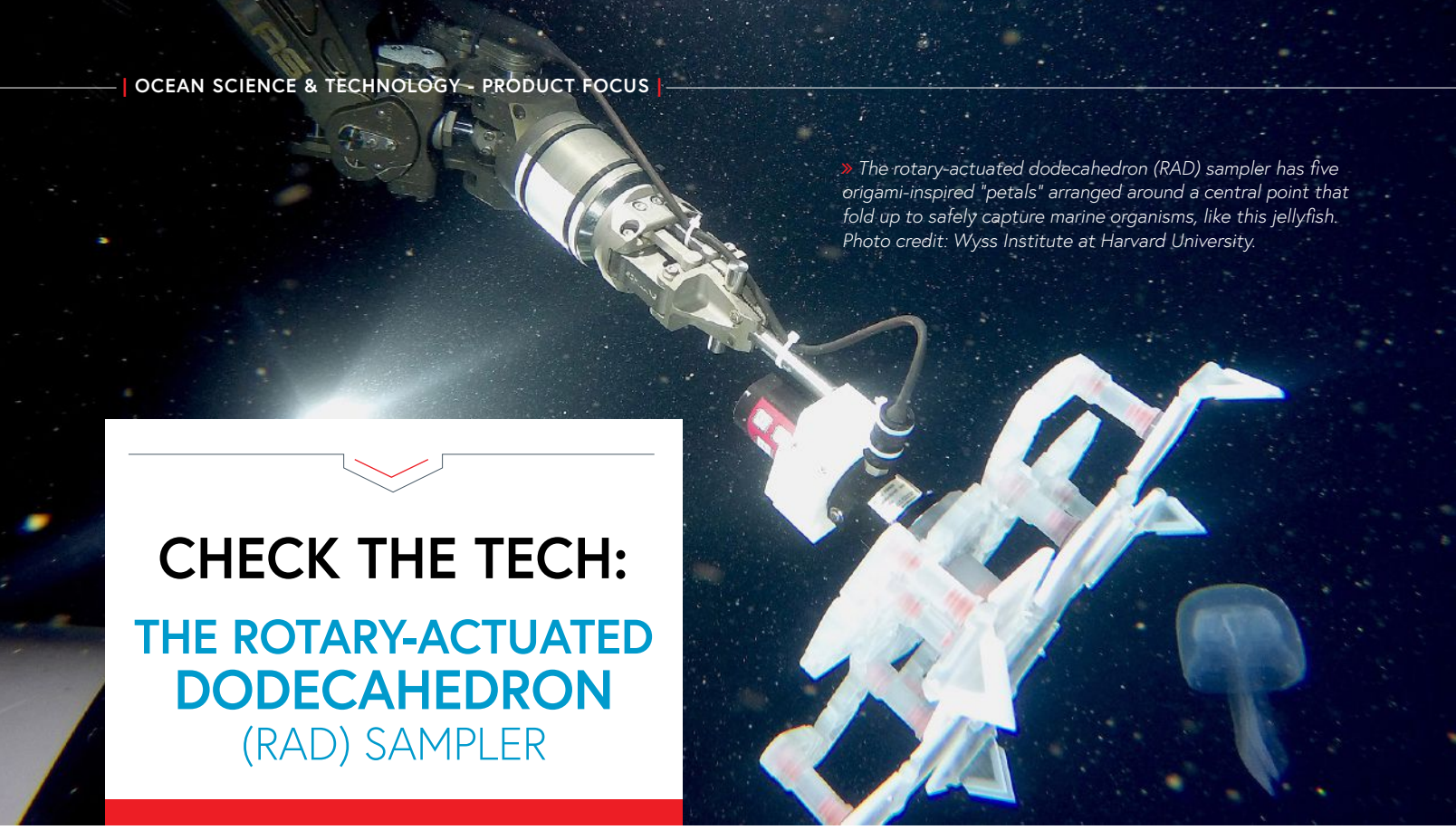


» *The rotary-actuated dodecahedron (RAD) sampler has five origami-inspired "petals" arranged around a central point that fold up to safely capture marine organisms, like this jellyfish. Photo credit: Wyss Institute at Harvard University.*

CHECK THE TECH:

THE ROTARY-ACTUATED DODECAHEDRON (RAD) SAMPLER

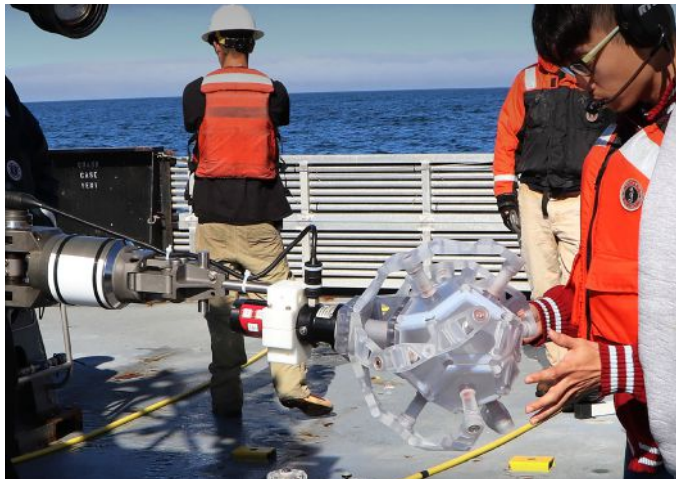
The open ocean is the largest and least-explored environment on Earth. It is estimated to hold up to a million species that have yet to be described. However, many of those organisms — like jellyfish, squid, and octopuses — are soft-bodied and difficult to capture for study with existing underwater tools, which too frequently damage or destroy them.

Now, a new device developed by researchers at Harvard University's Wyss Institute, John A. Paulson School of Engineering and Applied Sciences (SEAS), and Radcliffe Institute for Advanced Study safely traps delicate sea creatures inside a folding polyhedral enclosure and lets them go without harm using a novel, origami-inspired design. The research is reported in Science Robotics.

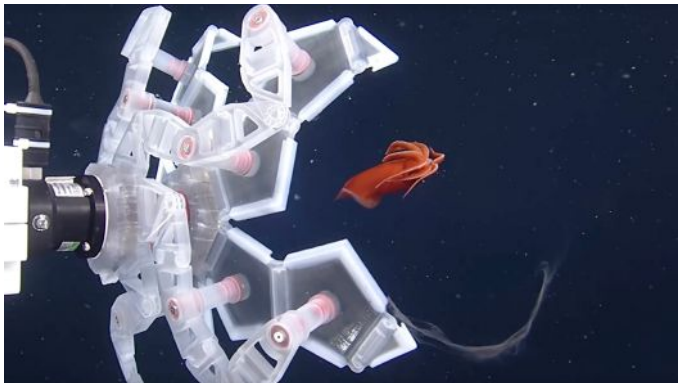
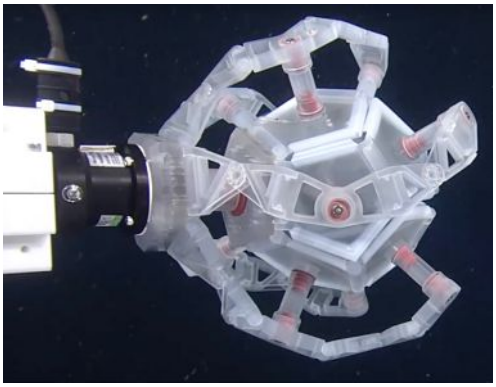
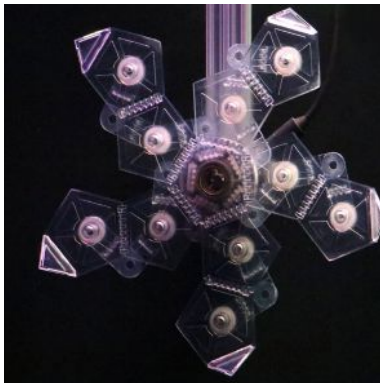
"We approach these animals as if they are works of art: Would we cut pieces out of the 'Mona Lisa' to study it? No — we'd use the most innovative tools available. These deep-sea organisms, some being thousands of years old, deserve to be treated with a similar gentleness when we're interacting with them," said collaborating author David Gruber, who is a 2017—2018 Radcliffe Fellow, National Geographic Explorer, and professor of biology and environmental science at Baruch College, CUNY.

The idea to apply folding properties to underwater sample collection began in 2014 when first author Zhi Ern Teoh took a class from Chuck Hoberman, a Wyss associate faculty member and Pierce Anderson Lecturer in Design Engineering at the Harvard Graduate School of Design, about creating folding mechanisms through computational means. "I was building microrobots by hand in graduate school, which was very painstaking and tedious work, and I wondered if there was a way to fold a flat surface into a 3-D shape using a motor instead," said Teoh, a former postdoctoral fellow at the Wyss Institute in the lab of Robert Wood; he is now an engineer at Cooper Perkins.

A fellow member of the Wood lab at the time, Brennan Phillips (now assistant professor of ocean engineering at the University of Rhode Island), saw Teoh's design and suggested he adapt it to capture sea creatures, which are notoriously difficult to grab with existing underwater equipment that is largely designed for the rough work of ocean mining and construction.



» *Lead study author Zhi Ern Teoh (right) tests the RAD sampler, mounted on the ROV Ventana, before its deployment into the Pacific Ocean at Monterey Canyon, Calif. Photo credit: Wyss Institute at Harvard University.*

» *Photo credit: Wyss Institute at Harvard University.*

The device Teoh built consists of five identical 3-D-printed polymer "petals" attached to a series of rotating joints that are linked together to form a scaffold. When a single motor applies torque to the point where the petals meet, it causes the entire structure to rotate about its joints and fold up into a hollow dodecahedron (like a 12-sided, almost-round box), earning it the name of Rotary Actuated Dodecahedron (RAD). The folding is entirely directed by the design of the joints and the shape of the petals themselves; no other input is required.

The team tested the RAD sampler at Mystic Aquarium in Mystic, Conn., and successfully collected and released moon jellyfish underwater. After making modifications to the sampler so it could withstand open-ocean conditions, they mounted it on an underwater remotely operated vehicle (ROV) provided by the Monterey Bay Aquarium Research Institute in Monterey, Calif., and tested it in the field at depths of 500—700 meters (1,600—2,300 feet) using the ROV's manipulator arm and human-controlled joystick to operate the sampler. The team was able to capture soft organisms like squid and jellyfish in their natural habitats, and release them without harm.

> *"The RAD sampler design is perfect for the difficult environment of the deep ocean because its controls are very simple, so there are fewer elements that can break. It's also modular, so if something does break, we can simply replace that part and send the sampler back down into the water," said Teoh. "This folding could also be well-suited to be used in space, which is similar to the deep ocean in that it's a low-gravity, inhospitable environment that makes operating any device challenging."*

Teoh and Phillips are currently working on a more rugged version of the RAD sampler for use in heavier-duty underwater tasks, like marine geology, while Gruber and Wood are focusing on further refining the sampler's delicate abilities. "We'd like to add cameras and sensors to the sampler so that, in the future, we can capture an animal, collect lots of data about it — like its size, material properties, and even its genome — and then let it go, almost like an underwater alien abduction," said Gruber.

"Our group's collaboration with the marine biology community has opened the door for the fields of soft robotics and origami-inspired engineering to apply those technologies to solve problems in an entirely different discipline, and we are excited to see the ways in which this synergy creates novel solutions," said Wood, who is a founding core faculty member of the Wyss Institute, the Charles River Professor of Engineering and Applied Sciences at SEAS, and also a National Geographic Explorer.

Additional authors of the paper include Kaitlyn Becker, Griffin Whittredge, and James Weaver from the Wyss Institute and SEAS.

This research was supported by the National Science Foundation and the National Academy of Sciences.

$70 BILLION OPPORTUNITY IN U.S. OFFSHORE WIND SUPPLY CHAIN

America's offshore wind industry, which is projected to generate nearly 20 gigawatts (GW) of clean, cost-competitive power in seven East Coast states by 2030, presents a nearly $70 billion CAPEX revenue opportunity to businesses in the U.S. offshore wind supply chain, reports a new white paper by the Special Initiative on Offshore Wind (SIOW) with analysis by the Renewables Consulting Group (RCG).

The analysis offers a road map for states and a menu for suppliers to build GWs of new U.S. offshore wind power capacity over the next decade. The study does so by quantifying the timing and pace of $68.2 billion in supply chain contracting prospects to install 18.6 GW of offshore wind procurements forecast for clean-energy consumers on the Atlantic Seaboard by 2030.

Key industry components required for such a utility-scale build-out of U.S. offshore wind include:

- More than 1,700 offshore wind turbines and towers: $29.6 billion
- More than 1,750 offshore wind turbine and substation foundations: $16.2 billion
- More than 5,000 miles of power export, upland and array cables: $10.3 billion
- More than 60 onshore and offshore substations: $ 6.8 billion
- A wide range of marine support, insurance and project management activities: $ 5.3 billion

The study also details rising state commitments and forecast power procurements through 2030: New York, 7.7 GW (9 GW by 2035), New Jersey, 3.5 GW, Massachusetts, 3.2 GW, Connecticut, 2 GW, Maryland, 1.2 GW, Rhode Island, 1 GW, and Virginia, 12 megawatts. Together, these total more than 18 GW of U.S. offshore wind power.

"America's offshore wind industry is taking off and what people see now is just the tip of the iceberg," said Stephanie McClellan, study author and Director of SIOW, at the University of Delaware's College of Earth, Ocean and Environment. "States and industry suppliers are leading the way and eager for clarity on the path ahead. Our analysis illuminates the market's supply chain needs, timing and pace, and $70 billion in CAPEX for businesses to translate GWs into growth opportunities and build this extraordinary enterprise."

"This report provides a roadmap for companies that will create new jobs and generate competition, which means better prices for producers and better electricity rates for consumers in the future", said President Randall Luthi of the National Ocean Industries Association (NOIA).

"Gulf Island Fabrication constructed the foundations for the five turbines at Block Island, RI – so we know the power and value of offshore wind," said Bill Blanchard, Senior Vice President, Business Development, at the Texas-based firm. "This new study shows there's a lot more where that came from. Five foundations down, 1,750 more to go. That's the kind of business opportunity the offshore energy industry can get excited about."

"In quantifying the industrialization of offshore wind in the U.S., this white paper illustrates just how much potential there is in the sector, top to bottom," said Jason Folsom, Boston-based U.S. National Sales Director for MHI Vestas Offshore Wind. "It presents an exceptionally compelling case on the emergence of offshore wind as an engine for U.S. energy transition." The firm plans to install 84 of its new 9.5 MW turbines in Massachusetts' 800 MW Vineyard Wind project, which will be America's first utility-scale offshore wind farm.

Interest in U.S. offshore wind is reaching a fever pitch. Bids in the Bureau of Ocean Energy Management's December 2018 auction for new Massachusetts leases reached a record $405 million, and in January, New York State almost quadrupled its offshore wind commitment to 9 GW by 2035.

For the white paper, "Supply Chain Contracting Forecast for U.S. Offshore Wind Power," go to this link:

http://www.ceoe.udel.edu/File%20Library/About/SIOW/SIOW-White-Paper---Supply-Chain-Contracting-Forecast-for-US-Offshore-Wind-Power-FINAL.pdf

UK GOVERNMENT COMMITS TO OFFSHORE WIND SECTOR DEAL

» *Wind turbine parts being loaded onto a supply vessel. The U.K. Offshore Wind Sector Deal will invest up to £250 million in building a stronger UK supply chain.*

The United Kingdom has announced a new Offshore Wind Sector Deal. Sector deals are partnerships between the UK government and the specified industry sector.

According to the deal's position paper, it will maximize opportunities for UK industry by:

1. Providing forward visibility of future Contracts for Difference rounds with support of up to £557 million, with the next allocation round planned to open by May 2019, with subsequent auctions around two years thereafter.
2. The sector committing to increase UK content to 60% by 2030, including increases in the capital expenditure phase.
3. Increasing the representation of women in the offshore wind workforce to at least a third by 2030.
4. Setting an ambition of increasing exports fivefold to £2.6 billion by 2030.
5. The sector will invest up to £250 million in building a stronger UK supply chain, establishing the Offshore Wind Growth Partnership (OWGP) to support productivity and increase competitiveness.

The position paper also says, "Over the next decade, there will be a huge expansion of offshore wind around the world with some estimates envisaging a 17% annual growth from 22GW to 154GW in total installed capacity by 2030. In the UK, this could see offshore wind contributing up to 30GW of generating capacity . . . Building up to 30GW of offshore wind by 2030 could account for over £40 billion of infrastructure spending in the next decade."

Industry response to the sector deal was positive.

James Ritchie, Chairman of Energi Coast and CEO of Tekmar Group plc, said, "The Sector Deal will support the development of supply chain clusters, such as the maturing Energi Coast group of companies in the North East of England, which builds on a heritage from maritime and subsea oil and gas and have been at the forefront of this exciting renewable sector since its inception."

"The new Sector Deal endorses our recently announced strategy to work with our clients and partners to create a safe and liveable world," said Mark Heine, Fugro's CEO. "We have more than 20 years of experience working in offshore wind, with contracts at more than 100 offshore wind locations successfully completed."

For more information, visit www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal.

Ohmsett: Full-Scale Spill Response Testing and State-of-the-Art Data Collection

Ohmsett is the test bed for some of the most innovative technologies used in the spill response industry for oil spill detection, containment, and removal. Managed by the Bureau of Safety and Environmental Enforcement (BSEE) under a contract with Applied Research Associates, Inc. (ARA), it is the largest outdoor facility of its type in North America, providing the Bureau and other facility users from around the world with a unique oil spill response training and testing environment.

» *Ohmsett trains the oil spill response community on how to respond to an oil spill using a blend of classroom instruction and hands-on experience recovering real oil*

"Unlike smaller facilities that rely on scale models and oil surrogates, Ohmsett conducts research, testing, and training with full scale equipment using real oil in a repeatable and controlled simulated marine environment," said Paul Meyer, BSEE Ohmsett manager.

By providing independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy systems (wave energy conversion devices), customers are able to use the facility to conduct tests on skimming vessels, sorbents, dispersants, sunken oil detection, oil-in-ice recovery, remote sensing, marine hydrokinetic turbines, and much more. "Data obtained during these efforts support a variety of objectives that include: enabling manufacturers to quantify improvements to their equipment; providing government regulators and oil spill response planners with data on how equipment may perform under certain environmental conditions; and providing potential equipment purchasers with non-biased test results to inform their decisions," Meyer said.

The most notable feature of the Ohmsett facility is the above-ground concrete test tank measuring 667 feet long by 65 feet wide by 8 feet deep filled with 2.6 million gallons of crystal clear salt water. The wave generating capabilities include programmable amplitude, frequency and wave length, creating random waves that more closely approximate waves in the ocean, and waves that can be break at specific locations within the tank.

Additionally, Ohmsett provides a venue for first responders with the most realistic hands-on training available, enabling a rapid and efficient response to an actual spill event. "Using a blend of classroom instruction and hands-on experience recovering real oil (not a surrogate), participants are able to increase proficiency using booms and skimmers, practice removing spilled oil in harbor chop wave conditions, as well as analyzing skimming performance after collecting and measuring recovered oil," says Meyer.

BSEE is continuously investing in and expanding Ohmsett's capabilities to develop and test state-of-the-art equipment.

» *Ohmsett has the capabilities to produce and add ice to the test tank to help simulate Arctic conditions..*

This includes capital investments to the infrastructure for a better and more repeatable test environment, such as upgrading the bridge drive and wave generation systems from manual control to computer-controlled. "We've also improved the on-site oil/water lab for rapid analysis of test oil and recovered oil properties. This gives near-immediate feedback to researchers, who can then adjust their test parameters to optimize their time at Ohmsett," says Meyer. "We've expanded our ability to quantify the oil intentionally spilled in the tank, both from above the surface as well as using instruments beneath the surface."

According to Meyer, they are in the initial design stage of fabricating a 20-m long flume tank to compliment the capabilities of Ohmsett's 200-m long outdoor tank. "The flume tank would be ideal for smaller scale experiments such as sunken oil and bioremediation studies. This would allow researchers to fine-tune experimental methods for more expanded tests in the main Ohmsett tank."

» *The wave generating capabilities include programmable amplitude, frequency and wave length for sinusoidal waves, as well as the ability to create random waves that more closely approximate ocean waves.*

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BOEM CONDUCTS ONE LEASE SALE, PROPOSES ANOTHER

Gulf of Mexico Lease Sale Yields More Than $244 Million in High Bids

Region-wide Gulf of Mexico Lease Sale 252 generated $244,299,344 in high bids for 227 tracts covering 1,261,133 acres in federal waters of the Gulf of Mexico. A total of 30 companies participated in the lease sale, submitting $283,782,480 in all bids.

Lease Sale 252 included 14,699 unleased blocks, located from three to 231 miles offshore, in the Gulf's Western, Central and Eastern Planning Areas in water depths ranging from nine to more than 11,115 feet (three to 3,400 meters). It was the fourth offshore sale held under the 2017-2022 National Outer Continental Shelf Oil and Gas Leasing Program.

Commenting on the sale, National Ocean Industries Association (NOIA) President Randall Luthi said that "the trajectory of this and the past few sales shows stability and helps establish a new normal for the U.S. offshore industry. Companies continue to shore up existing development operations (in both shallow and deep water) in known geologic areas, but are not yet ready for heavy investment in truly new deepwater projects."

Proposed Region-Wide Oil & Gas Lease 253 for Gulf of Mexico

BOEM has also proposed offering 78 million acres for a region-wide lease sale scheduled for August 2019. The sale would include all available unleased areas in federal waters of the Gulf of Mexico.

Lease Sale 253, scheduled to be livestreamed from New Orleans, will include approximately 14,699 unleased blocks, located from three to 231 miles offshore, in the Gulf's Western, Central and Eastern planning areas in water depths ranging from nine to more than 11,115 feet (three to 3,400 meters). All terms and conditions are detailed in the Proposed Notice of Sale information package available at www.boem.gov/Sale-253/. Copies of the maps can be requested from the Gulf of Mexico Region's Public Information Unit at 1201 Elmwood Park Boulevard, New Orleans, LA, 70123, or at 800-200-GULF (4853). The Notice of Availability was made published in the Federal Register on 14 March 2019.

BOEM
Bureau of Ocean Energy Management

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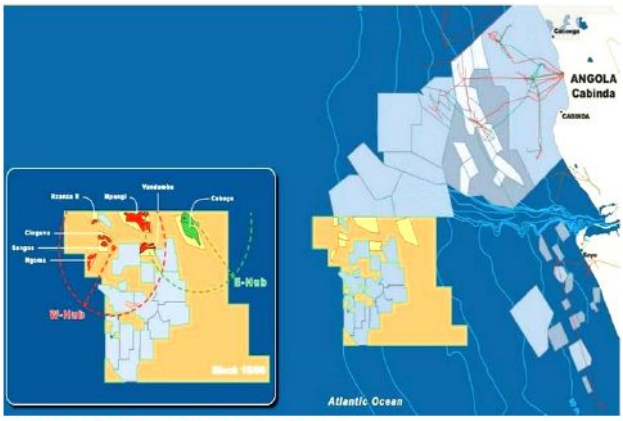
ENI MAKES MAJOR OIL DISCOVERY OFFSHORE ANGOLA

Eni has announced a major oil discovery in Block 15/06, in the Agogo exploration prospect, in Angola's deep water. The new discovery is estimated to contain between 450 and 650 million barrels of light oil in place, with further upside.

The Agogo-1 NFW well, which led to the discovery, is located approximately 180 kilometers off the coast and about 20 kilometers west from the N'Goma FPSO (West Hub). The well was drilled by the Poseidon drillship in a water depth of 1636 meters and reached a total depth of 4450 meters.

Agogo-1 NFW proved a single oil column of about 203 meters with 120 meters of net pay of high quality oil (31° API) contained in a sub salt diapirs setting in Lower Miocene sandstones with excellent petrophysical properties. The data acquired in Agogo-1 NFW indicate a production capacity of more than 20,000 barrels of oil per day.

Agogo is the third discovery of commercial nature since the Block 15/06 Consortium decided to launch a new exploration campaign in 2018, leading to the discoveries of Kalimba and Afoxé.



Location of Block 15/06 (Source: Eni) » *Photo credit: ENI*

The mapping and the drilling of Agogo prospect has been possible through the use of Eni's advanced and sophisticated proprietary seismic imaging technologies.

The Block 15/06 Joint Venture, composed by Eni (operator, with a 36.8421% stake), Sonangol P&P (36.8421%) and SSI Fifteen Limited (26.3158%), will work to appraise the discovery and start the studies to fast track its development.

WWW.ENI.COM

SONARDYNE'S SENTRY LEAK DETECTION SONAR DEPLOYED IN GULF OF MEXICO

A major U.S. oil company is set to reinforce its deepwater offshore asset integrity assurance in the Gulf of Mexico with the aid of a sonar monitoring system developed and delivered by subsea engineering specialist Sonardyne International Ltd.

The system, Sonardyne's wide-area Sentry Integrity Monitoring Sonar (IMS), has been deployed on the seafloor at more than 2,000 meters water depth. Sentry IMS, which can be installed short-term or permanently, is able to detect, classify and localize subsea releases of hydrocarbons from either the seafloor or oil and gas field production infrastructure.

In this latest deployment, Sentry is being deployed under a six-month trial that will demonstrate its ability to provide real-time subsea asset monitoring. The Sentry sonar head, which is mounted on a seafloor lander, is connected into an existing power and communication umbilical to a floating production facility. Inbuilt intelligence using algorithms developed by Sonardyne continuously assess the sonar data gathered by Sentry and generate near real-time automatic alerts of any hydrocarbon seeps detected in the water column.

As part of the trial deployment, simulations of an oil plume in the water were created, using nitrile-fiber strands, proving fast and accurate detection and classification of the equivalent release of 100 barrels/day of oil out to 244 meters, a distance only constrained by the trial environment. This was achieved within seconds of the simulated leak occurring.

Sentry's capability, however, covers 100 barrels/day mono-phase oil leaks at distances of up to 740 meters. For mono-phase gas leaks, the system is capable of detecting down to just 1 barrel/day at 500 meters or 100 barrels/day (as measured at depth) at 1,000 meters. Uniquely, Sentry is able to accurately localize leaks. Its titanium housing and ROV-deployable design makes Sentry ideal for deepwater asset integrity monitoring.

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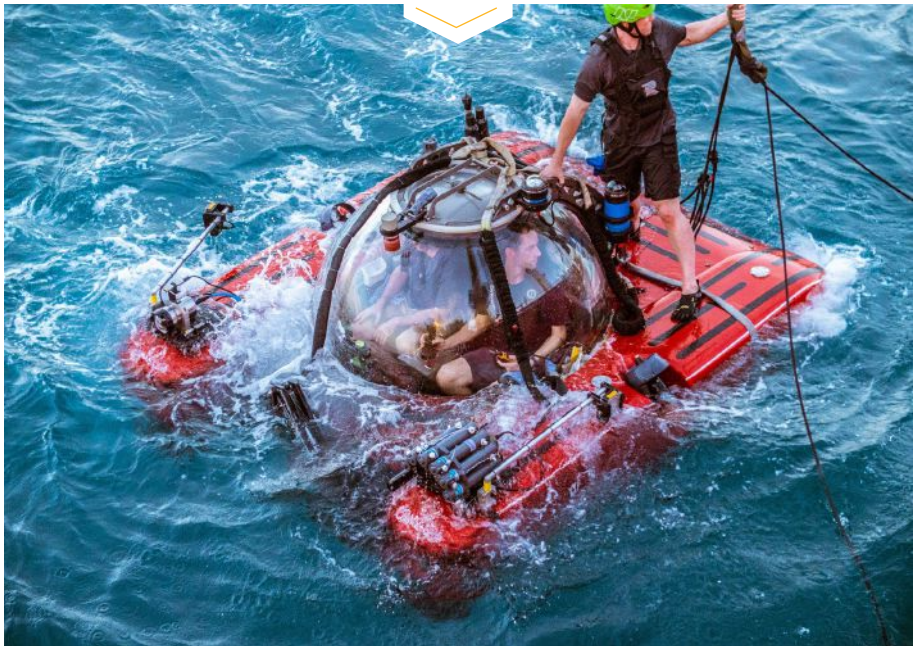
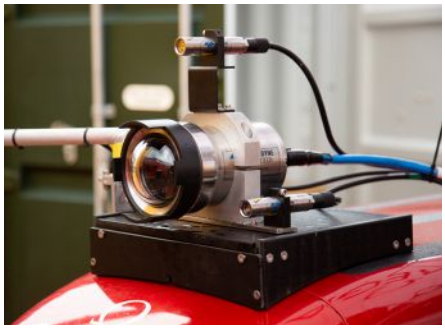
TELEDYNE MARINE SUBSEA TECHNOLOGY FOR NEKTON DEEP OCEAN EXPLORATION



» *Submersible equipped with Teledyne Bowtech lights and cameras before the dive.*

» *Survey boat equipped with a Teledyne RESON SeaBat T50-P ER Multibeam Sonar and Teledyne PDS acquisition software.*



» *Bowtech Underwater HD camera and lights.*

Teledyne Marine announces that the company has entered a partnership with the NEKTON Deep Ocean Exploration as an official subsea technology partner through value-in-kind contribution of equipment, technology and support.

Teledyne Marine and Nekton have a shared common goal to lead the discovery and increase the understanding of the ocean.

The purpose of the expedition in the Seychelles' is a major global scientific collaboration that aims to create a step-change in our knowledge of the Indian Ocean and catalyse its sustainable governance. The Seychelles covers an exclusive economic zone of 1.4 million square kilometers. The expedition will be carried out in specific areas within the plateaus of designated outer islands with depths of up to 500 meters.

Teledyne Marine, with its wide array of sensors and technology, is a key partner and extensive technology provider to this important scientific discovery opportunity. Teledyne Marine is providing:

- The Teledyne RESON advanced T50-P SeaBat multibeam echosounder installed on a small survey launch used for high resolution seafloor mapping and acquisition of unprecedented clean data
- The Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP) Workhorse mounted on the mother ship, the Ocean Zephyr, to measure the current in the water column. The multibeam echosounder and the ADCP both serve the dual purpose of supporting safe deployment of the submersibles, as well as providing data to the scientific team onboard.
- Two Teledyne software packages are in use during and after the expedition; Teledyne PDS acquisition software for data acquisition and real time data viewing, and Teledyne Caris HIPS & SIPS for post processing of the hydrographic data on the mother vessel.
- Teledyne Bowtech HD cameras and LED lights are mounted on the manned submersibles and Remotely Operated Vehicles (ROVs). These tools are vital in the study of the ocean health and will also provide live broadcasts with NEKTON's media partners.
- In addition, Teledyne has supplied a Teledyne SeaBotix ROV LBV300-5 Mini fitted with Teledyne BlueView high-resolution forward-looking sonar systems M900-2250. The BlueView sonar enables long range visualization beyond the range of visibility of underwater cameras.

Teledyne also has a team of engineers in the Seychelles to support mobilization and to train the NEKTON team in the field.

"This expedition is a bold step to accelerate our scientific understanding of the state of the Indian Ocean and we couldn't be doing this without the equipment, technology and support that Teledyne have provided us with. With Teledyne by our side as our official subsea Technology partner, we are able to carry out a health check of the ocean, "says Oliver Steeds, Nekton's Mission Director.

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AKER SOLUTIONS TO DELIVER SUBSEA COMPRESSION SYSTEM TO CHEVRON AUSTRALIA

Aker Solutions has been awarded a master contract to support the delivery of a subsea compression system for the Chevron Australia-operated Jansz-Io field offshore Australia.

The first service order under the master contract will be for front-end engineering and design of a subsea compression station that will boost the recovery of gas from the field. The FEED scope will also cover an unmanned power and control floater, as well as overall field system engineering services. The field control station will distribute onshore power to the subsea compression station.

The gas compression system will boost recovery of gas more cost-effectively and with a smaller environmental footprint than a conventional semi-submersible compressor solution. Aker Solutions in 2015 delivered the world's first subsea compression system for Equinor's Åsgard field offshore Norway.

"Aker Solutions has worked closely with its partners MAN Energy Solutions and ABB to reduce the size and cost of the compression system," said Luis Araujo, chief executive officer at Aker Solutions. "We are excited to work with Chevron Australia on our compressor-technology to boost recovery at the Jansz-Io field."

Compression will help maintain plateau gas production rates as reservoir pressure drops over time. While such compressors have typically been installed on platforms over sea level, placing them on the seabed and near the wellheads improves recovery rates and reduces capital and operating costs.

The Jansz-Io field is located around 200 kilometers offshore the north-west coast of Western Australia at approximately 1,350 meters below the surface. The Jansz-Io field is a part of the Chevron Australia-operated Gorgon Project, one of the world's largest natural gas developments.

"Australia will be the first place outside of Norway to use the subsea compression technology. Aker Solutions has been present in Western Australia for more than 20 years and we look forward to working collaboratively with the local industry on this development," said Araujo.

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SEAROBOTICS CORPORATION LAUNCHES THE SR-ENDURANCE 7.0

SeaRobotics Corporation (SeaRobotics) announces the successful completion of its factory acceptance testing of its new entry into the Autonomous Surface Vehicle (ASV) Workboat market with the SR-Endurance 7.0 meter system. The system is optimized for sonar research through the utilization of an optionally manned helm configuration and a serial diesel electric propulsion system. Outfitted with an instrumented launch and recovery system (LARS), and supporting hydrographic winch system, the SR-ENDURANCE 7.0 is capable of deploying towed sonar/instrument systems, dipping sonar/systems, or ROV systems.

"Having built numerous ASVs in the 6-11-meter range, we are now offering a commercial workboat for the research and survey markets," said Geoff Douglass, SeaRobotics ASV development manager. "In many operational scenarios the advantages derived from a variable depth sensor such as a multi-beam or side scan sonar, sub bottom profiler, or magnetometer, as well as the surface motion mitigation, make towed systems valuable in autonomous operations."

With an impressive endurance of up to 6 days at survey speed, and up to 10 hours between automatic battery recharge, the 80 HP, SR-ENDURANCE 7.0's remarkably quiet platform for sonar/sensor research belies its 80 HP strength. The multipurpose LARS and payload interface enable the integration of numerous users configured payload systems. A standard 6-inch pipe flange with cableway is mounted under the hull to provide additional instrument mounting options for additional instruments.

The optionally manned helm enables manned operation in congested waterways and for ramp operations when required. With the flip of a switch, semi-autonomous operations, remote piloting and direct remote-control functionality is provided. Navigation is supported by a pre-programmed, or remotely operated pan/tilt/zoom video system, 360-degree video coverage with 4 situation awareness cameras, RADAR, AIS, low bandwidth Iridium, and a high bandwidth line of sight RF link. Many more options are available

The SR-ENDURANCE 7.0 work-horse ASV can be configured with various propulsion configurations. The aluminum general purpose hull offers a large back deck area for mission reconfigurable payloads of various types. "We were delighted to design and build this new system, one which proved to be of critical importance to the research of the US Naval Research Laboratory (NRL)," stated Don Darling, President of SeaRobotics.

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» *Photo credit: Fugro*

FUGRO STRENGTHENS INTEGRATED UXO SERVICE FOR OFFSHORE RENEWABLES

Fugro is further strengthening its leading position as an unexploded ordnance (UXO) service provider with a recent multimillion-Euro contract award from TenneT. The Geo-data specialist is now set to commence integrated UXO services at an offshore wind farm development in Dutch coastal waters; the contract follows previous involvement in route survey activities at the site.

Bringing specialist vessel *Atlantis Dweller* into play in European waters for this contract reinforces Fugro's operational excellence and ability to deliver time savings. The DP2 multipurpose vessel is permanently equipped with a work class remotely operated vehicle, providing fast and safe identification of potential UXOs. Other technology includes a sub-bottom imager which can reduce dredge scope, resulting in notable time savings.

Commenting on the identification and clearance (ID & C) project that begins in April, Business Development Manager Martin Valk said, "Fugro has conducted site characterization work on a large number of offshore wind farm developments around the globe. Against a backdrop of continued growth in Europe, we are enhancing our ability to respond to demands for UXO ID & C services by bringing the *Atlantis Dweller* into our European vessel fleet.

"The vessel has been specifically configured for the offshore renewables market in Europe and is ideally suited for safe and efficient UXO ID & C services. Utilizing the *Atlantis Dweller* and the onboard technology enables us to deliver operational excellence underpinned by the highest levels of efficiency and safety."

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NKT FINALIZES PROJECT WITH THE WORLD'S LONGEST HVAC SUBMARINE CABLE

NKT has successfully completed the power from shore cable project connecting the Martin Linge oil and gas field in Norway to shore. The solution from NKT will help the field owner Equinor save 200,000 tonnes CO2 annually.

NKT has handed over the 163 km long high-voltage cable system powering the Norwegian oil and gas field Martin Linge from the shore. The cable solution is the world's longest submarine HVAC cable installed and will help save 200,000 tonnes CO2 annually.

NKT has successfully completed the project of the power from shore cable system for the Martin Linge oil and gas field in Norway for the end client Equinor. The cable system solution from NKT plays a key part in making the field more carbon-efficient as is it powered from shore by the record breaking 163 kilometers long 145 kV high-voltage alternate current (HVAC) power cable. The project has been successfully executed in the challenging environment of the North Sea on behalf of Subsea 7.

"We are happy to continue the good collaboration with Subsea 7 and Equinor and to be supporting their focus on driving sustainable offshore operations with our extensive experience in turnkey solutions for the oil and gas sector. It is a great achievement for NKT having installed the world's longest HVAC submarine cable solution and we once again demonstrate that we have the inhouse expertise to design, develop and install solutions in very demanding and complex environments," says Andreas Berthou, Executive Vice President and Head of HV Solutions at NKT.

NKT has specially designed, engineered, manufactured and installed the cable order comprising the 145 kV three-core XLPE HVAC submarine cable including fiber optic links with a 55 MW capacity. Furthermore, a 3,5 km long, 17,5 kV infield cable was installed - including 500 meters of dynamic cable. The dynamic cable that connects the platform to a floating storage and offloading vessel (FSO) anchored outside the platform, was intensely engineered by NKT to withstand the dynamic motions.

The power from shore solution from NKT will help Equinor save 200,000 tonnes CO2 annually once the field is

» *Photo credit: NKT*

in operation as the activities of Martin Linge will be powered from the onshore power grid instead of onsite generators. Other advantages with the power from shore solution are reduced maintenance, less noise and vibration on the platform.

NKT has extensive experience in designing and installing power from shore solutions for the offshore oil and gas industry for projects such as Gjöa and Goliat. In 2018, NKT successfully commissioned the power from shore power cable solution for phase 1 of the Johan Sverdrup oil field in the North Sea and entered into an agreement with Equinor to design, engineer, produce and install the power from shore connection for the second phase of the development.

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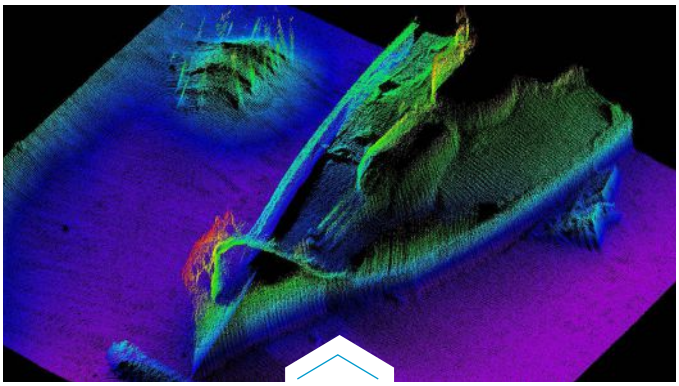
PROTECTING OFFSHORE ENERGY INFRASTRUCTURE USING UNMANNED SURFACE VESSELS (USVs)

BY GEORGE GALDORISI,
Director of Strategic Assessments and Technical Futures at the U.S. Navy's Command and Control Center of Excellence



» *Image captured by the Norbit iWBMS STX multi-beam sonar of the USS Arizona, which was sunk at Pearl Harbor in 1941, taking 1,177 lives with her. When mounted aboard a surface vehicle, such as a USV, multi-beam sonar technology can help conduct safer, faster and more thorough inspections of offshore oil and gas rigs as well as their vast array bottom-mounted pipelines and valves.*

The offshore oil and gas industry takes stewardship of the environment seriously and has put procedures in place to ensure the safety and security of its offshore infrastructure. However, the industry may be encumbered in this effort unless (or until) it embraces emerging USV technology to enable a more thorough – and safer – inspection of its offshore rigs.

The methods used to inspect offshore oil and gas platforms in 2019 are little changed from the procedures utilized decades ago. Rig operators use a combination of remotely operated vehicles (ROVs) in concert with divers to perform these inspections. This methodology is good as far as it goes, but ROVs have a limited field of view, and putting divers in the water always involves substantial risk and increasingly high cost. A number of companies have participated in industry fairs and have offered solutions to enhance the efficacy of oil and gas platform inspections.

To be clear, the offshore oil and gas industry is challenged to not only prevent catastrophic spills from occurring, but to also deal with more routine issues like wear and tear of underwater components in order to spot impending failures before they happen and take corrective action where needed. And much like an iceberg, what the eye can see above the water when viewing an oil or gas rig is only part of the story. There is a tremendous amount of the infrastructure that is below the surface – and unseen.

Beyond these mechanical issues, the oil and gas industry must guard against pernicious attacks on its offshore platforms by environmental activists – or even by terrorists. It is not too much of a stretch to imagine that if just one oil or gas platform in the Gulf of Mexico was attacked, the entire production could be shut down for days or even weeks. The impact on oil and gas prices would be immediate – and disastrous.

Unmanned surface vehicles (USV) can greatly enhance the ability to rapidly and safely inspect offshore oil and gas rigs. While these USVs will not completely replace ROVs and divers, they can be used first to identify areas needing further inspection, thus greatly reducing the need for ROVs and divers.

Part of the attraction of using a USV for offshore oil and gas platform inspections is that unmanned surface vehicles have had extensive use in military exercises, experiments and demonstrations in both near-shore and open-ocean operations, as well as hundreds of hours of use in a number of civilian missions ranging from commercial canal and dam hydrography, to commercial power plant inspections, to port and harbor security.

These civilian missions are ones where USVs have used the same kind of above- and below-surface sensors that would be used for offshore oil and gas rig inspections. For example, over the past several years of commercial applications, several different size (6- 8- and 12-foot) MANTAS have been equipped with a number of sensors such as a Teledyne BlueView M900 single-beam echo-sounder, Teledyne RESON T20 high resolution multi-beam sonar, Norbit iWBMS STX multi-beam sonar, SeaFLIR-230 Gyro-stabilized High Definition EO/IR zoom camera with laser tracking, FLIR M232 thermal camera, FLIR Duo EO camera, and others.

This USV technology can be used today to conduct safer, faster and more thorough inspections of offshore oil and gas rigs as well as their vast array bottom-mounted pipelines and valves. This can result in a substantial decrease in the number of ROV missions and the use of human divers. One concept of operations would have one, or more, 12-foot MANTAS under the control of the Rig Command Center in an oil or gas platform.

It is likely that the platform owner would schedule routine inspections of one or more platforms on a periodic basis to check the integrity of the rig structure itself as well vertical pipes, fittings, bottom valves, pipelines and other components for wear and tear as well as impending failure. Beyond these routine inspections, the platform owners and operators would be able to conduct on-demand inspections in the wake of natural phenomena such as hurricanes or storm surges or when the Rig Command Center discovered something out of the ordinary based on a number of in-place, static, sensors.

There are a wide-range of ways a platform operator could

» *SeaFLIR-230 Gyro-stabilized High Definition EO/IR zoom camera, which is optimized for maritime operations and includes multiple sensor systems.*

» *Teledyne RESON SeaBat T-series sensors.*

use USVs to ensure oil and gas rig security. Three that come immediately to mind are:

- One of the early indicators of material failure of oil or gas rig components involves oil from the rig seeping into the surrounding water. USVs can be equipped with water-monitoring gear such as Current-Temperature Depth (CTD) sensors, Acoustic Doppler Current Profilers (ADCP), flourometers and others to detect changes in the water quality in the immediate vicinity of the rig.

- For surface investigation, which would include area security, external rig structure investigation and surface contact monitoring, among other missions, USVs can be equipped with a Gyro-stabilized High Definition EO/IR zoom camera, or, other alternatives.

- For underwater imaging, USVs can be equipped with a multi-beam sonar, a forward-looking or side-scan sonar, or any of many other commercial-off-the-shelf underwater sensors that can image underwater piping and bottom structures. This technology has been well tested and is in high demand to inspect commercial dams, energy plants, canals and other structures.

Utilizing a USV, the rig operator has a number of options to employ the USV for periodic or on-demand inspections. Today's USVs can be programmed to operate in an autonomous or semi-autonomous mode to search along a pre-determined course through the use of pre-programmed waypoints, or it can be controlled by the operator via a laptop, tablet, or smart phone. As the mission progresses, the video and sonar imaging can be sent directly to the rig in real-time, providing immediate notification of what the vehicle discovers above or below the water surface, thus enabling operators and management to make time-sensitive decisions.

There are various ways to leverage USVs for the rapid and economical inspection of oil and gas rigs. Under one concept of operations (CONOPS), an operator in the rig command center would have a USV on patrol on a predictable pattern inspecting the rig above and below water. If the vehicle discovers an anomaly, the operator will be alerted in real time. Then, the operator can switch to remote manual control and can command the USV to conduct finer-grained analysis with the same – or different – sensors.

If this investigation uncovers an area of concern, then an ROV, or, if necessary, a diver, can be deployed to make a repair. Clearly, this CONOPS will secure the integrity of the rig while also reducing the false alarms generated of other methods. Conversely, if the investigation does not reveal an issue, the USV can return to its autonomous mission profile that the operator had previously programmed.

Gulf of Mexico oil and gas rigs are, in some areas, close enough for several rigs to share one USV. For example, with a cruise speed of 20 knots, a burst speed of 40 knots and a cruise radius of 60 nautical miles (much more with solar panels installed), one MANTAS can service a number of rigs. This scheme can be particularly valuable as it could well result in sharing best-practices among various oil and gas companies where, if a USV discovers that a valve, fitting or other gear on one rig has failed, other rig operators can inspect that particular item with increased periodicity.

Offshore oil and gas production in the Gulf of Mexico is a mainstay of America's energy independence and growing status as a net energy exporter. Every industry indicator suggests that the number of oil and gas rigs in the Gulf of Mexico will increase, at least through the end of this decade – and perhaps longer – under the America-First Offshore Energy Strategy.

Protecting these expensive and vulnerable rigs from failure, sabotage, or other hazards is a first order priority for the industry and one that is increasingly expensive. Using low-cost, commercial off-the-shelf USVs can ensure a more comprehensive inspection of rigs and all their attendant fittings and pipelines while saving time and money, all while not endangering human divers. This is a win-win for the industry.

SUBMARINE NETWORKS Q&A WITH BRIAN LAVALLÉE, SENIOR DIRECTOR AT CIENA

Q What methods is the submarine industry using to manage and control their networks today?

Submarine networks carry more than 95 percent of the world's intercontinental electronic communications traffic and are responsible for over $10 trillion worth of transitions every day. They are the backbone of the internet, but simply have not received the same media attention as counterparts on land or in space.

Traditionally, submarine networks have been managed manually with offline tools such as ledgers and spreadsheets. Most operators today use some type of network management system software, with a growing adoption and integration of automation and analytics. Automation allows operators to select service path endpoints and the network automatically provisions the service – something that in the past would have taken days to months now takes only minutes, maybe even seconds. Plus, because this involves machine-to-machine communications, the chances of an error are significantly reduced, making the process quicker and more secure. Analytics allows for understanding the health of the network on an ongoing basis and proactively and reactively choosing the best path for a service across the network.

Q Where do you see subsea fiber technology headed in the next few years? What trends or developments are the most important?

Data traffic is expected to grow significantly in the coming years, with bandwidth increasing around the world. There is no sign that this growth will slow down anytime soon. The increase in traffic is in part due to some of the more obvious offenders – just look around and you can't help but notice the number of people glued to their phones consuming videos and playing games. Also, as developing countries continue to have access to and embrace technology, the amount of traffic will grow by leaps and bounds. And not so obvious, but right now one of the biggest culprits is machine-to-machine traffic between data centers where accessed content is hosted and shared. Some of these bits will travel between data centers over land, but others will make the long jump across the ocean, moving through fiber optic cables on the seafloor.

No matter where the traffic is coming from, the enormous growth in bandwidth demand is pushing the technology that enables submarine networks to the limit, requiring innovations in all parts of the end-to-end network, from data center to data center.

Q What does the growth in data traffic mean for subsea cable? That is, how much more can capacity be increased without having to lay new cable?

We're approaching Shannon's Limit in the submarine cable industry, getting close to how much information we can send down an individual optical fiber. Shannon's Limit effects every type of communications, whether you're a wireless carrier or submarine cable operator – there's a limit to the amount of information you can share through a particular communications medium.

About ten years ago, coherent technology came into the submarine cable market and it's now the standard to upgrade any subsea cable. As the bandwidth continues to grow, coherent modems are the technology of choice and the industry keeps developing technologies, such as improved forward error correction, linear and non-linear mitigation techniques, and so on. Once we hit that maximum limit on the fiber, we'll have to deploy more submarine cables, which may likely be based on Spatial Division Multiplexing (SDM) offering significantly more fiber pairs than existing subsea cables.

Q How does the rapid adoption of coherent detection modems help enable submarine networks to maintain pace with bandwidth demands?

Adopting coherent technology allows submarine network operators to significantly increase bandwidth capacity far higher than initial total design capacities. One of the key attributes of coherent optical technology is the high coding gain, soft-decision Forward Error Correction (FEC), which enables signals to travel longer distances, while requiring fewer regenerator points. This provides a wider margin, allowing higher bit-rate signals to traverse greater distances – increasing bandwidth significantly while simplifying photonic lines, requiring less equipment and lowering costs. A variety of impairment mitigation techniques incorporated into DSP technology has also enabled massive capacity increased on both old and new submarine cables.

Q What role does proactive analytics play?

Analytics can uncover trends in a network and help address failures before they occur by determining what is "normal" and what is "not normal" through the ongoing analysis of streaming network sensor data. Analytics provides actionable insights so that operators can address potential issues proactively rather than reactively. Having this insight is the first step in creating a network that is capable of identifying its own weaknesses, and automatically adjusting without human involvement.

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STAYING AHEAD OF THE CURVE WITH MARITIME SATELLITE CONNECTION

By Stephen Conley, Global Maritime Segment Lead, *SES Networks*

Adopting and implementing a digital agenda requires its own unique skillset. Within the context of shipping, there has historically been no clear path to this. In a multi-faceted industry with continuous cost pressures and slim margins, digital innovation needs to be embraced and applied throughout the supply chain. But this requires a shift in culture. Such a change can be developed and nurtured from within a company, but it begs the question: how can we ensure optimal, efficient and continual innovation within a fast-paced, ever changing environment?

It goes without saying that the implications can be intimidating. Investing in a core infrastructure needs to come with guarantees – namely, will this keep us ahead of the curve by generating consistent operational improvements? Evidencing real, tangible benefits to customers and suppliers is crucial for the up-take of digital technologies. While deep learning via big data collection – to take an example I've recently worked through with a client – seems like a forward-thinking tactic, such data is only useful if it can be applied to enable a measurable efficiency improvement.

Digital innovation is continuous, and we are at the stage where the technology and resource to exact measurable improvement is available. Harnessing these tools through the power of connectivity opens up a wealth of benefits.

One such route is communications, and in many ways it's the backbone of maritime logistics. From seafarers at sea and ashore, to ship owners and operators, real-time data transference is vital for the success of the industry. Satellite-enabled technology is the cornerstone of this global information network. By being better connected, there will be more training opportunities leading to highly skilled workers with more commercially-savvy choices, offering a real competitive edge to those who use it.

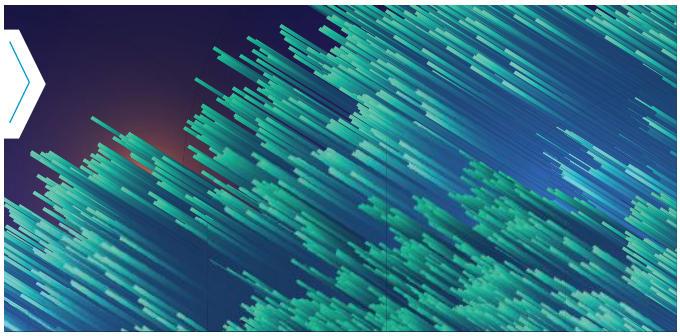
Not only will vessel operation be optimised via the wealth of digital tools available, but the safety, welfare and job satisfaction of seafarers can be exponentially increased. Investing in seafarers' wellbeing, whether that's providing crucial offshore training to ensure a highly skilled workforce, or enabling a crewmember to video-call friends and family, helps bolster the shipowner as a progressive employer.

The technology to be hyper-connected is already here. It's well acknowledged that this has not always been the case, and all too often substandard connectivity has been provisioned to those at sea under the guise of something more reliable.

However, connectivity at sea can, and should, be as effective as land-based services. SES Networks' Signature Maritime Solutions leverage an extensive geostationary satellite network supported by our Skala Global Platform, a next-generation ground system, to keep seafarers and vessels connected across the length and breadth of the world's oceans. By investing in a solution such as this, maritime experts have the opportunity to get several steps ahead. With the connectivity foundations laid, digitalisation will be smoothly integrated and the commercial benefits of new technologies will be realised sooner.

While future technology developments are difficult to predict, preparing for advancement across all sections of the supply chain is a good place to start. In order to remain competitive, investing now for a digital future of seamless, global communication will drive higher standards across the board, and ensure that maritime is ready to reap the benefits of a progressive future.

PRYSMIAN RETURNS TO THE SUBMARINE OPTICAL CABLE BUSINESS



Prysmian Group, through its submarine telecom division NSW, will showcase for the first time, after the merger with General Cable, its state-of-the-art range of products and services for the submarine telecommunication cable industry.

"By joining Prysmian Group, NSW has the possibility to enhance its position in the submarine telecom business thanks to a wider portfolio of products, technologies and assets. We can also count on a strong global footprint which enables us to better support the development of innovative network infrastructures worldwide," stated Ashutosh Bhargava, Head of Submarine Telecom BU, Prysmian Group.

Special focus will be dedicated to the new NSW MINISUB® 0.6 cable family, a rugged, compact fiber optic submarine repeatered cable with unique features, such as high count of 32 powerful ITU-T G.654.D fibers, low conductor resistance of 0.6 Ω/km, installation in water depths up to 8,000 m and extraordinary operating voltage of 15 kV DC.

The Group can call on full expertise in submarine telecommunication connections and an extended ability to offer turnkey products and services (including design, manufacture and installation).

NSW has already a strong track record of submarine telecommunication milestone projects such as SHEFA-2 (Denmark-UK), Janna (Italy), Hawk (Mediterranean area), KystTele Polar Circle (Norway), Jaka2LaDeMa (Indonesia), OTE & Hellas Tellas Online (Greece), Telsur (Chile), Cook Strait (New Zealand), Palapa Central & Palapa East (Indonesia), Prat (Chile) and other various worldwide projects.

DEFENDING THE UNDERWATER DOMAIN: UDT 2019 DIVES DEEP

Not since the Cold War has the underwater domain played such a critical role in military strategy and tactics. With emerging regional powers bringing significant new capabilities into play and nations around the world embarking on ambitious underwater equipment programmes, the underwater domain is at the very forefront of the modern battlefield.

Taking place in Stockholm, Sweden, from 13-15th May 2019, the Undersea Defence Technology (UDT) exhibition and conference will provide a timely look into some of the most relevant work being done in this sector.

"The underwater defence technology sector is undergoing a period of great change," Bert Johansson, UDT 2019 Committee Chair, said. "Within the context of a rapidly evolving defence environment where peer and near-peer adversaries present a growing threat that Sweden – with its key geographic location the Baltic coast – understands all too well, the military underwater domain is being relentlessly challenged to provide solutions to tomorrow's problems.

"As a result, underwater technology development is being driven at a speed and in directions that we have seldom seen before."

FACING UP TO NEW CHALLENGES

Combat diving is firmly on the agenda, with the Military Diver Capabilities conference returning as a discussion platform for those engaged in diver operations, training, equipment research and development. Commanders, divers, project managers and technicians from across the world will have the opportunity to see the latest developments in diver equipment, systems and national capabilities.

Over the course of the three-day mainstream conference, key issues facing global military forces as they tackle new challenges in the global underwater defence and security environment will be considered from every angle.

Mine Counter-Measure (MCM) capabilities is set to be a hot topic at the event, and is being taken up by Pawel Polanski, Underwater Weapons Department Manager at R&D Marine Technology Centre, Gdynia. Polanski will present on the topic of degaussing systems (DG) for MCM vessels with emphasis on its more advanced version running in a closed loop (CLDG).

"The recently awarded contract for twelve MCM vessels for Belgian and Dutch Navies, as well as ongoing construction of Kormoran class mine hunters for the Polish Navy show that mine warfare will be continue to be an important part of navies' operations," Polanski said. "Simultaneously over past years we have seen a steady movement towards the use of unmanned systems in MCM operations, and those two projects are good example of that."

But while unmanned MCM is increasingly keeping personnel out of harm's way, it presents its own challenges.

"Going back to the signatures – with all that in mind – the signature management cannot be a little bit relaxed, we are still required to meet strict standards, provide vessel safety and moreover do this in ever growing budget constraints," Polanski said. "So the development of the efficient DG with CLDG capability within our project is a way to meet both signature level and budget limits.

"CLDG has been already deployed on board MCM vessels while recent works in RIMPASSE trials, DGA/G2ELab presentations concerning submarines and ongoing works within COSIMAR and MASTERCODE projects indicate that signature management is an important task and its advancement should be pursued for both MCM vessels and combatants."

UNDERWATER EYES

On day three Commander Walter Cappelli, Underwater Technologies and Weapon Systems, Naval Armament Directorate, Italian Ministry of Defence, will present on the

SASSO programme, which deals with opto-acoustic sensors for underwater surveillance.

Cappelli points to a number of challenges currently facing the underwater defence arena: the ability to efficiently operate in shallow waters, extend the area controlled by a platform, and the need to develop new means for underwater hardkill, but it is the underwater unmanned vehicle domain that present some of the biggest opportunities for innovation.

The needs here are plentiful: to develop heterogeneous, multidomain, modular, interoperable sensors and data fusion techniques based on AI for the detection, localization, identification and tracking of targets in shallow water; to extend high resilience capability and deployability in multi-environment scenarios to enable effective monitoring and data collection; and enable robust, adaptive, autonomous decision systems based on redundant anomalous behaviour detection techniques with distributed cognitive methodologies to support human intervention.

Key to all of this according to Cappelli? Industrial cooperation.

"The total amount of financing for technologies dedicated to the underwater applications is reduced, except for oil and gas and Artic research, compared to space, air and land," he said. "Industries have consequently reduced their involvement in underwater technologies which can hardly find application in other fields.

"The evolution [requires] the strengthening of industry through international cooperation and, with regard to the European Union, through the creation of common European requirements supported by common finance."

Also on day three, Dr Ioseba Tena, Global Business Manager - Marine Robotics Systems, Sonardyne Spain will discuss the use of covert communications as an enabler for the coordination of force multipliers, such as unmanned underwater vehicles. He will present a novel technology for transferring large volumes of data wirelessly over significant distances subsea, and shed light on how free space optical modems can be used to enable rapid data transfer from and real-time control of unmanned systems.

"I think this is a game changer and will be particularly beneficial for covert operations," Tena said. "Robots are transforming the way we interact within the underwater domain. They pose many challenges both technical and operational, and we need to adapt our traditional tools to both communicate with them and make them part of our CONOPS, as well as understand how others are using them."

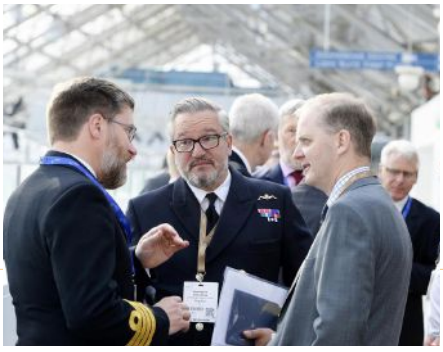
As advances in sensor technology and AI allow platforms to become smaller and more capable, the door to fully exploiting these capabilities is wide open in the underwater domain.

"We have seen the dawn of the unmanned maritime systems age - these systems require that we re-think the subsea domain," Tena said. "Anti-submarine warfare is transformed when the submarines are unmanned, long-endurance and numerous because they become accessible to more players."

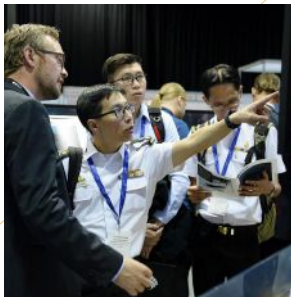
At the same time, battery technology and the miniaturisation of electronics is enabling development to push into completely new directions, such as the ability to deploy acoustics beacons subsea for years at a time.

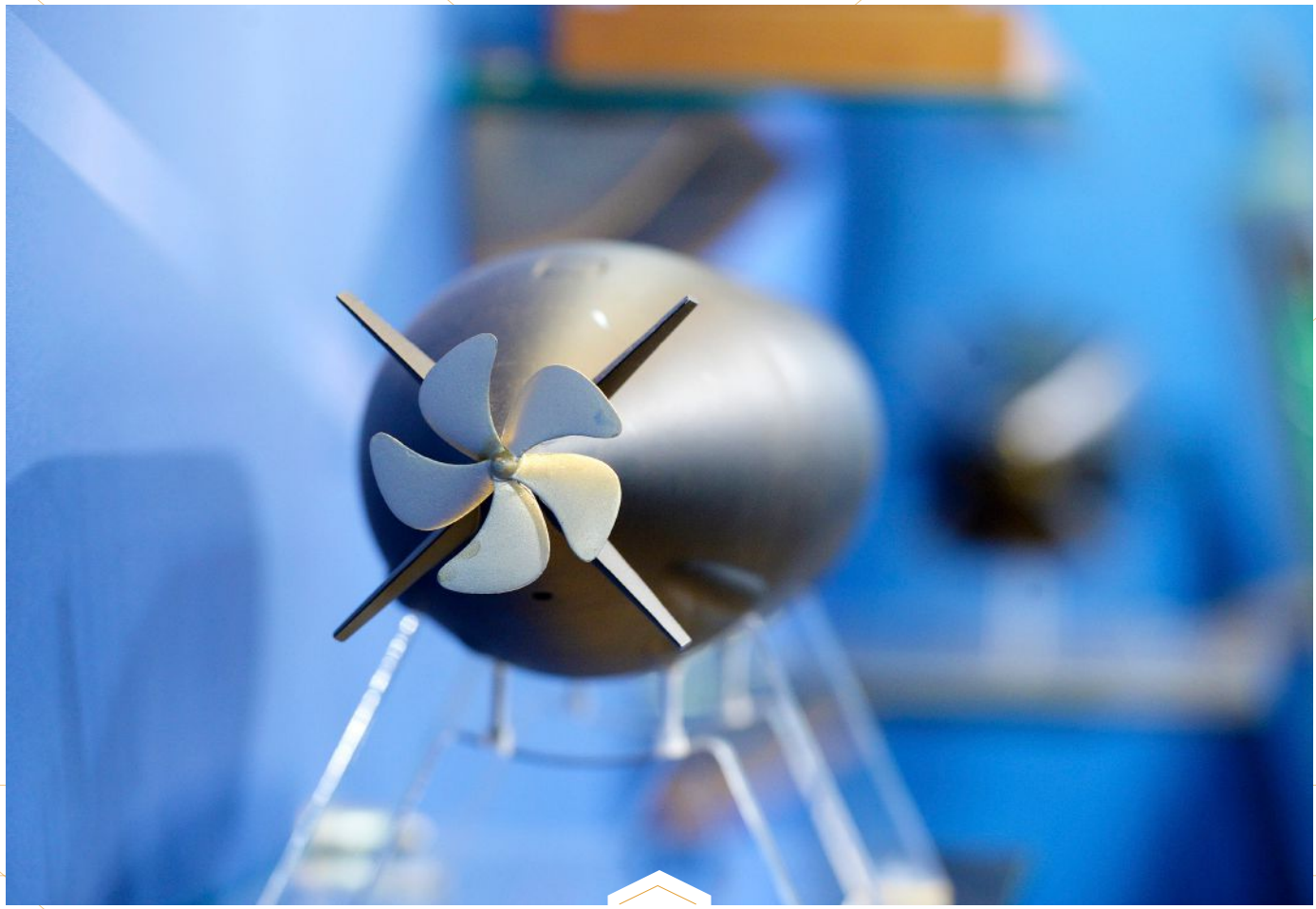
With all these presentations and more, UDT 2019 promises a stimulating and rewarding event for the underwater defence and security community.

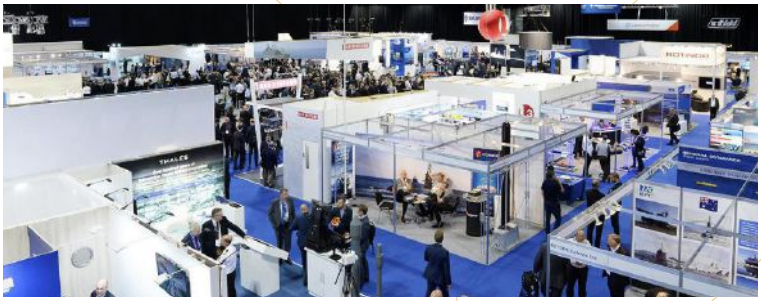
"UDT 2019 offers an ideal opportunity for scientific and industry organisations as well as for defence to collaborate and connect, present new ideas, share experiences and conclusions, as well as gathering comments and feedback from peers," Johansson said. "I am excited to see what the brightest minds in our industry are working on to tackle the underwater defence challenge head on."



» *Bob Anstey, Commodore Royal Navy, speaks at UDT 2018. Photo courtesy of UDT.*







» *Photos courtesy of UDT.*

| DEFENSE |

NAVY TO DEPLOY LOCKHEED MARTIN LASER WEAPON TO DESTROY OR DAZZLE

» *Artist's rendering of the ship-based high-powered laser weapon that the Navy and Lockheed Martin have designed. Photo credit: Lockheed Martin.*

The United States Navy's surface warfare chief says he wants to deploy a laser aboard a destroyer within the next two years, according to USNI News.

The navy plans to install the High Energy Laser and Integrated Optical-dazzler with Surveillance (HELIOS) system for use against small boats.

"We are going to burn the boats, if you will, and move forward with this technology," Rear Adm. Ron Boxall said during the Booz, Allen, Hamilton, and CSBA Directed Energy Summit 2019.

The weapon can also down unmanned aerial vehicles. And if the Navy wants to avoid an international incident, the weapon can "dazzle" a UAV's electro-optical sensors, effectively destroying the sensor without taking down the aircraft.

Developed by Lockheed Martin under a $150 million contract, the 60-kilowatt HELIOS system is three times more powerful than the AN/SEQ-3 laser weapon system the navy unveiled on USS *Ponce* in 2014. The Navy plans to install HELIOS aboard an unspecified Arleigh Burke-class Flight IIA destroyer, in the next several years, Boxall said.

As laser technology matures, direct energy weapons are expected to be deployed on all of the Navy's guided missile destroyers by the mid to late 2020s. HELIOS will be fully integrated into the Aegis combat system of the Navy's surface fleet. The weapon's sensors will enhance Aegis's ability to track and guide weapons to destroy enemy targets. On a long-term view, lasers are expected to replace conventional weapons because of its low cost per shot rate.

Still, there are some technical challenges. As is the case with ground- and air-based laser systems, ship-fired lasers require large amounts of mobile electrical power necessary to generate and strengthen laser attacks. With this in mind, some of the Navy's newest surface combatants are, by design, engineered with much greater on-board power technology. For instance, the new Navy USS Zumwalt stealthy destroyer is powered by a cutting-edge Integrated Power System (IPS), an electric drive engineered to power ship propulsion, as well as on-board systems, such as computers, sensors and weapons. Many point to the Zumwalt as an indication of the type of ship platform able to quickly integrate new weapons, such as lasers and railguns, as they emerge.

> *"The problem I have today is the integration of that system into my existing combat system. If I'm going to burn the boats, I'm going to replace something I have today with that system doing that mission with these weapons."*

"If I have this system that can kill and I have a system that can actually sense, then I have to make sure it integrates with the other things I have on my ship that can sense and kill, namely the Aegis weapon system," Boxall said.

CHINA'S DEFENSE SPENDING IS STILL MASSIVE, DESPITE CUTS

According to Dr. Andrew S. Erickson of the U.S. Naval War College (NWC)'s China Maritime Studies Institute (CMSI) China's navy is receiving warships so quickly that Chinese sources liken this to "dumping dumplings into soup broth."

Overall, the Asian nation will raise defense spending by 1.19 trillion yuan (about 177.61 billion U.S. dollars) in 2019.

Dr. Erickson writes, "Don't get distracted by Beijing's state media hype designed to downplay and justify: The big story about China's defense budget for 2019 isn't that the percentage growth rate is slightly lower than last year's (0.6% less), it's that it's still huge at 7.5%!"

He adds, "China's defense budget is the world's second-largest by any measure. In recent years, it's been growing at rate sustained by no other major power. And it's powered by what is at very least the world's second-largest economy, allowing for significant future funding increases even if China's economic engine continues to slow down (as it almost certainly will)."

Among its investments, Erickson writes that China is "taking the world's largest navy by number of ships, concentrating these forces in a large part around the Near Seas. The major scenarios that it cares about could be called home games, rather than away games, whereas the U.S. Navy is dispersed all around the world. There's simply no way the U.S. Navy is ever going to take all of its assets and focus them all on maritime East Asia."

However, Erickson cautions that we have far less public insight into China's defense spending than they have into ours.

"Beijing will not even release something as simple as a precise and credible breakdown of spending by service," he notes.

To read the full article, visit www.andrewerickson.com/2019/03/china-set-for-yet-another-big-defense-spending-increase-in-2019/.

INDUSTRIAL CONSORTIUM WINS CONTRACT FOR SECURE NETWORK FOR FRENCH NAVY VESSELS

» *Photo courtesy: Airbus*

The French defense procurement agency DGA (Direction générale de l'armement) has awarded the RIFAN 2.1 contract to an industrial consortium headed by Aiarbus and also comprising the Naval Group and Rohde & Schwarz. The contract was signed for a maximum duration of eight years and up to a maximum amount of € 150 million.

The contract covers work to maintain and adapt the existing IP network for the French naval forces, RIFAN 2 (Réseau IP de la Force Aéronavale étape 2), to the needs of the Navy in the coming years, to integrate new ships and remedy hardware and software obsolescence.

It will also enable the future front-line frigates of the FDI ('frégates de défense et d'intervention') program and the future replenishment tankers of the BRF ('bâtiment ravitailleur de forces') program to be integrated into the RIFAN 2 network. The network adaptations will involve both its central architecture and an update of the cybersecurity incident monitoring and detection system.

WWW.AIRBUS.COM

2020 VISION: PENTAGON'S LATEST BUDGET REQUEST EMPHASIZES SHIPBUILDING AND EMERGING TECHNOLOGIES

» *The Sea Hunter unmanned ocean-going vessel represents a prototype of what could ultimately become an entirely new class of ocean-going vessel able to traverse thousands of kilometers over open seas for months at a time, without a single crew member aboard—as the Medium Displacement Unmanned Surface Vehicle (MDUSV). Photo courtesy of the Office of Naval Research.*

On 11 March 2019, President Donald J. Trump sent Congress a proposed Fiscal Year (FY) 2020 Budget request of $750 billion for national security, $718.3 billion of which is for the Department of Defense (DoD). The FY 2020 Budget maintains momentum from the sustained funding increases enacted in FY 2017, FY 2018, and FY 2019. It would also provide the largest military pay raise in ten years (3.1 percent).

The budget includes the largest ship building request in 20 years and the largest research and development request in 70 years.

The FY 2020 budget request increases and diversifies strike options, including offensive-armed unmanned surface and underwater vessels, and advanced long-range missiles. The proposal requests funding for 2 large unmanned surface vessels in FY 2020, which brings the total number of battle force ships funded in FY 2020 to 14.

Across the Future Years Defense Program (FYDP), ship construction includes 55 battle force ships and 10 large unmanned surface vessels. According to the FY 2020 Defense Budget overview, "The USV investment, paired with increased investment in long-range maritime munitions, represents a paradigm shift towards a more balanced, distributed, lethal, survivable, and cost-imposing naval force that will better exploit adversary weaknesses and project power into contested environments."

Total FY 2020 investment requested for the Maritime Domain is $34.7 billion, including:

- 2 large unmanned surface vehicles - $447 million
- 3 Virginia Class Submarines - $10.2 billion
- COLUMBIA Class Ballistic Missile Submarine - $2.2 billion
- 1 CVN-78 FORD Class Aircraft Carrier - $2.6 billion
- 3 DDG-51 Arleigh Burke Destroyers - $5.8 billion
- 1 Frigate (FFG(X)) - $1.3 billion
- 2 Fleet Replenishment Oilers (T-AO) - $1.1 billion
- 2 Towing, Salvage, and Rescue Ship (T-ATS) - $0.2 billion

Among the budget requests for emerging technologies is $3.7 billion in support of Unmanned / Autonomous projects "to enhance freedom of maneuver and lethality in contested environments."

Other emerging technology projects listed are Artificial Intelligence / Machine Learning ($927 million), Hypersonics weapons ($2.6 billion), and Directed Energy investment, such as lasers ($235 million).

The FY 2020 budget request also funds programs that implement survivability improvements to the U.S. maritime defensive capabilities, which consist of the Surface Electronic Warfare Improvement Program Block 3 electronic attack capability (pacing the advanced threats) and the Advanced Off-board Electronic Warfare Program, consisting of long duration, off-board decoys to address identified electronic warfare gaps.

The budget also includes funding for military construction for emergencies, to include border security and reconstruction efforts to rebuild facilities damaged by Hurricanes Florence and Michael ($9.2 billion).

The FY2020 budget for Special Operations Forces (SOF) also mentions additional surface and sub-surface maritime craft.

Acting Secretary of Defense Patrick M. Shanahan said, "With the largest research and development request in 70 years, this strategy-driven budget makes necessary investments in next-generation technology, space, missiles, and cyber capabilities. The operations and capabilities supported by this budget will strongly position the US military for great power competition for decades to come."

The above summary focuses on Naval technology. The entire budget proposal and additional material are available at: http://www.defense.gov/cj.

IXBLUE'S GAPS ACOUSTIC POSITIONING SYSTEM
FOR MINE WARFARE APPLICATIONS

The French General Directorate of Armament for Technical Naval Applications (DGA Technique Navales – DGA/TN, formerly GESMA), an entity specialized in experimentation in the area of mine warfare, has selected iXblue's Gaps acoustic positioning system for its Autonomous Underwater Vehicle (AUV) positioning and monitoring applications.

"The choice of Gaps by the DGA/TN, which is the reference in France in the area of mine warfare, is a clear mark of the confidence placed in our underwater positioning technology", explains Hubert Pelletier, Head of the Acoustics Division of iXblue. "This contract, which further strengthens a longstanding working relationship with the DGA/TN, is testimony to the quality and reliability of our Gaps acoustic positioning system for strategic military applications such as mine warfare."

Incorporating iXblue's Phins inertial navigation system, the Gaps system is equipped with a pre-calibrated USBL (Ultra Short Base Line) antenna and offers very high-precision geo-referenced positioning performance, particularly in shallow waters and in noisy environments. Its telemetry function also allows for the recalibration of the inertial navigation systems (INS) on board the underwater vehicle thanks to an acoustic communication link, as well as for the command and control of the AUV. The broad opening of its 3D antenna, up to as much as 200 degrees, also gives it unrivaled capacity in terms of horizontal tracking, enabling the system to cover a very extensive area and keep the mothership well away from the area of risk. Compact and lightweight, Gaps is very easy to use and integrate and can be installed on different types of platforms (hulls of ships, hoisting systems, poles, buoys, surface drones).

This new contract announced by the DGA/TN confirms the success that iXblue's acoustic positioning system has been experiencing over the last few years. Gaps has already been adopted by more than 120 key players in the military and civil sectors worldwide, and has thus established itself, in recent years, as a leading product for operations requiring the precise positioning of underwater vehicles, towed fish and divers.

WWW.IXBLUE.COM

POMPEO STRESSES U.S. COMMITMENT TO KEEPING SOUTH CHINA SEA TRADING LANES OPEN

In recent public appearances, U.S. Secretary of State, Mike Pompeo has been emphasizing his nation's commitment to preventing any blockade of the South China Sea. During a news conference with the Foreign Affairs Secretary of the Philippines on 1 March 2019, Pompeo said the United States is committed to ensuring the South China Sea remains open to all kinds of navigation. He assured the Philippines that America will come to its defense if its forces, aircraft or ships come under armed attack in the South China Sea.

Pompeo followed this up with a keynote speech at the CERAWeek energy conference in Houston, Texas on March 12, when he said, "China's illegal island-building in international waterways isn't simply a security matter. By blocking development in the South China Sea through coercive means, China prevents ASEAN members from accessing more than $2.5 trillion in recoverable energy reserves. To contrast, the United States Government promotes energy security for those Southeast Asian nations. We want countries in the region to have access to their own energy."

Asked how he sees the role of the U.S. in the Indo-Pacific in terms of the overall growing competition in the region, Pompeo said, "The challenge that's presented to America and to the world by China is different than one that we've confronted before. Our National Security Strategy defines how we think about China in the Trump administration. There are many differences, but one of the most fundamental is we've never had another country of the scale of China, with the military of the scale of China's, that has now expanded into space and property that they do not have a lawful claim to, but with which America has such a deep, intertwined economic and commercial set of relationships. It was often the case, as it is with certain countries today, that we don't have those commercial relationships, so we move away and try and drive them out of the marketplace. China is more complicated and more difficult, but no less challenging to ensuring that America's wealth creation engine is around 10 and 20 and 30 years from now.

> *"In the Indo-Pacific proper, I don't travel to any country in Asia, South Asia, Southeast Asia where energy isn't a topic. I will be honest; where – depending on where I am, they mention it either in public or in private. Many of them don't have the capacity on their own to stand up to the coercive behavior of China, where China moves in and attempts to use its economic clout to influence and control their government. They all welcome companies from the United States. They welcome American capacity for the rule of law. They may not always say this, they may not always speak their mind publicly, but know that I have literally not met a single one of those countries or leaders from one of those countries that didn't want a more American opportunity, more American resources, more American technology and innovation as part of the mix."*

» *The aircraft carrier USS John C. Stennis (CVN 74) transits the South China Sea, March 3, 2019. John C. Stennis is deployed in the U.S. 7th Fleet area of operations in support of security and stability in the Indo-Pacific region. Photo credit: Mass Communication Specialist 3rd Class Grant G. Grady, U.S. Navy.*

Not everyone agrees with Secretary Pompeo over his commitment to the Philippines on this subject. In a 2017 opinion piece, Benjamin Herscovitch of the public policy think tank, the Cato Institute wrote, "To avoid needlessly entangling itself in the South China Sea dispute, the United States should not support the territorial claims of any state and should make clear that the U.S.-Philippine Mutual Defense Treaty does not apply to disputed territory and waters claimed by the Philippines."

In an interview conducted by Buena Bernal of Channel News Asia, which took place on 1 March 2019, Pompeo said, "We're perfectly prepared to let China compete all across the world. But when they do so it needs to be done in a free, open, transparent way. This is part of the United States Indo-Pacific strategy. We're a Pacific nation. We value these open trading lanes. We value the security of the Philippine people, and we have a mutual defense agreement that provides for that. America is committed to this. We continue to be committed to supporting the Philippine people in their own security so that they can grow their economy, as well . . . Each of our countries thrives when we exchange goods and resources and technology, and to do that China can't claim all of the – all of the water. They can't claim an ocean. That's not the way international law works, and it is not good for the world. The United States is determined to ensure that these waterways remain open and our freedom of navigation exercises are an element of that."

» *U.S. Secretary of State Mike Pompeo addresses the audience at the CERAWeek energy conference in Houston, Texas on March 12.*

L3 TO DELIVER INNOVATIVE SOLUTIONS TO THE CSC PROGRAM

L3 Technologies is leveraging its established Canadian companies to deliver industry-leading solutions to the CSC program composed of maritime technologies, systems integration and all-encompassing in-service support.

» *Photo: Business Wire*

L3 Technologies announces that in-country technology, experience and infrastructure proved a winning combination for Canada's new fleet of surface combatants, as Canada's Combat Ship Team has been awarded the Canadian Surface Combatant (CSC) design contract by Irving Shipbuilding. Irving Shipbuilding is the Canadian Surface Combatant Prime Contractor and will build all 15 ships at Halifax Shipyard. L3 is a key partner with Lockheed Martin Canada (LMC) and BAE Systems on the Combat Ship Team.

The CSC program is the largest, most complex procurement ever undertaken by the Government of Canada and includes the construction of Type 26 Global Combat Ships that will replace the Royal Canadian Navy's Halifax-Class frigates and Iroquois-Class destroyers.

L3 Technologies will be providing the Integrated Platform Management System, Integrated Communication Systems, electro-optical infrared (EO/IR) sensors, weapons stowage and torpedo handling systems and helicopter hangar doors.

"This strategic and significant international win is yet another recent example of how L3 is capturing new business and strengthening our position as a leading supplier of maritime solutions to customers on a global scale," said Christopher E. Kubasik, L3's Chairman, Chief Executive Officer and President. "From the start, we collaborated and integrated our mission-proven maritime capabilities into a single offering to ensure the Royal Canadian Navy would receive a technologically advanced, all-inclusive solution that would maximize operational effectiveness throughout the ship's entire life cycle."

L3's ISR Systems business segment will provide an innovative, multi-band Infrared Search & Track (IRST) system and Electro-Optical Surveillance Sensor (EOSS) that leverages technologies from fielded surface ship EOSS solutions and the MX™-Series EO/IR product lines.

L3's Communications & Networked Systems segment will provide its Integrated Communication Systems and the Canadian-developed Integrated Platform Management System, as well as weapons storage and handling systems, and onboard helicopter hangar doors.

L3's strong Canadian presence supports the CSC program with more than 2,200 employees working in Mirabel and Montreal, Quebec; Burlington, Ottawa and Toronto, Ontario; Halifax, Nova Scotia; and testing on both coasts of Canada.

To learn more about L3, visit the company's website

WWW.L3T.COM

WILL SPRING BRING GOOD NEWS FOR ENERGY MARKETS?

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

CRUDE OIL MARKET

Crude oil markets have been in an uplifting phase as sentiment surrounding the effectiveness of the OPEC- and Russian-engineered output cuts are gaining traction. Earlier this year, Russia was slow implementing its 400,000 barrels a day output cut, blaming cold weather for the inability of producers to throttle back flows. As Western Siberia exited its bitter cold winter period, producers have been able to reduce production quicker, heading output toward the lower target. This progress was a factor leading to the cancellation of the planned April meeting of OPEC's production monitoring group that assesses the workings of the organization's output quotas. Some of the key members of that group, along with Russian representatives, met in late March and concluded overall output was falling sufficiently to limit any supply surge in supply that would contribute to a build-up in global inventories and lower oil prices. This view came as President Donald J. Trump tweeted for OPEC to boost output again.

Helping OPEC and Russia achieve their goal has been the sanctions on Venezuelan oil, as well as those on Iran. The Venezuelan oil sector has been slammed by a series of external and internal problems. The U.S. financial sanctions against PDVSA, the Venezuelan national oil company, caused some crude oil buyers to not only stop buying any oil, but actually attempt to return cargos purchased just as the sanctions were put in place. We understand the payments were sent to a restricted bank account available for use by the opposition to President Nicholas Maduro's government. The cargos are sitting in ships off the Venezuelan coast accruing daily demurrage charges. Further impacting Venezuela's outputs has been the report that the German shipping company operating PDVSA's tanker fleet has parked the ships and removed its crews over the failure to be paid.

Adding to these operational issues was the week-long national power outage that knocked out the pumps at the primary oil export facility. No oil was shipped for a week, and even then, the only ship to load and depart was destined for China, who is crediting the cost against repayment of prior loans to Venezuela. That means PDVSA is experiencing a further shrinking of its cash flow, which is pinching repair and maintenance activity. To keep the oil business functioning, the skilled refinery workers have been shipped to drilling rigs across the country to open up new wells. They have been replaced by military personnel, raising concerns about how long before inexperienced workers cause an accident at one of PDVSA's refineries.

With global supply constrained, the focus of oil traders is on the possibility of a global recession that would reduce demand. While a popular concept due to the age of the current economic upcycle, there is no conviction that a recession will occur in 2019 or 2020, despite reductions in global growth projections by the World Bank and other economic forecasters. Unless, and until, there is real evidence of a slowing in oil demand growth, market sentiment is for higher oil prices in the foreseeable future. As crude oil has risen 39 percent since last Christmas Eve, pushing oil briefly above $60 a barrel, expectations are that oil prices could easily reach the mid-$60s. If that happens, it will cement the view that last year's downturn and the current recovery, is producing a pattern that very clearly resembles the early months of the 2014-2016 oil price cycle. That may be a pattern to keep an eye on.

June will be the focal point for the oil market, as it marks the terminus of the current OPEC/Russia production cut agreement. Most likely it will be extended, as any increase in output could expand global oil inventories, destroying the positive market sentiment that has been restored during the first three months of 2019. If the global economy fails to weaken, taking oil demand down, any continued supply restraint should support oil prices, and possibly move them higher. Springtime will be a key test for market sentiment.

NATURAL GAS MARKET

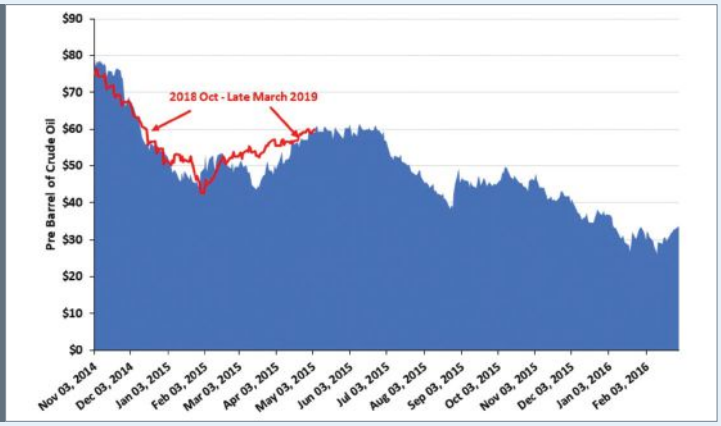
Continued weakness in natural gas prices frustrates gas traders, as well as exploration and production company managements. Despite several Polar Vortex winter blasts sending temperatures to record lows, gas inventory drawdowns have failed to lift gas prices. Low gas prices exist despite higher LNG takeaways, plus greater gas volumes consumed in generating electricity. The problem for gas prices is production – it never seems to stop rising. In fact, the Energy Information Administration's most recent Short-Term Energy Outlook for March projects higher output for the past two months (covering the period when actual production data is not yet available) and for future months extending through December 2020. Supply is projected to grow eight percent, which is weighing on the market. If gas supply grows that much, then gas consumers need not be concerned about the current low level of gas storage.

Last week's gas storage report shows national inventories are 20.5 percent below last year's low, and 33.2 percent below the 5-year average. Interestingly, in the year ago storage data, every geographic region, but the East and Midwest, are down more than 20 percent. The East region's volume is 8.5 percent below last year, while the Midwest has 13.9 percent less gas supply. Both regions have been hit by several late winter/early spring storms and bouts of cold temperatures. In fact, the joke in these regions was that people are referring to Punxsutawney Phil, the famous meteorological groundhog, as a liar, given the weather experienced since his declaration on February 2nd of an early spring. People may have forgotten that the forecast called for only six more weeks of winter, and in 2019, that may actually

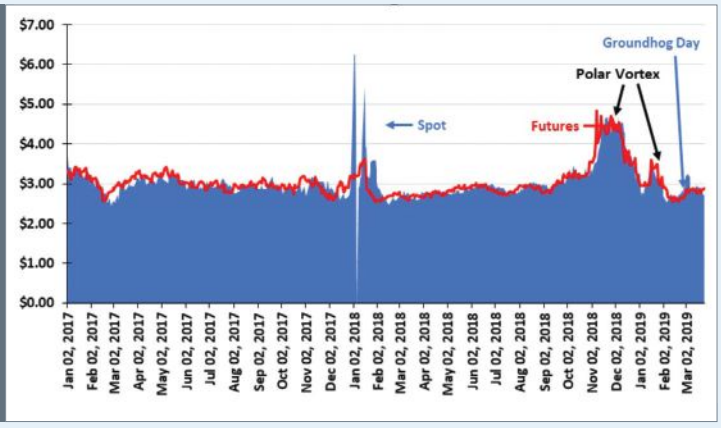
prove to be the case. Phil is guilting of not telling them that those additional six weeks of winter would be brutal!

Traders see all the gas market fundamentals as positive for higher prices, except for gas supply. As long as the oil shale boom continues to unleash large volumes of associated natural gas, and flaring operations are restricted, gas consumers can rest easy that adequate supply will be available to meet current consumption as well as rebuild the storage needed to meet next winter's demand. Instead of climbing above $3 per thousand cubic feet, prices are languishing below $2.70/Mcf. The current forward price curve is not supportive of $3/Mcf gas until the dead of next winter, and even then, it is a seasonal uplift and not a permanently higher base level. The most boring commodity market looks set to remain boring, at least for a while.

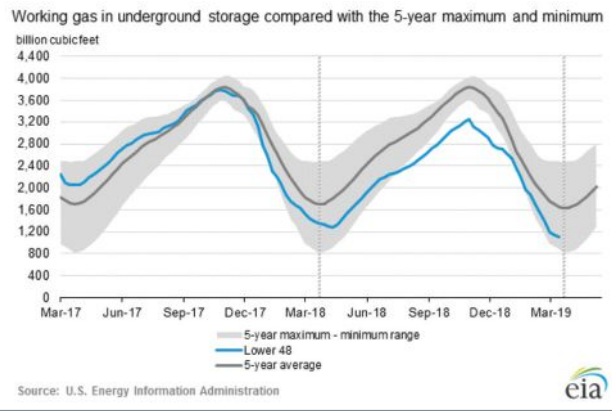
Current Oil Prices Are Consistent With 2015 Peak; Are We Heading Higher?



Did The Groundhog Really Lie About Spring's Arrival?



Recent Weekly Gas Storage Points To Better Supply Outlook

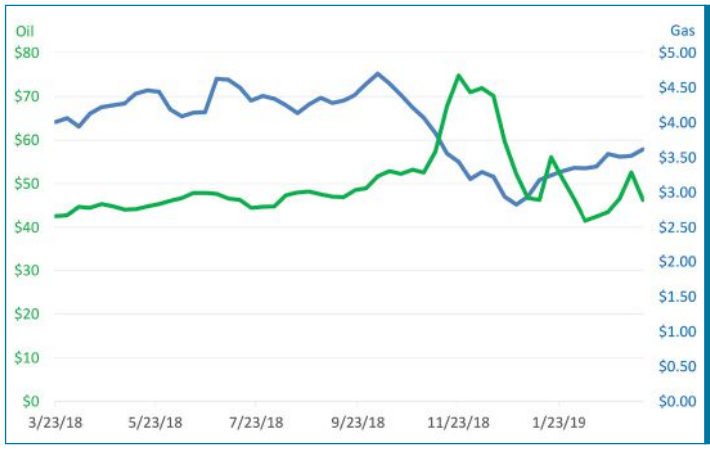


CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF MARCH 18, 2019

Energy prices moved up slightly in the past month. Oil prices rose to nearly $58 per barrel on March 15. That is up from about $54 per barrel in mid-February. Disruptions in Venezuela's oil output were offset by rising U.S. inventories, while concerns over the possibility of a global eco-nomic slowdown continue to weigh on the market, according to CNBC.

Natural gas prices spike to above the $3.25 per million BTU mark in early April but quickly came back does to $2.89 by March 15. This is slightly higher than a month earlier, where prices were around the $2.65 per million BTU mark.



WEEKLY WTI CRUDE & NATURAL GAS SPOT PRICES

Last 52 Weeks

WTI Spot Price

$57.81

$53.88 previous month

TRENDING UP

Henry Hub Spot Price

$2.89

$2.65 previous month

TRENDING UP

KEY EQUITY Indexes

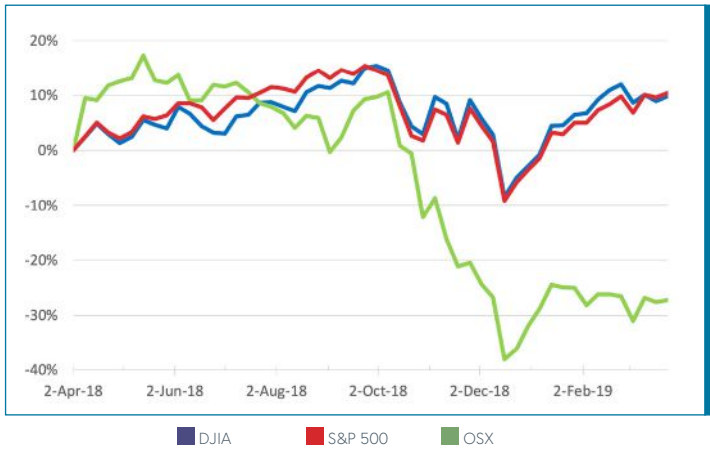
PRICES IN US DOLLARS AS OF MARCH 25, 2019

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

Equity markets showed little movement in the past month. The Dow Jones Index edged up above the 26,000-point mark in late February but dropped back to 25,657.73 by March 25. That makes it basically flat for the month as recession fears have risen and fallen during the past month.

The S&P 500 has seen a little stronger growth. Rising from around 2,500 points in mid-February to 2,818.46 by March 25. The PHXL Oil Services Index (OSX) has been basically flat for the month, alt-hough it did slip from approximately 95 points in mid-February to 94.30 points on March 25.

SELECTED EQUITY INDEXES



CUMULATIVE PERCENTAGE CHANGE

Last 52 Weeks

25,657.73

Down **192.90** from previous month

TRENDING DOWN

DJIA

94.30

Down **1.67** from previous month

TRENDING DOWN

OSX

2,818.46

Up **43.58** from previous month

TRENDING UP

S&P 500

Coming this winter!

NEW! 2019 UPPER DECK Equipment Guide

UPPER DECK is proud to announce an expanded, all new digital deck equipment guide to be published in Q4 of 2019!

This comprehensive, must-have guide for marine and related industries contains comparative product information for Winches, A-Frames, Cranes and, Buoys and be distributed through ON&Ts' over 20,000 subscribers. In addition, the deck equipment guide will:

- ☑ Contain contact information of manufacturers and rental companies
- ☑ Will have additional global distribution via its availability on ON&T's website for all of 2020 (under "Buyers' Guide")
- ☑ Will be promoted heavily on social media

Don't miss out on this opportunity to reach and connect with industry leaders and professionals!

Visit www.oceannews.com for more updates.

jlewis@tscstrategic.com

AMERICAS

OTC
Houston, TX » May 6-9
www.2019.otcnet.org

Telecom Exchange
New York, NY » May 14-15
www.thetelecomexchange.com/nyc

H2O Conference
Halifax, Nova Scotia » June 6-7
www.h2oconference.ca

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

Brazil Offshore
Rio do Janeiro, Brazil » June 25-28
www.brasiloffshore.com

ESRI User Conference
San Diego, CA » July 8-12
www.esri.com/en-us/about/events/uc/overview

PORTS'19
Pittsburgh, PA » September 15-18
www.portsconference.org

Teledyne Marine Tech Workshop
San Diego, CA » October 6-9
www.teledynemarine.com/events/TMTW2019

LAGCOE
New Orleans, LA » October 9-11
www.lagcoe.com/home-expo

AWEA Offshore WINDPOWER
Boston, MA » October 22-23
engage.awea.org/Events

OCEANS'19
Seattle, WA » October 28-31
www.seattle19.oceansconference.org

OTC Brazil
Rio de Janeiro, Brazil » October 29-31
www.otcbrasil.org

EUROPE

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

DEVEX
Aberdeen, UK » May 7-8
www.devex-conference.org

UDT
Stockholmsmassan, Sweden » May 13-15
www.udt-global.com

Seanergy
Dunkerque, France » June 5-7
www.seanergy2019.com

OMAE
Glasgow, UK » June 9-14
www.event.asme.org/OMAE

OCEANS '19 Europe
Marseille, FR » June 17-20
www.oceans19mtsieeemarseille.org

European Wave and Tidal Energy Conference
Napoli, Italy » September 1-6
www.ewtec.org/conferences/ewtec-2019

SPE Offshore Europe
Aberdeen, UK » September 3-6
www.offshore-europe.co.uk

DSEI
London, UK » September 10-13
www.dsei.co.uk

Ocean Energy Europe
Dublin, Ireland » Sept. 30 - Oct. 1
www.oceanenergy-europe.eu/annual-event/oee2019

Offshore Energy
Amsterdam, The Netherlands » October 8-9
www.offshore-energy.biz

AUSTRALASIA

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

Offshore Well Intervention Asia Pacific
Kuala Lumpur, Malaysia » May 2-3
www.interventionasiapac.offsnetevents.com

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

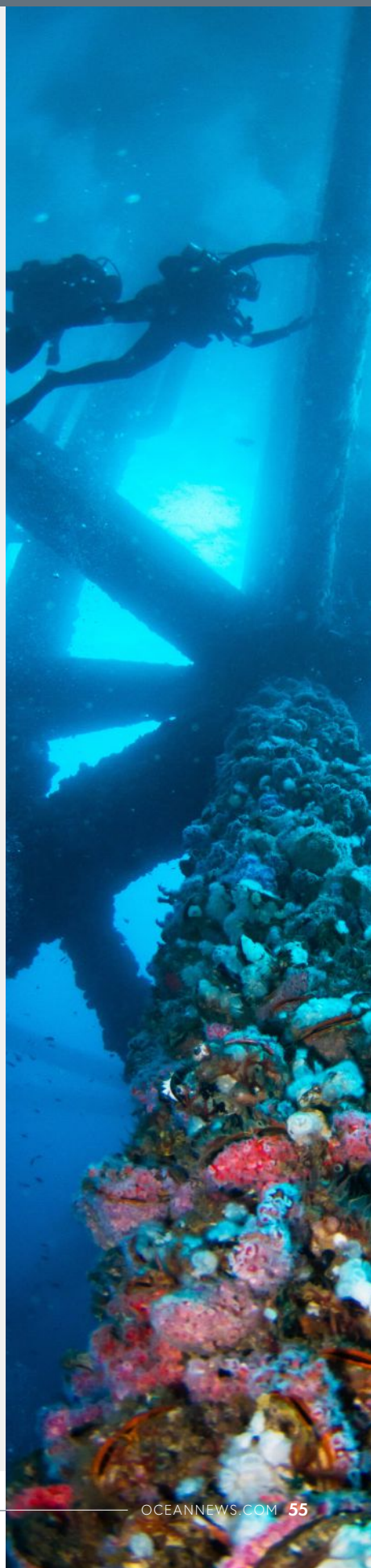
Submarine Networks World
Singapore » September 17-19
www.terrapinn.com/conference/submarine-networks-world/index.stm

Bahrain Int'l Defense Conference
Manama, Bahrain » October 28-30
www.bahraindefence.com

ADIPEC
Abu Dhabi » November 11-14
www.adipec.com

Oceanology International China
Shanghai » November 13-15
www.oichina.com.cn/en/home

EDITORIAL FOCUS	PRODUCTS & SERVICES FOCUS	SHOW DISTRIBUTION
JANUARY		
» Deepwater Inspection, Repair & Maintenance » ROV Tooling	Manipulator Arms & Tools; Pumps, Hoses and Hose Connectors; Cameras, Lights	Underwater Intervention » February 5-7 Subsea Expo » February 5-7 Oceanology Americas » February 25-27
FEBRUARY		
» Subsea Cables » Offshore Communication	Cable Installation Services and Equipment; Telecommunication Technologies	Int'l Wind Partnering Forum » April 9-10
MARCH		
» Mapping & Survey » Oceanology » MetOcean	Bathymetric Mapping/Charting; Data Acquisition & Processing	US Hydro » March 18-21 Ocean Business » April 9-11
APRIL		
» Offshore Technology » Maritime Security & Ocean Intelligence	Testing Facilities; Military Tech and Contractors	OTC » May 6-9 UDT » May 13-15 AUVSI XPONENTIAL » April 30 – May 2 💻
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	SPE Offshore Europe » September 3-6 Teledyne Marine Tech » October 6-9
SEPTEMBER		
» Renewables » Offshore Energy Installation & Maintenance	Energy Storage Devices; Inspection Drones; Current Meters	Ocean Energy Europe » Sept. 30-Oct. 1 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



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$193.4 MILLION BUDGET PROPOSED FOR BOEM IN FISCAL YEAR 2020

President Donald Trump has proposed a $193.4 million Fiscal Year (FY) 2020 budget for BOEM. The President's request support efforts advancing Executive Order 13795, Implementing an *America-First Offshore Energy Strategy*, which requires BOEM to develop and implement a 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Program (National OCS Program). With this request, BOEM proposes to focus resources on the aforementioned Leasing Program, Renewable Energy, Marine Minerals, and Environmental Analyses. Additional details are available at www.doi.gov/budget/appropriations/2020/highlights.

IOSTIA LAUNCHES CAREER CENTER

The International Ocean Science & Technology Industry Association (IOSTIA)has launched a career center that connects association professionals with employers.
"Providing our members with opportunities for professional development and career growth is core to our mission to serve the ocean science and technology industry," said Rich Lawson, CEO of IOSTIA. "Our members are highly appealing to companies in the US and abroad because they've demonstrated a commitment to the highest levels innovation."

In addition to job opportunities, the IOSTIA Career Center will include:

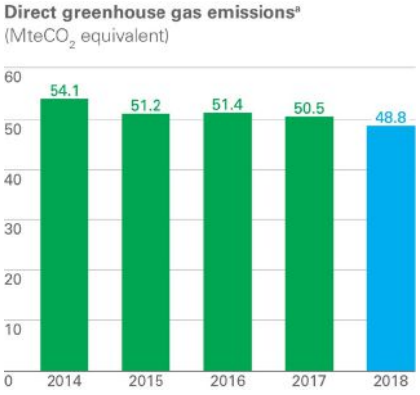
- The ability for professionals to post anonymous resumes.
- Options for employers to expose jobs to passive job-seeking professionals who do not visit job boards, including Job Flash emails to IOSTIA's registered job seekers.
- Integration of job content into social media channels.
- Extensive employment brand advertising opportunities for employers.
- A mobile-responsive environment.
- Job alerts that match personal goals and interests.
- Integration of career resources, training and other benefits offered by IOSTIA to members.
- The ability for job seekers and employers to gain exposure throughout partnering YourMembership's network of nearly 2,500 niche Career Centers.

For more information, visit www.iostia.org and select Career Center in the navigation bar.

IOSTIA
Advancing the Business of Ocean Technology

BP ESTABLISH $100 MILLION FUND FOR EMISSIONS REDUCTION PROJECTS

BP has announced that it has established a $100 million fund for projects that will deliver new greenhouse gas (GHG) emissions reductions in its Upstream oil and gas operations. The new Upstream Carbon Fund will provide further support to BP's work generating sustainable greenhouse gas emissions reductions in its operations.



IMCA Appoints Technical Director

» *Mark Ford, IMCA's New Technical Director*

Mark Ford, Technical Manager of the International Marine Contractors Association (IMCA), has been promoted to Technical Director of the global organization.
Ford joined the IMCA Secretariat in 2012 from Charles Taylor Consulting, where he worked as a senior surveyor and divisional director in the safety and loss prevention department. At Braemar Engineering he was a consultant engineer specializing in FMEA studies of offshore vessels. Earlier, he worked as a Superintendent Engineer managing a fleet of vessels with respect to dry dockings and technical maintenance. Mark has a 25-year career at sea including extensive experience as Chief Engineer on DSVs and offshore support vessels. In 2018 he was unanimously endorsed by the International Association of Classification Societies (IACS) to become a member of the IACS Advisory Committee (AVC).

Further information is available at www.imca-int.com.

IMCA

EXPRO AWARDED ROSPA ORDER OF DISTINCTION

International oilfield services company, Expro, has been recognized with an Order of Distinction for 15 consecutive gold awards in the RoSPA (Royal Society for the Prevention of Accidents) Health and Safety Awards.

The award is presented to organizations that sustain the highest standards of health and safety management and innovation over consecutive years. It recognizes Expro's continued success in safety, as well as a range of new safety initiatives carried out during the past year. Expro has been recognized by RoSPA every year since 2005, including four Oil and Gas Sector awards, the Gold Medal in 2010, the Scotland Trophy in 2013, and the President's Award in 2016.

www.rospa.com/awards

ROLLS-ROYCE COMMERCIAL MARINE NOW AN INTEGRATED PART OF KONGSBERG

The Kongsberg Group ASA (KONGSBERG) purchase of Rolls-Royce Commercial Marine (RRCM), announced on 6 July 2018 was completed April 1, 2019. The group has now become a more complete technology supplier, and has strengthened its competitiveness as a strategically important supplier for shipping companies, and shipyards, as well as other customers and partners. A broader product portfolio, complete solutions and increased volume of service assignments, strengthens the position as a global leading technology supplier in the maritime industry.

Today, Kongsberg Maritime's equipment is installed on more than 30,000 vessels worldwide. With the acquisition of RRCM, KONGSBERG is now represented in 40 countries, close to 11,000 employees and an annual turnover of more than NOK 22 billion.

Kongsberg Maritime is now a global leader on automation, navigation and control systems, propellers, propulsion systems, deck handling equipment and ship design. Collectively the group will be a leading innovator in the maritime industry where sustainable solutions and digitalization transforms the industry.

The parties have agreed a value for Rolls-Royce Commercial Marine of GBP 500 million (on a cash and debt free basis and with working capital at an agreed level). The final purchase price is determined based on Rolls-Royce Commercial Marine's cash, debt and working capital at time of completion of the transaction.
www.kongsberg.com

KONGSBERG

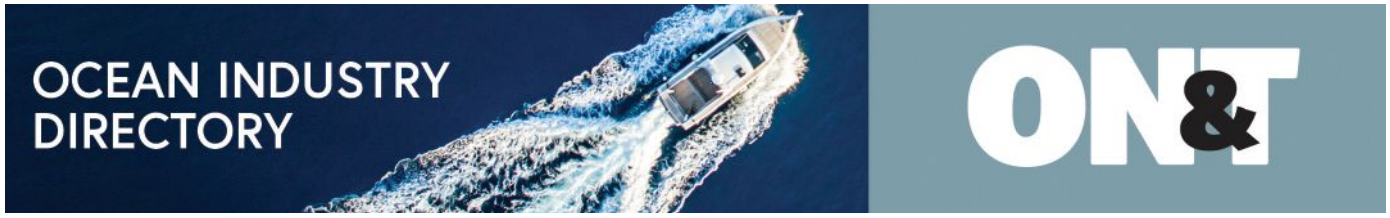
NEW 2019 UV Buyers' Guide / Coming this summer!

The UV Buyers' Guide was our MOST POPULAR publication last year, and for good reason.

- ☑ It is essential. Whether you are listing a vehicle, or looking for one, this comprehensive catalog is a must-read for operators in the subsea industry.
- ☑ It is up-to-date. The information it includes comes straight from the providers and is backed by our four decades of experience building this type of publication.
- ☑ The Guide is sectioned into eight classifications based on the ROV Committee of the Marine Technology Society (MTS).
- ☑ For each vehicle, we've indicated the industry segment the vehicle fits within.
- ☑ The Guide is a living document. Not only does ON&T update it every year, but we include links to more detailed specifications.

Visit www.oceannews.com for more updates.

jlewis@tscstrategic.com



ACOUSTIC SYSTEMS

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Website: www.appliedacoustics.com
Contact: Gavin Willoughby

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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Contact: Glenn Pollock

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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Website: www.oceansonics.com

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.

Ocean Sonics is dedicated to your success. We provide services in deployment, system design and integration, and data processing.

Listen Now. The Ocean Sonics Way.

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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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E-mail: reson@teledyne.com
Website: www.teledynemarine.com/reson/
Contact: Shannon Searing

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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E-mail: rdisales@teledyne.com
Website: www.rdinstruments.com
Contact: Paul Devine

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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Fax: +1 902 468 4442
E-mail: emily@metocean.com
Website: www.metocean.com
Contact: Emily MacPherson

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

BUOYANCY PRODUCTS

DEEPWATER BUOYANCY, INC.

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E-mail: sales@deepwb.com
Website: www.DeepWaterBuoyancy.com
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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info@nautilus-gmbh.com
Website: www.vitrovex.com
Contact name: Steffen Pausch

Nautilus Marine Service provides the finest VITROVEX® glass housings that are capable of operating in the most extreme regions of the Earth. VITROVEX® glass enclosures offer the dual advantage of buoyancy and pressure proof housings - a perfect combination for small and autonomous underwater instrumentation packages.

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Fax: 401-884-8868
E-mail: richard@subsalve.com
Website: www.subsalve.com
Contact: Richard Fryburg

Since 1977 Subsalve USA has been America's #1 manufacturer of standard and custom flotation devices and we are the innovators in buoyancy and engineered inflatables. Our products include: Professional, Commercial, Standard, Shallow Water, Enclosed Flotation Bags, Cable & Pipeline Floats, Water Load Test Bags, Rapid Recovery & Mark V/ORCA EOD Systems.

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ARTIC RAYS LLC

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Website: www.articrays.com
Contact: Lee Fray

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.

CATHX OCEAN

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E-mail: apastor@cathxocean.com
Website: www.cathxocean.com
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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Website: www.deepsea.com

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.

Design criteria for products include ease of service, reliability, high performance, and cost effectiveness. Products are rigorously tested in both the initial design process and manufacturing stage to perform in the harsh marine environment–from wet/dry surface applications to full ocean depth deployments. DeepSea Power & Light offers a versatile product line while developing new designs to continue exceeding market expectations.

SIDUS SOLUTIONS, LLC

7352 Trade Street
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Email: info@sidus-solutions.com
Website: www.sidus-solutions.com

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 for and 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.

CABLES

CORTLAND COMPANY

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Contact: Slobodan Nikolić - +1 (832) 416-3819

Cortland is a global designer, manufacturer, and supplier of technologically advanced ropes, slings, cables, and strength members. Collaborating with customers, our team uses its experience in high performance materials and market knowledge to transform ideas into proven products.

Our products feature the most advanced synthetic strength members in combination with electrical or optical elements. For more than 35 years, our custom-built solutions have been developed for work in the toughest environments and to overcome some of the world's greatest challenges.

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Website: www.falmat.com
Contact: Shawn Amirehsani

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

SOUTH BAY CABLE CORP

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E-mail: bill@southbaycable.com
Website: www.southbaycable.com
Contact: Bill Tell, Sales Manager

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

CONNECTORS

BIRNS, INC.

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Contact: Eric Birns

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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E-mail: sales@birnsaquamate.com
Website: www.birnsaquamate.com
Contact: Eli Bar-Hai

Birns Aquamate design and manufacture underwater electrical connectors, cable assemblies, and cable terminations. The company produces a wide range of standard industry 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.

SEACON

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E-mail: elcajonsales@te.com
Website: www.seaconworldwide.com

For the widest range of connectivity and sensor solutions designed for subsea applications, TE Connectivity (TE)'s portfolio includes over 2,500 underwater electrical and fiber optic connectors, and complete connectivity systems to give you a wide range of advanced connectivity options. The portfolio includes not only SEACON products, but DEUTSCH connectors, Rochester engineered cables, and TE sensors – giving you one-stop access to rugged, reliable solutions.

TELEDYNE MARINE

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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

HYDRO LEDUC NA, INC.

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Tel: 281-679-9654
E-mail: bogden@hydroleduc.com
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.

DIGITAL VIDEO RECORDING SYSTEMS

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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 realtime 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....

EQUIPMENT RENTAL

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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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Tel: +1 772 219 3000
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Email: contact@oceanspecialists.com
Website: www.oceanspecialists.com

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

KONGSBERG SEATEX AS
Pirsenteret
N-7462 Trondheim, Norway
Tel: +47 73 54 55 00
Fax: +47 73 51 50 20
E-mail: km.seatex.sales@kongsberg.com
Website: www.km.kongsberg.com/seatex
Contact: Finn Otto Sanne at finn.otto.sanne@kongsberg.com

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.

LIQUID STORAGE

AERO TEC LABORATORIES, INC. (ATL)
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Ramsey, NJ 07446 USA
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Fax: +1 201 825 1962
E-mail: atl@atlinc.com
Website: www.atlinc.com
Contact: David Dack

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, ethyleneglycol, hydraulic fluids and chemical cleaning cocktails. Expedited deliveries are also available.

MARINE ENVIRONMENTAL CONSULTING SERVICES

CSA OCEAN SCIENCES INC.
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Fax: +1 772 219 3010
E-mail: gstevens@conshelf.com
Website: www.csaocean.com
Contact: Gordon Stevens

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.

MARINE VENTURES INTERNATIONAL, INC. (MVI)
8524 SW Kansas Avenue
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Fax: +1 772 419 9628
E-mail: bpudney@marineventures.com
Website: www.marineventures.com
Contact: Bruce Pudney

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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NAVIGATION & POSITIONING SYSTEMS

ADVANCED NAVIGATION
Level 8, 37 Pitt Street, Sydney 2000
New South Wales, Australia
Tel: +61 2 9099 3800
E-mail: sales@advancednavigation.com.au
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.

EVOLOGICS GMBH
Ackerstrasse 76
13355 Berlin, Germany
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Fax: +49 (0) 30 4679 862-01
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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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.

RJE INTERNATIONAL, INC.

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E-mail: sales@rjeint.com
Website: www.rjeint.com
Contact: Bruce O'Bannon

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.

NETWORK & DATA COMS

KONGSBERG SEATEX AS

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

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.

OCEANOGRAPHIC INSTRUMENTS/SERVICES

ASL ENVIRONMENTAL SCIENCES, INC.

Victoria, BC, Canada
Tel: +1-250-656-0177
E-mail: asl@aslenv.com
www.aslenv.com

• **Metocean Equipment Leasing:** Acoustic Doppler Current Profiler ADCPs (including StreamPro & RiverRay), Ice Profilers, AZFP, acoustic releases, wave/tide gauges, pingers, satellite beacons, CTD+DO+Tu profilers, DO & turbidity loggers, weather station, cages, flotation, bottom frames.

•**Oceanographic Products:** Acoustic Zooplankton Fish Profiler (AZFP), Ice Profiling Sonar (IPS5) & shallow water Ice Profiler (SWIP), Imagenex scanning sonar logger (IRIS), instrument cages, bottom frames. Custom acoustic products and system integration.

• **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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Website: www.nke-instrumentation.com

- Fresh and marine waters multiparameter probes: CTD, dissolved oxygen, turbidity, chlorophyll, Phycocyanin, Phycoerythrin, CDOM, detection of hydrocarbons, pH, Redox.
- Dedicated monitoring data loggers and equipment for: sediment transport, underwater systems behavior, marine corrosion, pCO2 sensor (stand alone or on drifting buoy), density, absolute salinity.
- Intelligent network: environmental parameters (meteorologic and oceanographic), Ecosystems Approach to Fisheries (EAF–Voluntary fishing vessels), Webdata application.
- Provor and Arvor profiling subsurface floats (ARGO project): CTD, dissolved oxygen, BGC, deep; Argos and Iridium transmission.
- Drifting surface buoys with temperature and GPS receiver for Surface velocity project.

RBR

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Website: https://rbr-global.com/

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

ROMOR OCEAN SOLUTIONS

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Contact: Darrin Verge, President & CEO

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.

SEA-BIRD SCIENTIFIC

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Website: www.sea-birdscientific.com
Contact: Calvin Lwin, Sales

Sea-Bird Scientific provides best-of-class sensors and systems for oceanographic research and environmental water quality monitoring of physical and biogeochemical properties. Sea-Bird Scientific is the leader in accurate, stable ocean instruments for measuring conductivity (salinity), temperature, pressure, oxygen, pH, chlorophyll, CDOM, turbidity, beam attenuation, irradiance, radiance, PAR, nitrate, and phosphate. Our CTD profilers, water samplers, moored CT recorders, wave/tide recorders, DO sensors, and optical sensors are used by research institutes, ocean observing programs, government agencies, and navies globally.

STAR-ODDI

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Gardabaer, Iceland
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E-mail: baldur@star-oddi.com
Website: www.star-oddi.com
Contact: Baldur Sigurgeirsson

A manufacturer of miniature data loggers with sensors as temperature, depth/pressure, salinity, tilt/acceleration, compass direction/magnetometer, light levels, acoustic receiving/transmitting. The loggers are used for various researches, including oceanography, fishing gear studies, equipment behavioral monitoring and fish tagging.

SONAR SYSTEMS

ECHOLOGGER

303 Venture Center,
76 Hanggongdaehak-Ro, Deokyang-Gu,
Goyang-Si, Gyungki-Do, 10540, Korea
Tel: +82-2-3158-3178
Email: info@echologger.com
Website: www.echologger.com
Contact: Doowon Choi

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

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

KLEIN MARINE SYSTEMS, INC.

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Salem, NH 03079
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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

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

Marine Sonic Technology builds high quality, high resolution side scan sonar systems. Located in Yorktown, Virginia, Marine Sonic has been in business for more than 25 years. Our towed systems are rugged, easy to deploy and simple to operate. We also offer highly efficient AUV/ROV embedded systems, which occupy minimal space and low power consumption.

SOUND VELOCITY PROBES/CTDS

SAIV A/S

Nygardsviken 1, 5165
Laksevag, Norway
Tel: +47 56 11 30 66,
Fax: +47 56 11 30 69
E-mail: info@saivas.com
Website: www.saivas.no
Contact: Gunnar Sagstad

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

SUBSEA FABRICATION

NEW INDUSTRIES

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

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

SUBSEA TECHNOLOGY

KONGSBERG MARITIME AS – SUBSEA DIVISION (DIVISION OF KONGSBERG GROUP)

Strandpromenaden 50
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Kongsberg Maritime is a marine technology company providing innovative solutions for all marine industry sectors including merchant, offshore, subsea, naval and fisheries. The company delivers systems that cover diverse maritime applications. Within subsea, Kongsberg Maritime's sonars, Sub-bottom profilers, multibeam and single beam echo sounders, cameras, positioning and underwater communication & monitoring systems, instruments, software and Marine Robotics are used in survey and inspection operations worldwide. Working closely with customers to develop technology that pushes the limits in subsea applications, Kongsberg Maritime is also dedicated to developing innovative environmental monitoring solutions such as the K-Lander system in addition to cutting-edge Marine Robotic platforms such as the futuristic Eelume vehicle.

UNMANNED MARITIME VEHICLES

GENERAL DYNAMICS MISSION SYSTEMS' BLUEFIN ROBOTICS PRODUCTS

553 South Street
Quincy, MA 02169
Tel: +1 617 715 7000
E-mail: adam.mara@gd-ms.com
Website: gdmissionsystems.com/underwater-vehicles/bluefin-robotics
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.

INTERNATIONAL SUBMARINE ENGINEERING LTD. (ISE)

1734 Broadway Street,
Port Coquitlam, BC, V3C 2M8
Tel: 1-604-942-5223
E-mail: info@ise.bc.ca
Website: https://ise.bc.ca/

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:

- Autonomous Underwater Vehicles (AUVs)
- Remotely Operated Vehicles (ROVs) for subsea operation
- Human Occupied (HO) submersibles
- Customized systems for the offshore oil industry
- Customized systems for the Military-Naval sector
- Hydraulic, pneumatic, and electric robotic manipulators
- Teleoperated and autonomous robotic systems
- Robotic systems for nuclear Industry applications
- Communications and real-time control system

L3 OCEANSERVER, INC.

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

iVER3-580 Autonomous Underwater Vehicle

L3 OceanServer, Inc. is one of the leading manufactures of unmanned underwater vehicles (UUVs) with over 300 units delivered to customers around the world.

The Iver UUV is an affordable, simple to operate commercial system for military, survey, water quality, and research applications.

OUTLAND TECHNOLOGY

38190 Commercial Ct.
Slidell, LA 70458 USA
Tel: 985-847-1104
Fax: 985-847-1106
E-mail: jeff@outlandtech.com
Website: www.outlandtech.com
Contact: Jeff Mayfield

Offering the most rugged equipment and unsurpassed customer service, Outland Technology has been the world's leading manufacturer of underwater video, lighting 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.

TELEDYNE OCEANSCIENCE

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Poway, CA 92064
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Website: www.teledynemarine.com/oceanscience
Contact: Jamie Carrig

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.

VIDEORAY

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Fax: +1 610 458 3010
E-mail: sales@videoray.com
Website: www.videoray.com
Contact: Chris Gibson

With more than 3,700 ROVs in service around the world, VideoRay is the global leader in Observation ROV technology. VideoRay's underwater robot systems are extremely versatile, portable, affordable, and reliable solution for underwater operations including surveys, offshore inspections, search & recovery, homeland & port security, science & research, aquaculture, and many other underwater applications. The latest Mission Specialist systems provide solutions for particularly difficult underwater challenges. VideoRay is available on the General Services Administration (GSA) Schedule.

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Website: www.okeanus.com
Contact: Ted Brockett

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SOSI and DT Marine brand winches, handling systems, and engineered solutions are now available exclusively from Okeanus Science & Technology. Proven, reliable, and cost-effective standard and custom designed winches range from small all-electric instrumentation winches to high horsepower all-electric or hydraulic umbilical and multi-purpose oceanographic systems. SOSI brand winches can be packaged and supplied with skids, A-frames, over-boarding sheaves, HPUs, and other auxiliary equipment. Okeanus has offices in Houston, TX, Redmond, WA and Houma, LA. Call, email or visit www.okeanus.com for more information.

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USBL POSITIONING SYSTEMS

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

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

LBL POSITIONING SYSTEMS

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

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

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

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

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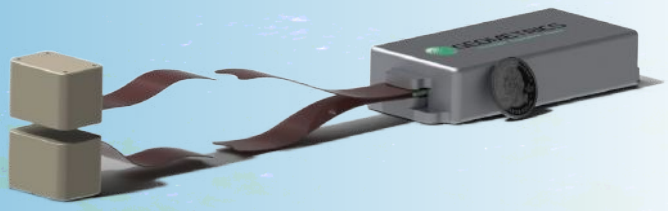

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