August 2018

ON&T

Ocean News & Technology

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THE UNMANNED VEHICLES ISSUE:

Bringing You the Latest Features and News About ROVs, AUVs, and UUVs.

SEE PAGES 10, 20, 32, 34 & 40

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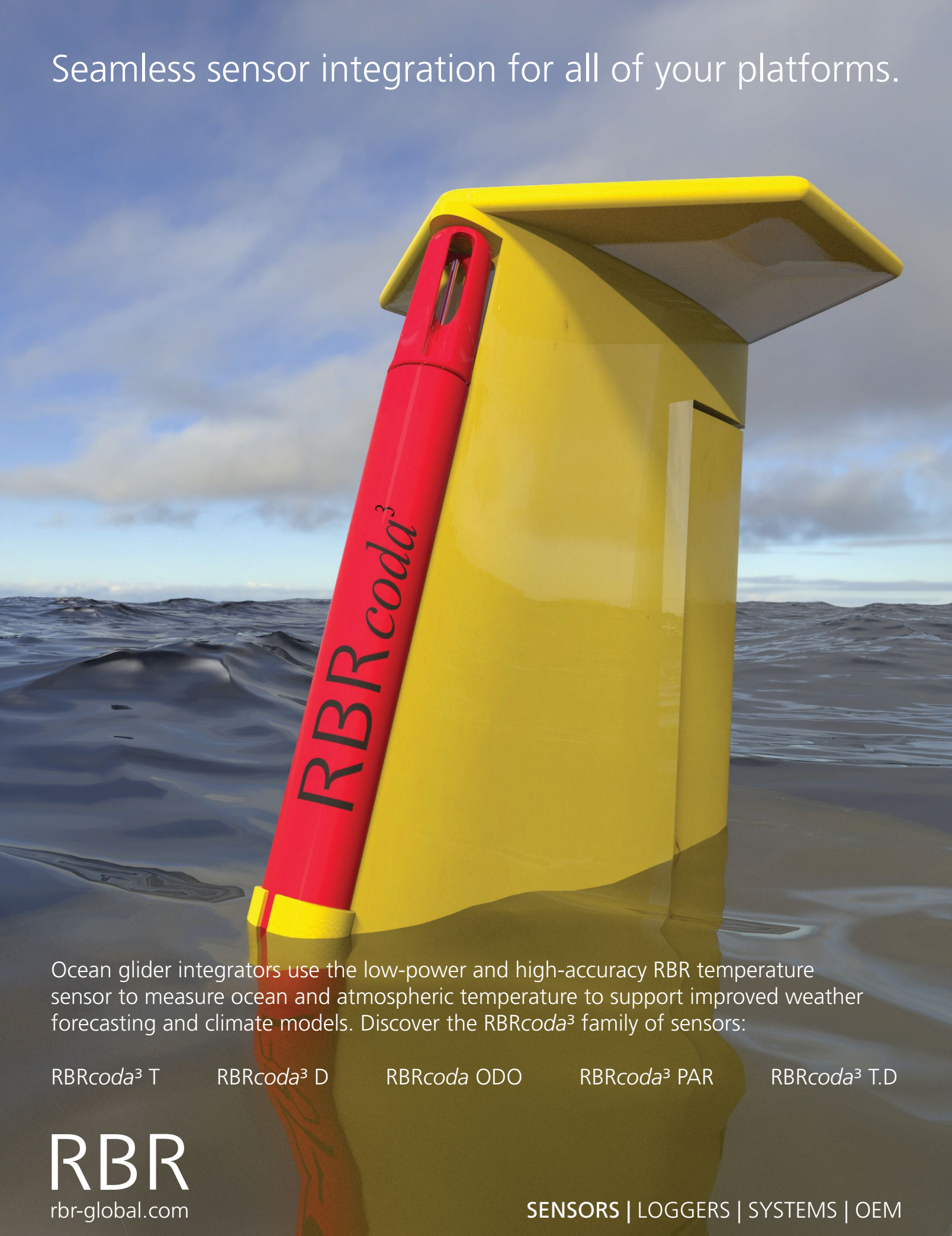

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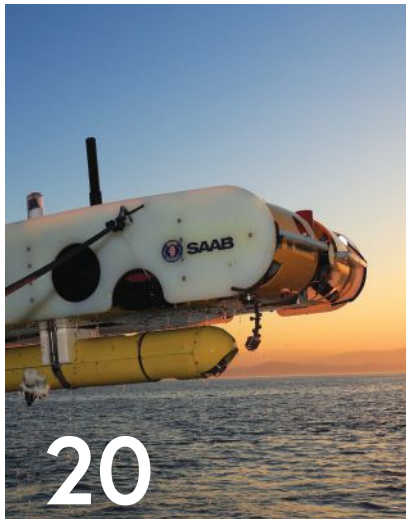
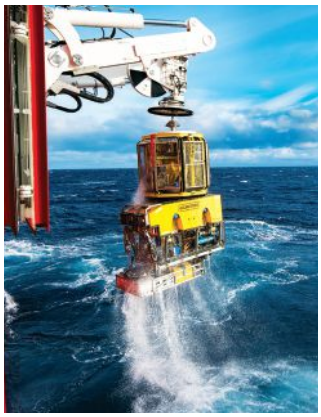


FEATURES

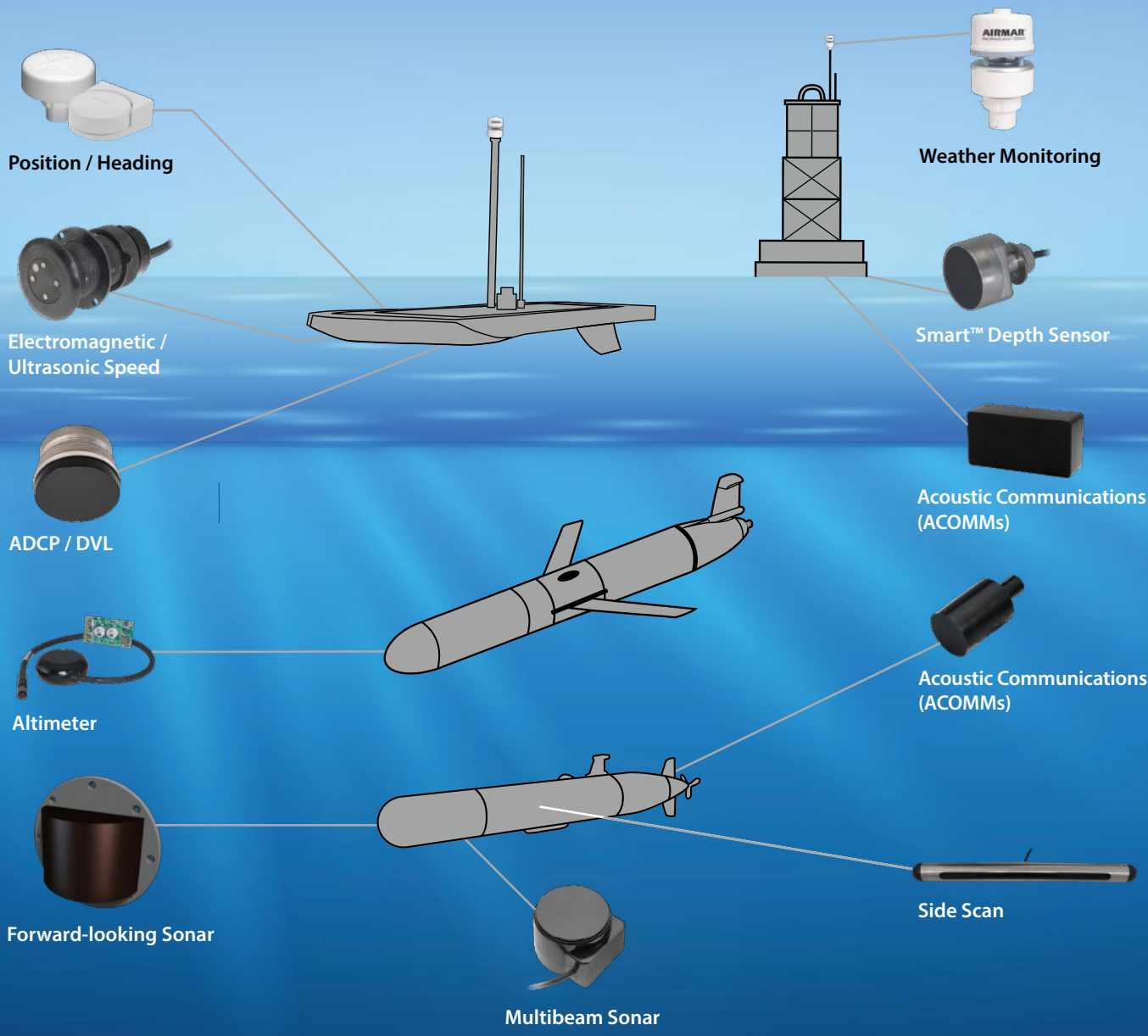
DEPARTMENTS

IN EVERY ISSUE



ON THE COVER:
The Oceaneering® Millennium® Plus remotely operated vehicle, as shown with modular BOP intervention skid, successfully completes another mission.

Sensor Intelligence from Surface to Seabed



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Introducing the Unmanned Maritime Systems Advocacy Committee

BY BRIAN WYNNE,
President and CEO of AUVSI.

The Association for Unmanned Vehicle Systems International (AUVSI), the world's largest non-profit organization dedicated to the advancement of unmanned systems and robotics, has formed an Unmanned Maritime Systems (UMS) Advocacy Committee.

The Committee will be chaired by Thomas Reynolds, vice president of Business Development for Hydroid Inc./Kongsberg Maritime.

Wayne Prender, vice president for Applied Technology and Advance Programs at Textron Systems, will be the vice chair.

The Committee also includes representatives from BAE Systems, L3 Technologies, Leidos, Lockheed Martin, Northrop Grumman, and Seaborn Defense.

The Committee's goals are set forth in a formalized set of Policy Priorities, summarized below, which state that the UMS Advocacy shall:

Establish itself as the preeminent industry voice influencing acquisition and regulatory policies and processes. The Committee will inform legislators and regulators of the capabilities that facilitate the development, experimentation, and deployment of UMS across vehicle classes and domains. The Committee shall further this goal by: 1) establishing and maintaining a cooperative relationship with congressional members and staff and other appropriate federal government officials; 2) providing a forum to inform Congress of the industry's defense and security capabilities in order to deliver UMS to a broader market; 3) advocating for UMS acquisition policies and procedures that promote the appropriate industry roles in the UMS programs of the Department of Defense (DoD); and 4) engaging the DoD and other government and commercial entities to provide a collective industry voice.

Facilitate the growth of UMS through active engagement with the government and commercial sectors. The Committee will focus on ensuring close and robust relationships with federal defense and civilian government and commercial business. The shared goal of these stakeholders is to maintain a fair and open, morally responsible, and unfettered response to military and commercial needs providing for our mutual benefit.

The Committee shall further this goal by: 1) elevating awareness of the value of UMS to legislators and regulators; 2) maintaining a close cooperative relationship with government and commercial partners; 3) providing a forum for industry to streamline contractual mechanisms; and 4) facilitating the growth of the unmanned systems industry into vertical markets.

Collaborate with ship owners, operators, shipyards, ports, federal maritime agencies, technology developers, classification societies and academia to further integrate advanced automation for maritime platforms into the domestic market. The Committee shall further this goal by: 1) partnering with maritime industry stakeholders in the development of a U.S.-based consortium to help shape the operational environment and further domestic acceptance of the technology; 2) providing industry with the necessary conduit to regulators and lawmakers to safely and expeditiously integrate autonomous vessels into the maritime transportation system; 3) developing close working relationships with the key legislators and other government officials; and 4) ensuring that the commercial sector develops the appropriate domestic market for this technology while maintaining a strong industry voice.

Develop the future of the UMS workforce through technology-focused education. To do this, the Committee will: 1) Initiate conversations with industry stakeholders to explore development of future curricula that will foster the development of a skilled workforce; 2) Identify technology skills that are needed in the shipbuilding and design trades, the shoreside services marketplace, and logistics and port operations personnel; and 3) Look to international, forward-leaning technology preparedness training that may be adopted domestically.

For more information, visit WWW.AUVSI.ORG

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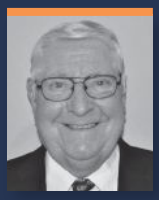
THE DIVER'S APPRENTICE:

PIONEERING APPLICATIONS OF ROV TECHNOLOGY

In our June issue, ON&T looked at the development of remotely operated vehicle (ROV) technology from a Naval Research perspective. For this issue, we asked ON&T Advisory Board member Drew Michel to provide insights about how ROVs came to dominate the subsea intervention world. We also asked Kevin Peterson, Chairman and CEO of the CSA group, to provide photos and captions from the same time period.

Drew and Kevin were two of the pioneers of the ROV industry in the 1970's, with Drew managing Taylor Diving's ROV business and Kevin doing the same at Martech. While they began as competitors in the ROV world, they also worked together then, and for decades that followed. Along the way, they help shaped the ROV industry into what it is today.



Andrew "Drew" Michel, *a USN veteran, worked for Taylor Diving from 1968 to 1986. His early work with diving related electronics and early ROVs earned his induction into the Commercial Diving Hall of Fame. His subsequent ROV work with major energy companies during a 50-year career resulted in his recent induction into the Offshore Energy Center Hall of Fame as an Industry Pioneer.*

Kevin Peterson, *Chairman and CEO of the CSA group, managed and operated the first ROVs used in the Gulf of Mexico for Martech in the mid-1970s. Peterson co-founded JERED, the first dedicated ROV company in the US. After JERED was acquired by Oceaneering, Peterson served as the VP in charge of their ROV & Intervention Systems in the early 80's. He later joined the Perry Group and led the formation of Perry Tritech Inc., a leading developer of heavy work ROV systems, interchangeable work packages, and seabed trenching systems.*

WHY DID THE OFFSHORE INDUSTRY CONSIDER USING ROVS IN THE FIRST PLACE?

DM There is no other practical, safe, and economically feasible way to perform deep underwater intervention work. At the depths necessary for modern underwater intervention work, the risks are prohibitive for divers. Human operated vehicles (HOVs) also put humans at risk underwater and are less cost effective due to the support needed.

When commercial ROVs came into their own in the mid-1970s, the operator could remain in a safe, comfortable environment while the ROV performed the work underwater. This proved essential as the first deepwater wells were developed.

KP *In July of 1977, Martech International of Houston, Texas deployed a Hydro Products' RCV-225 to inspect Total's MCP-01 production platform: the first time an ROV "successfully" performed a comprehensive inspection of an offshore platform in the U.K. Sector of the North Sea. Once the external portion of the platform inspection had been completed from onboard the Edda Sprint, the RCV-225 was moved to the platform for deployment into the internal platform structure (shown here). The launch and recover system (LARS), combined with the tether management system (TMS), provided the crew with access to areas that had previously been very difficult or impossible to inspect. Photo credit and caption: Kevin Peterson.*

WHO WERE SOME OF THE FIRST COMPANIES TO PROVIDE ROVS TO INDUSTRY?

After a decade of development by companies working with the Navy (see ON&T June 2018), companies like International Submarine Engineering Ltd. (ISE) in British Columbia, Canada; Perry Oceanographic in Riviera Beach, Florida; and Hydro Products and Ametek Strata in San Diego, California were quick to begin commercial activity based on work done for the military.

Hydro's RCV-125 at work in the Gulf of Mexico in 1977. The first commercial ROV operations in the Gulf of Mexico were performed by a Hydro Products RCV-125. It didn't have a tether management system (TMS), nor did it have a launch and recover system (LARS). The vehicle was deployed using a small davit, wire rope, and air tugger. The first RCV-125s were sold to Seaway Diving in Norway. The next two were sold to Martech. Photo credit: Kevin Peterson.

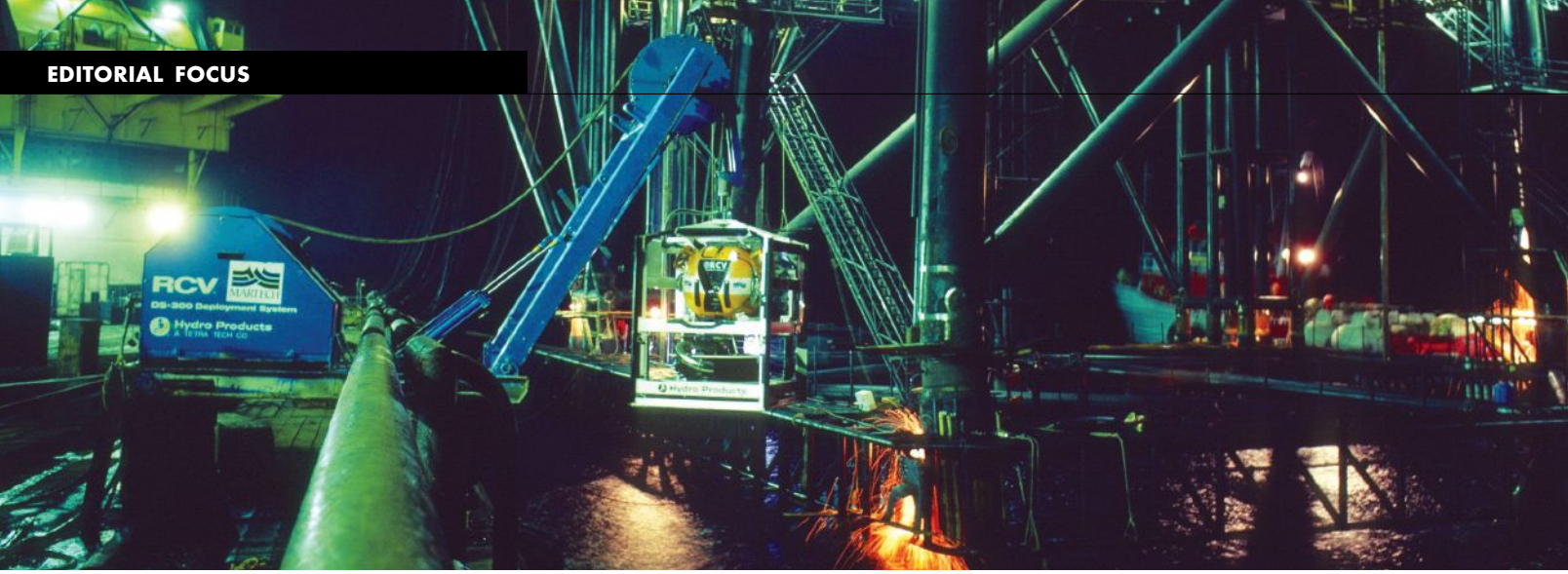
YOU WORKED ON THE SHELL'S COGNAC PLATFORM IN 1977. WHAT CAN YOU TELL US ABOUT THAT PROJECT?

The Cognac platform, constructed by McDermott in 1977, was built to operate at 1,030 feet below the ocean surface, which was considered the limit of saturation diving at that time. We (Taylor Diving) won the contract to do the diving, but it involved over a year of preparation, during which time I was doing some work with Hydro Products.

Up until that time, the work Hydro Products had done with the Navy on ROVs had been classified. When the Navy released the technology, Hydro showed me what eventually became the RCV-225. We decided to use it on the Cognac project, mainly to observe and back up the divers, though it was also used to perform a complete bottom survey prior to setting the jacket base section (JBS).

After the JBS was launched, the ROV verified that no damage was caused to bottom closures or ballast tanks. The RCV was used because even though the JBS was floating, it protruded 120 feet underwater. This would have required decompression dives and the size of the structure would have required diving from separate vessels or moving the derrick barge.

One area in which RCV visual information was useful was in lowering and stabbing of piles. Even though acoustic devices gave precise positioning and rate of closing information to the operators, visual contact with the 70-ton pile closing on the bell guide made the project a lot easier. As the pile was lowered, the ROV was moved up to the elevator holding the pile to determine proper attitude and assure that winches were synchronized. Then it was moved back to the bell guide to assist in the final line-up and stabbing. Once each pile was stabbed, a pile hammer delivered more than 500,000 foot-pounds of force to drive it into the sea floor. We kept a constant visual check of the proper slack needed for the hoses and cables using the RCV, and also monitored the depth to which the pile had been driven.

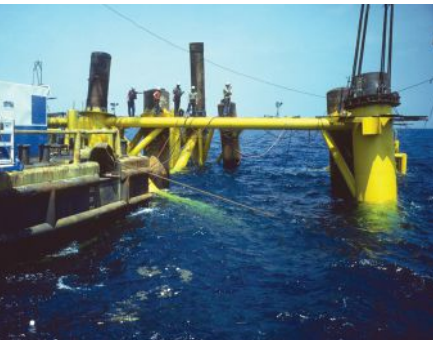


As the reliability of the RCV-225 improved, it became the tool of choice to support platform installations in the Gulf of Mexico. McDermott and Brown & Root were building and installing platforms at a record pace in the mid-to-late 70s and setting new water-depth records month after month. As water depths increased, diving became more expensive, and the ROV found its niche. Photo credit and caption: Kevin Peterson.

During all deep diving operations, the RCV-225 accompanied the divers. During diving bell runs, the launcher was lowered to working depth first and the RCV monitored the bell's descent. As the diver exited the bell, the RCV would aim toward it. The RCV's lights provided a visual target to which the diver could swim. The RCV also allowed barge personnel to observe the diver. As the diver arrived at the work site, the first task was to move the RCV behind him, checking his diving gear.

Visibility at 1,000 feet, even in clear water, is poor due to a complete lack of sunlight penetration, but the RCV's silicon intensified target camera produced a usable picture with as little as .002 foot-candles of light. A diver carrying a hand light can see about 30 feet at best, but the RCV on Cognac provided a clear field of view up to 400 feet away. This feature, plus the onboard compass, allowed the RCV to maneuver almost directly to an object that might take hours for a diver to find.

Another time-saving feature was the maneuverability of the RCV, particularly on a vertical axis. A diver saturated at 1,000 feet cannot safely ascend but a few feet above this depth, but on one occasion, a burning umbilical was fouled at the 500-foot level. The observing RCV quickly ascended to 500-foot and the RCV operator directed barge personnel to take up and relieve tension on certain cables and hoses to the JBS, thereby freeing the rig. If we had not had an ROV onboard, there would have been no recourse but to saturate another team of divers in the second chamber or decompress the saturated divers to 500 feet. The latter method would have taken five days. With the equipment supporting the platform installation sitting idle, the costs of a delay would have been at least 4 million dollars, but with the RCV-225, we were able to just "fly" up to the hoses and untangle them.



ROVs provided barge and crane operators with "eyes" beneath the water as they lowered and installed pilings, grouted legs and performed other tasks from the surface. The ROV and crew became a standard part of the platform installation process, from preliminary bottom inspection, to final positioning and set down of the jacket, to supporting the construction process. Photo credit and caption: Kevin Peterson.

ONCE YOU KNEW ROVS WERE WORTH USING, WHAT NEXT?

In 1983, Exxon's Lena Compliant Guyed Tower (CGT) was erected in approximately the same water depth and in the same general area of the Gulf of Mexico. This was the world's first commercial guyed tower production platform.

The contract included releasing hooks, cutting cables, placing explosive charges, and other assignments requiring a high degree of dexterity that had previously been considered solely within the realm of divers. Forty specific assignments were performed by the vehicles assigned to the Lena task. Before the tower was launched, we used an RCV-150 to inspect the bottom for debris, and to provide us with an accurate reading of water depth. The RCV-150 also proved a valuable tool for pile driving, clump weight installation, pipeline pools, and charge placement. Aside from providing real-time observations, the RCV-150 was fitted with specialized tools.

WHAT KINDS OF TOOLS WERE ON THE RCV-150 FOR THIS JOB?

A diver hands a wrench to an RCV-150 while an RCV-225 observes the action. Photo courtesy of Drew Michel.

For example, it was fitted with a hydraulic impact wrench so retaining nuts could be backed off to free the pile driving hammer if it became stuck to the pile. Also, if a hydraulic rig anchor release mechanism failed to respond to an acoustic signal, the vehicle could place a thermal cutter beneath the anchor release mechanism and sever the cable (an option we used only once). The thermal cutter and shaped charge both were used to cut mooring cables, so buoys could be salvaged; during the attachment of outboard connector segments, the vehicle could remove a safety release pin if the release hook did not respond to an acoustic signal.

For inspecting the guyline, a tool resembling the letter C was fastened to the end of a rod and straddled over the guyline. This kept the vehicle about a foot from the guyline, so it could travel both ways along the entire length for 100 percent inspection. This work was done in less than one-third the anticipated time frame.

For pulling pipelines through J-tubes on the structure, a hook was lowered from the vessel carrying the ROV and the vehicle guided the hook to a shackle that was pre-installed on each J-tube. When the cable supporting the J-tube was properly tensioned, the ROV cut the restraining rod with a thermal torch, transferring the weight to the cable so the J-tube could be lowered to the bottom.

During periods of slack time, the ROV inspected pipelines leading from the tower to platforms some 17 miles away. The entire inspection was performed in 30 hours with a complete visual inspection recorded on video tape. It also performed a complete visual inspection of the tower, including areas around conductor guides. During this operation, 165 cathodic protection (CP) readings were taken at pre-determined positions throughout the structure, along with many 35-millimeter color stereo photographs.

As small as it was, there are many examples of what the RCV-225 was able to accomplish with a knife, stick or some other crude device taped to the front of the vehicle. Photo credit and caption: Kevin Peterson.

The ROV also used a rotary saw to cut a hydraulic line, so a stuck hammer could be freed from a pile. This proved even quicker than the initial plan of using a hydraulic torque wrench fitted to the ROV. At another point, the ROV's sonar was used to locate and salvage an expensive current meter that was accidentally dropped overboard. The task was performed in 10 minutes with the ROV's Honeywell 902 tracking system. On yet another unplanned assignment, a potentially expensive corrective procedure was avoided when the ROV freed a cable that became entangled in the underwater pile driver. A rotary saw was used to cut the cable in several places.

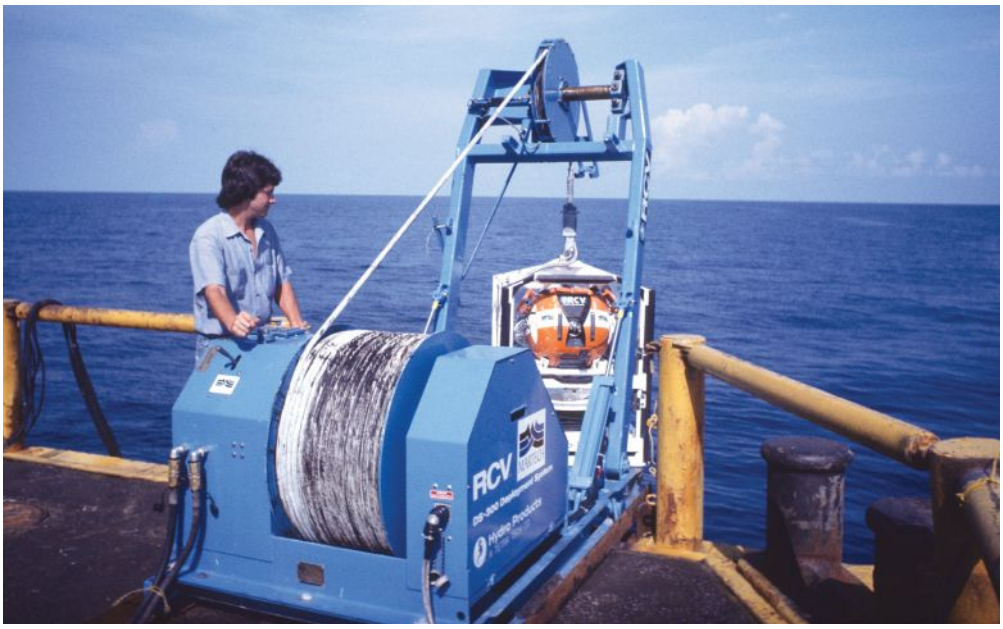
The ROV's versatility again was demonstrated when a 60-ton pile follower was accidentally dropped alongside the tower after a clamp failed. After inspecting the tower to make certain it was not damaged, the vehicle was used to fit a 26-inch cable around the follower which, fortunately, was stuck in the bottom in an upright position. The follower was salvaged without further incident.

SO, THIS SMALL ROV DID EVERYTHING YOU ASKED IT TO DO?

This project proved that versatility does not necessarily require a bigger, more complex, and more expensive ROV. We proved it again when we used a we used an RCV-225 to clear an extensive pipeline right-of-way in the Straits of Sicily. The sea floor contained outcroppings of volcanic rock and coral heads that needed to be leveled before the lines could be laid on firm bottom, but the 1,750-foot depth precluded the use of divers.

We used the RCV to position a 7-ton charge frame about 10 meters off the bottom, maneuver it precisely over the target areas, and lower it to the bottom. The RCV then cut a safety line and pushed a release lever, opening a hydraulic valve and releasing the shaped charges. If a charge did not release, the ROV maneuvered a small hook from the workboat's crane to engage a loop installed in each hydraulic cylinder. This allowed the crane operator to manually release the charge. With all charges released, the frame was hoisted a safe distance away before detonation. We completed approximately 3,000 detonations over about four months to clear the right-of-way and, once again, numerous jobs were performed by the ROV in addition to those stipulated in the original contract.

These examples of the early success that ROVs had in offshore commercial applications illustrate several reasons they have become essential. They reduce risk for both human divers and machines, and they reduce cost by solving problems that represent downtime for expensive equipment. All of this remains true today.



The RCV-225 was deployed by one person (Kevin Peterson in photo) and the crew would typically consist of a supervisor/pilot, an electrical technician, and a mechanical technician. Photo credit and caption: Kevin Peterson.

UK and Germany to Jointly Fund Arctic Science

The UK's Natural Environment Research Council (NERC) and Germany's Federal Ministry of Education and Research (BMBF) have jointly invested almost £8 million in 12 new projects to carry out crucial research in one of the most inhospitable regions on the planet. The new projects started in early July 2018 and join the existing NERC Changing Arctic Ocean research program.

Furthermore, the MOSAiC expedition will be launched in the autumn of 2019 - under the leadership of the Alfred Wegener Institute, the German research vessel *Polarstern* will be lodged in the Arctic sea ice for a year in order to drift with the ice across the central Arctic. This unique expedition will also involve scientists engaged in German-British collaboration.

The NOC will lead the APEAR project which aims to understand how sea ice decline and longer summer seasons will change the pathways of nutrients entering the Arctic Ocean from the Atlantic and Pacific. The partners in this collaborative project will collect and analyze unique, year-round in situ ocean data in the high Arctic. Once analyzed, these data will be combined with ultra-high resolution, state-of-the-art, sea ice-ocean-ecosystems modelling to examine changes in Arctic ecosystem provinces.

The NOC will also collaborate on the PEANUTS project which will examine how increased mixing in the Arctic could affect primary production. As part of this project, the NOC is preparing to deploy instrumentation for a year near the shelf edge in the Barents Sea. In addition, the project team will collect turbulence profiler data and water samples to learn more about nitrate uptake and cycling. The data will be used in biogeochemical ecosystem modelling to assess future Arctic change.

For more information, visit
WWW.NERC.UKRI.ORG/RESEARCH/FUNDED/PROGRAMMES/ARCTICOCEAN

Petrotechnics Launches Proscient V4.0

Petrotechnics has launched Proscient v4.0, which provides an integrated view of operational reality, with a way to visualize and manage activity and risk. The platform connects activity planning, maintenance management, operations and how work is executed. Operations personnel can "operationalize" the schedule by bringing together all of work and safety dependencies to improve plan accuracy and attainment.

Proscient v4.0 also closes the gap between process safety management and operations. It automatically connects the health status of process safety-critical equipment, maintenance and inspection data to their cumulative risk impact on the operational reality of your plant. Process safety risk is presented in a way the whole organization can understand – in time, location and in a dynamic barrier model. This makes major accident hazard risk visible, prominent, and available in real-time.

Adoption rates for Proscient have accelerated in the last 12 months as companies move to implement their digital vision. The technology is currently deployed or being deployed by nine North Sea operators including Petrofac, Teekay and Neptune Energy on more than 40 assets and by two operators on 12 assets in the Gulf of Mexico. Proscient is also picking up pace in the downstream and petrochemical industries, including ongoing deployments with BASF, Saudi Aramco and Petronas.

To date, individual Proscient customers have reported up to $6.5 million in annual savings, including a reduction in crew wait time of up to 75 percent, a 50 percent reduction in supervisor wait time and a reduction in annual downtime of up to 47 percent.

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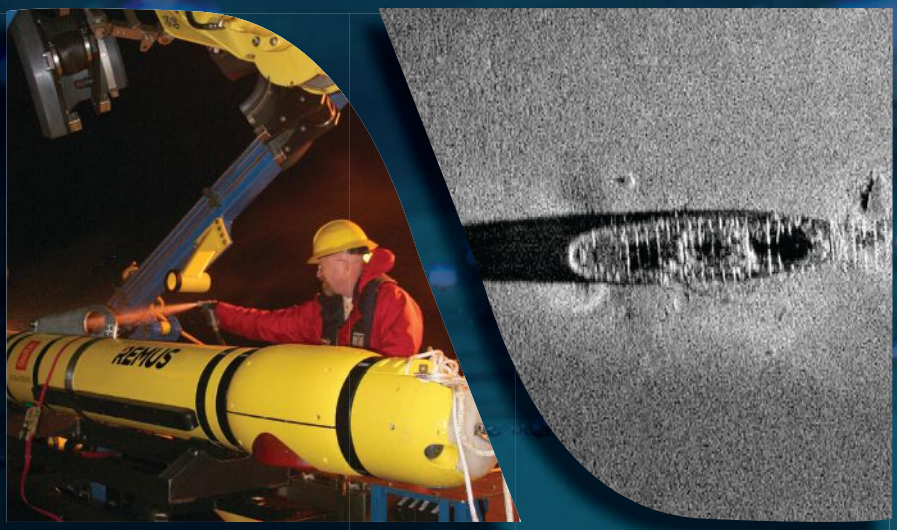

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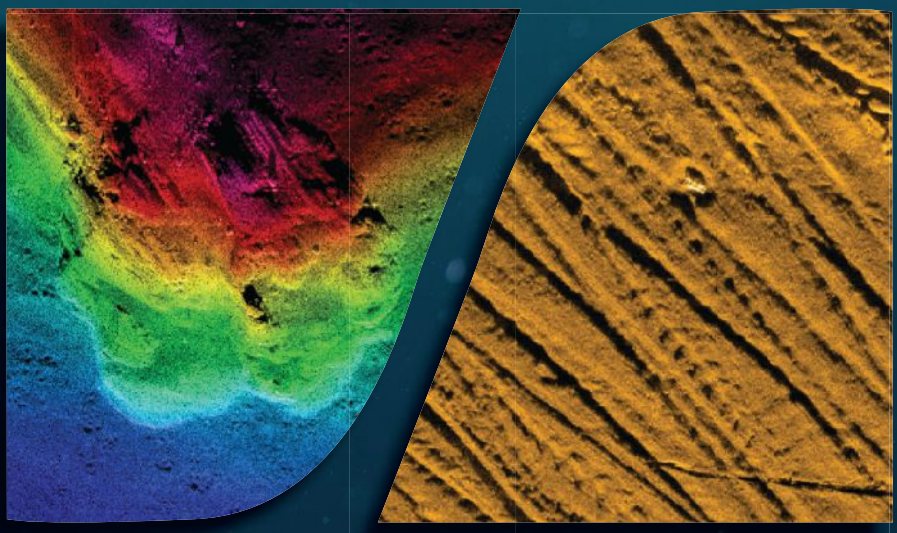

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LEFT: ROV Hercules is stored until its next mission. Photo courtesy of ECOGIG/Ocean Exploration Trust. / RIGHT: Scientists launch the AUV Sentry to track and pinpoint a subsurface oil plume. Photo courtesy of OET/NautilusLive.

Sea Grant Publication Describes Advantages and Disadvantages of Submersible Vehicle Technologies

The Gulf of Mexico Research Initiative (GoMRI) has released a new Sea Grant publication about the technology scientists use to look at and study the deep ocean, specifically manned and unmanned vehicles.

The 'Underwater Vehicles Used to Study Oil Spills' publication educates readers about how these underwater robotic devices work and how researchers have used them in the Gulf of Mexico.

Determining which technology to use can depend on the environment being studied, the amount of time a scientist has, the advantages and disadvantages of the technology, and the cost to operate the equipment.

Included in the publication is a table that gives the cost of use, type of use, advantages, and disadvantages for each of these technologies. The table has been reproduced below.

The authors of Underwater Vehicles Used to Study Oil Spills are Monica Wilson, Larissa Graham, Christine Hale, Emily Maung-Douglass, Stephen Sempier, Tara Skelton, and LaDon Swann of the Mississippi-Alabama Sea Grant Consortium.

Submersible	Operation Cost	Operation Effort	Advantages	Disadvantages
Deep Sea ROV	Approximately $15,000/day (not including ship cost)	· More people involved due to constant transmission of data and video · Intensive for the entire science party due to collaboration throughout the mission	· Available in a variety of sizes · Easy to deploy · Can stay submerged for days, not battery limited · Can be used on a wide range of research vessels · Mobility allows close up examination of seabed · Constant transmission of real-time data	· Cable entanglement/ management · Tricky to maneuver due to cable connection · Limited depth range due to length of cable
AUV	Approximately $500 - $10,000/day (not including ship cost)	· Data comes in periodically when vehicle surfaces and computers can download data · Allows vessel/ scientists to conduct other tasks while AUV is in the water performing its mission	· Does not require any human control · Operates free of cables, which increases efficiency and speed · Run times as short as a few hours to as long as months · Pre-programmable and can be commanded to change on the fly · Gives limited real-time data through acoustic links · Can be equipped with multiple sensors · Large boat not necessary to operate	· Limited battery power · Complicated and expensive to build · Can be heavy due to batteries and sensors · Limited sampling capabilities · Less suited for deployment in areas of high military, shipping or fishing activity due to sound wave interference and risks of colliding with other items in the water
HOV *Alvin*	Approximately $45,000/day (includes ship cost)	· Intensive for the two to three scientists inside the submersible · Less intensive for those onboard while they await for the submersible to return	· Gives scientists opportunity to visit the seafloor in person · Can be equipped with many different instruments to aid in observations and research	· Requires support of the *R/V Atlantis* · Limited operation time (5 hours total) · Gets very cold inside (50°F) · Cramped conditions for scientists on board · Difficult to deploy · Requires a large crew to operate

Sources for Table:

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To download the publication, visit WWW.MASGC.ORG/OILSCIENCE/UNDERWATER-VEHICLES.PDF

Meet Aquanaut:
The Subsea Transformer

The Aquanaut transforms from an AUV to an ROV. Image courtesy Houston Mechatronics.

Cutting the Tether

The Aquanaut from Houston Mechatronics is a multi-purpose subsea robot that employs a patented shape-shifting transformation from an autonomous underwater vehicle (AUV) to a remotely operated vehicle (ROV).

As a tetherless subsea transformable robot, the Aquanaut reduces the costs of subsea services by performing both AUV-style inspection missions and the work of a light intervention ROV. The fully electric vehicle enables the efficient collection of data over long distances, as well as manipulation of subsea objects at a lower cost than today's technology.

Its novel and patented shape-shifting morphology allows for both long range and efficient cruising, but also hovering with full attitude control for stable in close manipulation tasks. It is enabled by a NASA-inspired spaceflight robotics Command and Control (C2) architecture that affords operators the capability to do user in the loop control over low data rates, thereby eliminating the need for costly ships and mission limiting tethers.

Major Support

In case you think this is a novelty, the team behind this subsea service company has deep expertise in robotics and intelligent automation. For example, it includes Nic Radford, who previously spent 14 years at NASA's Johnson Space Center in the Dexterous Robotics Laboratory. Furthermore, Houston Mechatronics gets support from the U.S. Department of Defense, while major funding has also come from oil and gas investors (e.g., a recent Series B investment of $20 million from Transocean and Schlumberger).

The underwater robot Aquanaut is being developed for both commercial endeavors in the energy domains and defense related initiatives. On the commercial side, the company is building a robotics-as-a-service business around operating Aquanaut for tasks that are currently performed by ROVs attached to vessels or drilling platforms. Houston Mechatronics expects to begin marketing the robotic to specific customers in 2019.

1929 Grand Banks Underwater Avalanche Reconstructed

Photo credit: University of Liverpool

An international team of researchers has reconstructed the 1929 Grand Banks underwater avalanche to better understand common geohazards.

Despite being extremely common, little is known about underwater avalanches as they are exceptionally difficult to measure, inaccessible, and destructive. However, they pose a major geohazard to seafloor infrastructure, such as telecommunication cables that carry more than 95 percent of global internet traffic, and oil and gas pipelines.

The 1929 Grand Banks underwater avalanche, which was triggered by an earthquake off the coast of Newfoundland, is the first and only underwater avalanche of this size to have been directly measured. The team mapped the bathymetry of the seafloor where the 1929 avalanche passed through and collected core samples of deposits that it left behind. They then combined this forensic evidence with the historic measurements of flow speed from the old cable breaks to reconstruct the properties of the avalanche.

Dr. Stevenson, chief sedimentologist on the research cruise, said: "It is awe inspiring when you piece together how big and powerful this avalanche was: 230 meter thick, which is about the height of Canary Wharf in London, moving at 40 mph, and highly concentrated with fist-sized boulders, gravel, sand and mud. It would not have been a good place to be at the time."

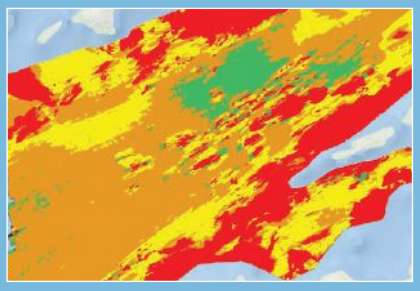
"Underwater avalanches are a bit of a mystery to scientists because they are really difficult to measure directly. What tends to happen is that avalanches destroy the measuring equipment you place in their path. . . At the time, it transformed how scientists viewed the seafloor and it's taken almost 90 years for us to revisit the area and confidently piece together its fundamental properties."

"This research cruise has enabled us to reconstruct the fundamental properties of this underwater avalanche which has implications for seafloor infrastructure. It can help provide engineers and modelers with the information they need to design expensive seafloor installations to withstand similar flows around the world or build them out of harm's way. It also provides the first real-world example of a giant avalanche which scientists can use to validate their theories and models."

Triggered by a 7.2 magnitude earthquake, the Grand Banks underwater avalanche was huge, generating a tsunami that killed 28 people and burying an area the size of the U.K. in half a meter of sand and mud. It also broke seafloor telecommunications cables along its path. The exact location and timings of the cable breaks were recorded, allowing a calculation of the speed of the avalanche.

The paper `Reconstructing the sediment concentration of a giant submarine gravity flow' is published in *Nature Communications* (doi: 10.1038/s41467-018-05042-6).

For more information, visit
WWW.LIVERPOOL.AC.UK



OceanWise Adds Dynamic Software Extension

OceanWise has added a dynamic software extension to Maritime Toolbar for Esri ArcMap, which helps the user manipulate maritime data. 'Object Based Image Analysis' or 'RSOBIA' segments imagery data into geographic areas with similar statistical properties and makes a polygonised map of the results.
www.oceannews.com/news/science-technology/oceanwise-adds-dynamic-software-extension

Ice-tethered AZFP deployment under multi-year sea ice in the Canadian high Arctic.

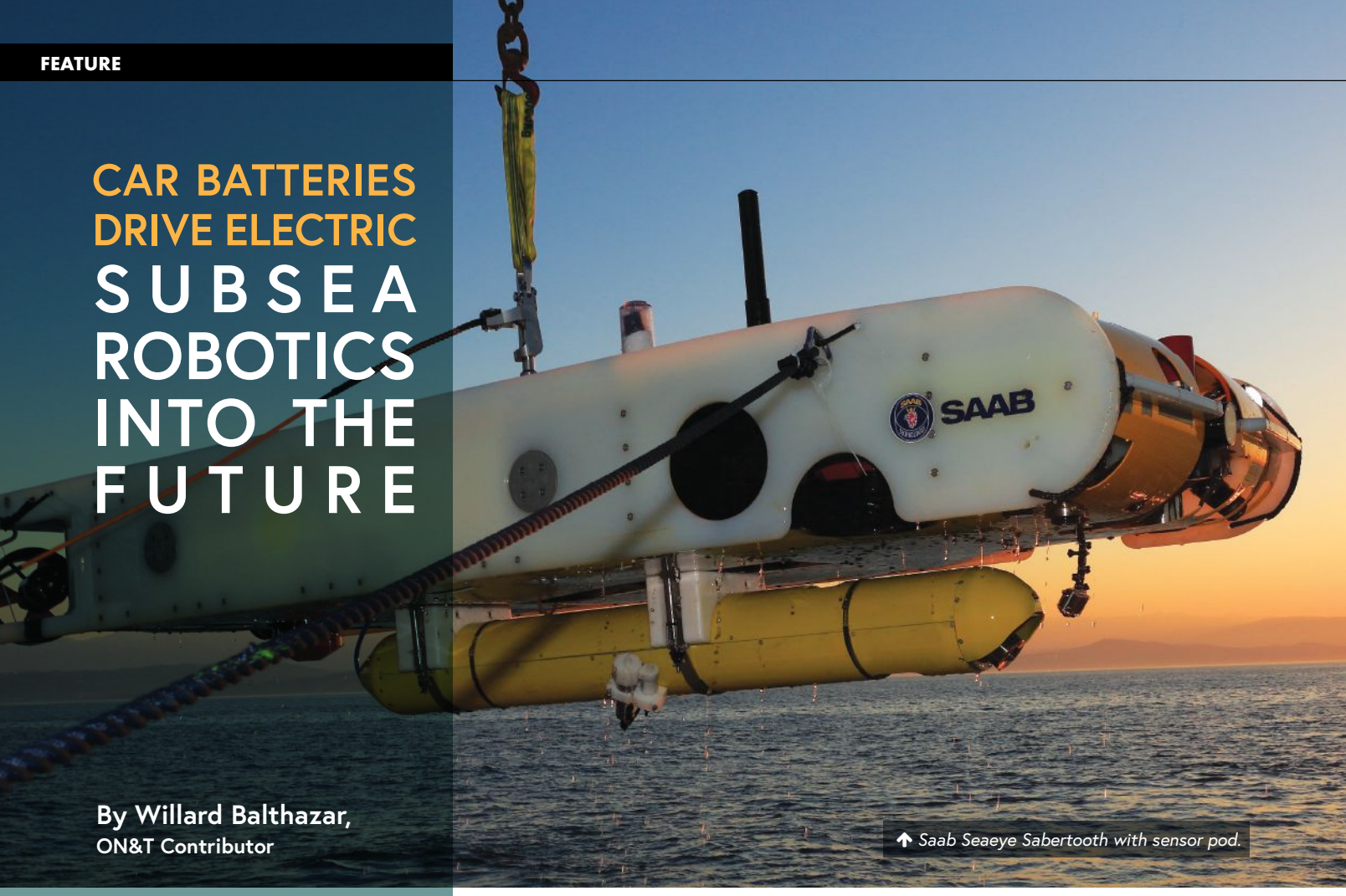
Acoustic Zooplankton Fish Profiler Food Web Study

The Central and Arctic Division of Fisheries and Oceans Canada plans to deploy an array of three multi-frequency Acoustic Zooplankton Fish Profilers manufactured by ASL Environmental Sciences in the Amundsen Gulf in 2018. Data from the array will be used in conjunction with winter and summer net sampling programs to better understand the early life history of Arctic cod (*Boreogadus saida*) and the zooplankton copepod *Calanus* spp., both of which are keystone species in the Arctic marine food web.
www.oceannews.com/news/science-technology/acoustic-zooplankton-fish-profiler-food-web-study

Seawater Yields Yellowcake Uranium

For the first time, researchers at Pacific Northwest National Laboratory (PNNL) and LCW Supercritical Technologies have created five grams of yellowcake — a powdered form of uranium used to produce fuel for nuclear power production — using acrylic fibers to extract it from seawater.
www.oceannews.com/news/science-technology/seawater-yields-yellowcake-uranium

CAR BATTERIES DRIVE ELECTRIC SUBSEA ROBOTICS INTO THE FUTURE



↑ *Saab Seaeye Sabertooth with sensor pod.*

By Willard Balthazar,
ON&T Contributor

Electric car battery innovations have brought batteries mainstream with new battery technologies helping underwater electric e-robotics advance into an all-electric future.

Matching clever batteries to developments in electric e-robotics that include smart power technology, intelligent control architecture and component miniaturization, is helping create a new breed of vehicles that are smaller, smarter, more agile and more powerful.

Operators want this because small, powerful vehicles with full tasking capability bring the benefit of a smaller footprint and bigger payload, cutting operating costs considerably. For instance, electric vehicles can do the same work as their hydraulic equivalent, but are far smaller, and have double the power density. Eventually work-capable electric e-robotic systems will undertake all underwater tasks at a much lower cost.

New developments are already bringing considerable efficiencies and cost savings. Satellite links and 4G networks, for example, are providing global remote control of electric underwater robotic vehicles, reducing the need for offshore piloting personnel while advancing the potential for long-distance control of remote resident systems.

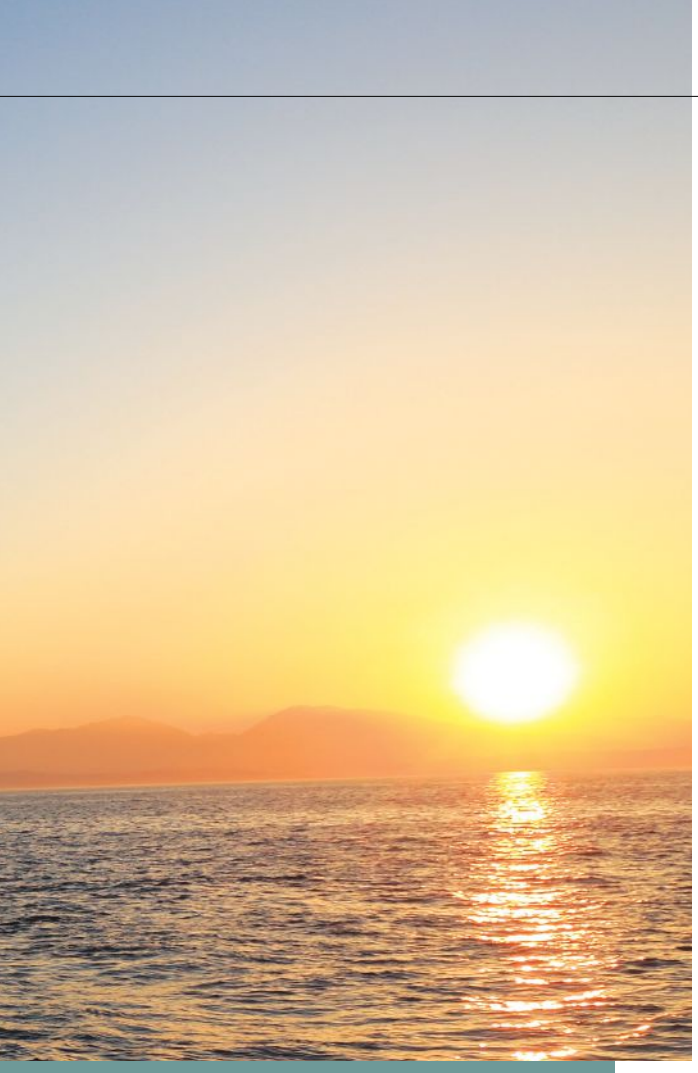
Considerable savings come from vehicles being support-ship independent where advances in battery technology and its management now make it possible for an e-robotic vehicle to remain resident on the seabed for long periods of time. From here they can roam tetherless, controlled from afar, as they undertake inspection and light intervention tasks.

Eliminating dedicated support vessels and locating operators onshore reduces costs and restrictions imposed by weather and sea states. Clever, high powered, small, lightweight batteries have made such advances possible and helped introduce innovations in e-robotic vehicles that allow them to swap between a tethered and an un-tethered role.

20 KILOMETER FIBER CONTROLLED MISSIONS

Not only can this new breed of vehicle roam free and afar, and otherwise engage a tether for light work tasks, but a vehicle can be sent 20 kilometers on a mission under the control and observation of a fine fiber-optic cable. Then, when the target is reached, the vehicle can engage more battery power for the task in hand, where a battery typically provides three times more power than is possible with a normal umbilical powered operation.

For such robotic vehicle operations all power must be derived from batteries so efficiency is vital to maximize endurance and operational cost effectiveness.



The key to effective design for a robotic system, both battery and surface powered, is power efficiency: keeping elements small and using high frequency power supplies.

One such dual powered case has been pioneered by Saab Seaeye, an 800Hz power system that reduces the onboard transformer size to less than a quarter of the size of a transformer using a typical 50Hz supply.

And although battery technology has improved and is cheaper with batteries that once could only be recharged 800 times now taking 2,500 charges, efficiency comes from designing the entire system to make the batteries last even longer.

A vital design objective is to maximize the proportion of the total vehicle mass available for the energy source. An efficient robotic system needs low vehicle drag; the smallest, thinnest, lightest components and materials possible; an effective power management system; powerful and efficient thrusters; and an appropriate depth rating.

Again, in the case of dual powered systems, leveling out surface power demands with batteries is also an important consideration. For example, using on-board battery power for heavy duty tasks can reduce the size of the generator, umbilical and winch needed for dual powered systems, thereby lowering costs.

The importance of power efficiency is growing as more electric tooling options are introduced to replace hydraulic ones such as torque tools and manipulators.

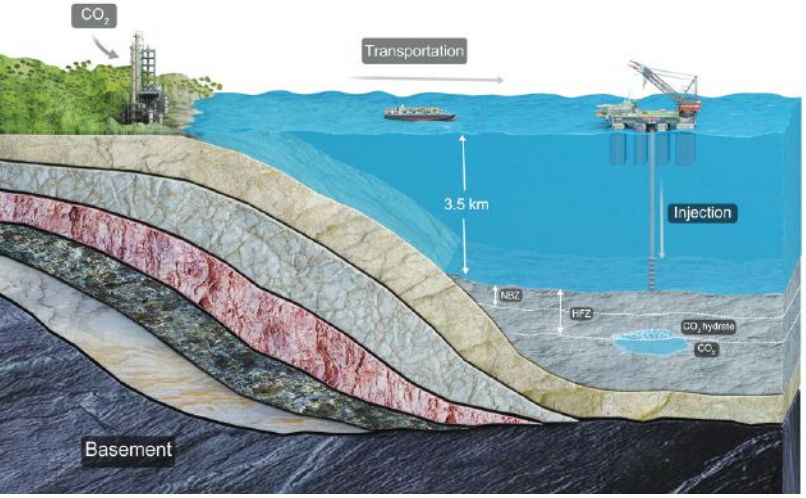
The Saab Seaeye Sabertooth, as a hovering autonomous system, has led the way for the emergence of tethered and untethered capabilities and the potential for an autonomous system to engage in light work intervention tasks.

Advances in remote and resident robotics along with environmental monitoring, and extended deep tunnel inspection, have been made possible by the battery power technologies developed in the 3000m rated Sabertooth and its iCON intelligent control architecture pioneered by Saab Seaeye.

It has meant that such a system based at a remote location can be launched untethered (on routine inspection, repair and maintenance work), from its docking station where tooling packages are stored, batteries recharged, and data, video and instructions loaded over the internet. The Sabertooth can also be sent 24 kilometers down a tunnel for extended inspection if needed.

Such advances are leading toward the era of an all-electric future for underwater robotics with tethered vehicles performing all work tasks and tetherless vehicles capable of light intervention with all systems having the power and intelligence to expand the possibilities of e-robotics in all areas of underwater enterprise.

→ *Saab Seaeye pioneered battery efficient autonomous e-robotics such as the Sabertooth that can perform long excursions, hover and perform light intervention tasks.*



Researchers: Burying CO2 in Deep-Sea Sediments is "Safe and Permanent"

Chinese scientists claim that burying carbon dioxide (CO2) in deep-sea marine sediment is "generally safe and permanent."

Carbon capture and storage is considered a promising method for reducing atmospheric CO2. Conventional methods include injecting the gas into deep saline aquifers, oil and gas fields, and coal seams. A team led by Zhang Dongxiao from Peking University explored storing CO2 in deep-sea sediments and found that extreme conditions at the bottom of the ocean help hold the gas in place. Under great pressure and at low temperature, CO2 and water trapped in the sediment below the sea floor create "hydrate clogs" that can serve as an "impermeable cap" impeding the gas from flowing upward, according to the research. The research states that CO2 stored in this method is not in direct contact with the water, preventing any environmental impact on the sea.

"Data from our simulation show that storing CO2 in deep-sea sediments is viable," Zhang said.

The equipment used for injecting the CO2 is similar to the semi-submersible offshore platform for drilling for methane hydrate, and scientists are exploring the possibility of conducting experiments on these platforms, Zhang said.

The paper cautions that "faults or fractures may be pre-existing in the sediment or be induced by tectonism or excessive injection overpressure that may create a permeable pathway directly to the seafloor," though they also state that the formation of hydrate seals could seal the permeable channel and prevent leakage.

"Since the whole system is very susceptible to pressure and temperature, changes in the marine environment, such as ocean temperature and sea level, may affect the post-injection fate of CO2 and the efficiency of sequestration."

The open source research findings were published in *Science Advances* at www.advances.sciencemag.org/content/4/7/eaao6588.

Scientists Discover Coral 'Oases' Where Reefs Thrive

National Science Foundation (NSF)-supported marine biologist Peter Edmunds of California State University, Northridge, and other researchers have identified "oases" where corals appear to be thriving. The researchers amassed data on the condition of corals in the Pacific and the Caribbean. With additional support from the U.S. Geological Survey (USGS) John Wesley Powell Center for Analysis and Synthesis, they reviewed the data.

The ecologists have now developed a framework for identifying oases in several coral reef regions; all have been studied for decades. The framework considers the health of coral communities, how often the communities have been disturbed, and how long they've remained in a healthy (or unhealthy) state.

"We were able to bring together information from many locations, something not possible just 10 or 20 years ago," Edmunds said. The scientists categorized 38 oases as either "escape," "resist" or "rebound" oases.

Escape oases are coral communities that have been able to avoid disasters such as bleaching, invasions by coral-eating sea stars, and the wrath of hurricanes. Resist oases are corals that appear hardy and able to resist environmental challenges. Rebound oases are coral reefs that have suffered damage but have rebounded.

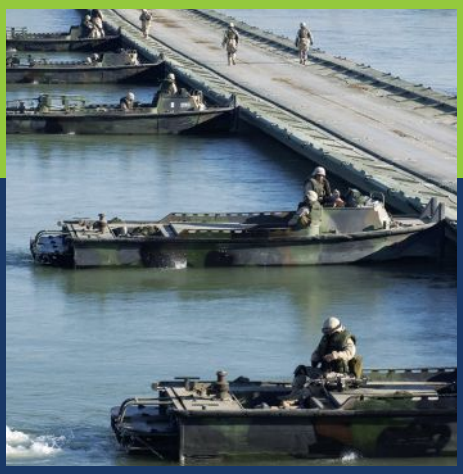
Edmunds, who has studied coral reefs in St. John, U.S. Virgin Islands, and at the NSF Mo'orea Coral Reef Long-Term Ecological Research (LTER) site in Moorea, French Polynesia, said he has been surprised by the ability of reefs in Mo'orea to rebound.

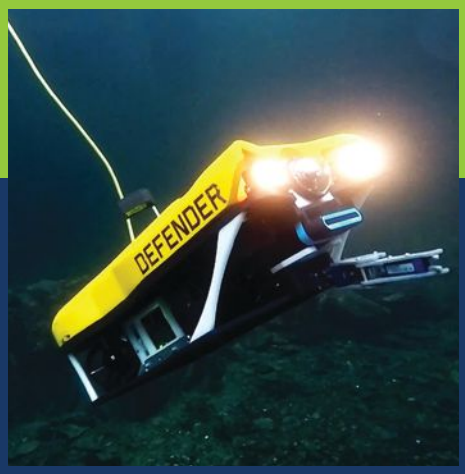
"Our team started working there in 2005, and almost immediately found hordes of coral-eating sea stars," he said. "By 2010, there was close to no coral on the outer reefs. And yet, within eight years, the coral has regrown. In places, about 80 percent of the seafloor is now covered with live coral. It's a remarkable example of an oasis."

Edmunds said he hopes the journal paper, published in the *Journal of Applied Ecology* in June 2018, will provide a tool that can be used to identify areas that warrant stronger protection.

Scientist Ashley Potter swims along a transect line that marks a Mo'orea reef study area. Photo Credit: Peter Edmunds, CSUN

These vehicles have two things in common:





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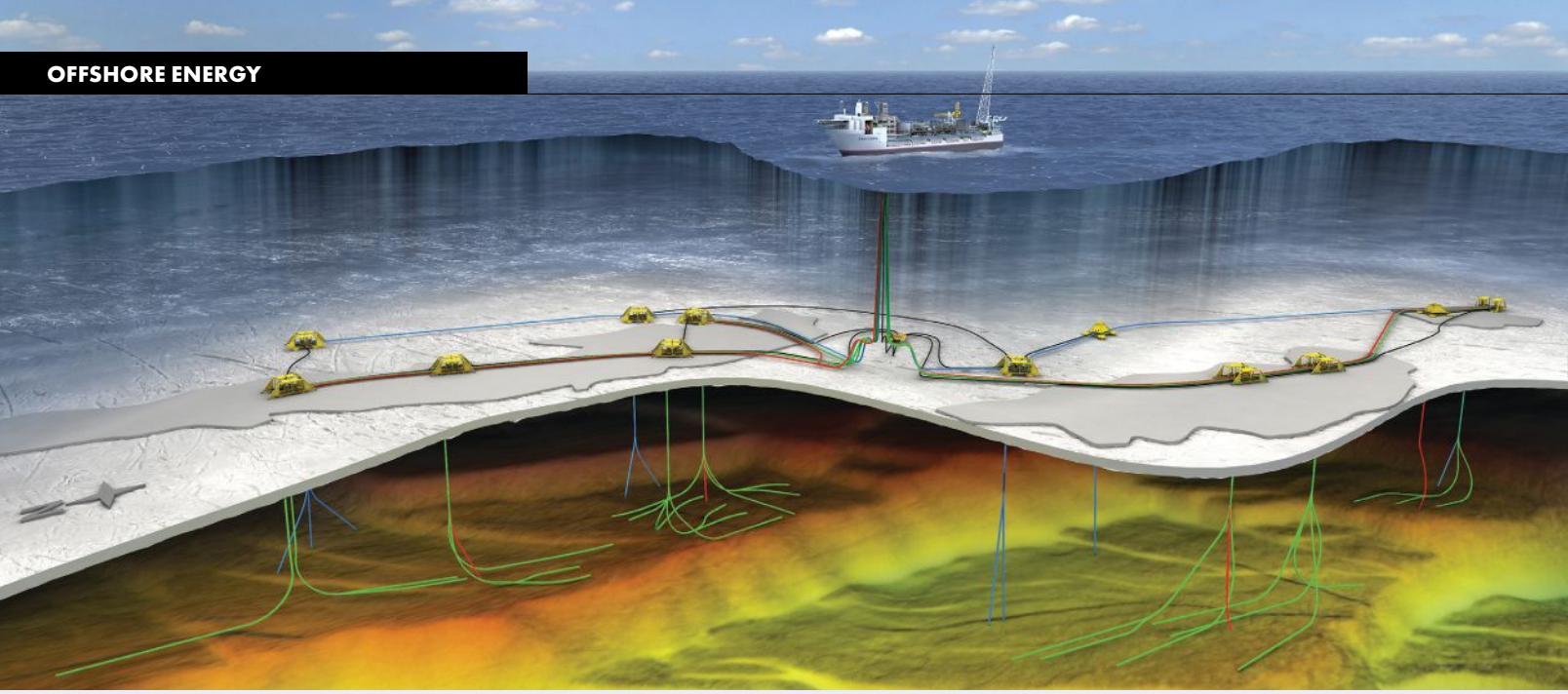

Illustration of the Johan Castberg field in the Barents Sea. According to the Norwegian Petroleum Directorate, major discoveries such as Johan Castberg and Johan Sverdrup are being developed with new infrastructure.

Norwegian Shelf Bustling with Exploration and Discovery

According to the Norwegian Petroleum Directorate (NPD), 20 development projects are currently under way on the Norwegian Shelf, and 13 exploration wells in the first half of 2018 have yielded six discoveries. Production, however, has been somewhat lower in the first six months of the year as compared with the same period last year.

Total petroleum production from the Norwegian Shelf at the end of the first half of 2018 is about 114.9 million standard cubic meters (Sm3) of oil equivalents (o.e.). Of this, around 43.2 million Sm3 o.e. are oil and around 10.2 million Sm3 o.e. are NGL and condensate.

Approximately 61.5 million Sm3 o.e. of gas has been sold, which is slightly higher than in the comparable period last year and in line with NPD's expectations. The total volume is 4.4 million Sm3 o.e. lower than in the same period in 2017.

In addition to ongoing development projects, authorities have received two new applications for development and operation so far this year. In May, Wintershall submitted an application for Nova, where a tie-back to the Gjøa installation is planned. On July 3, Equinor submitted an application for development and operation for Phase 3 of Troll. In the third quarter, NPD also expects a PDO for Johan Sverdrup, Phase 2. All of these fields are located in the North Sea. The authorities approved seven applications for development and operation during the first half of 2018.

The NPD expects that 40-50 exploration wells will be drilled in 2018, compared with 36 in 2016 and 2017. In the first six months of this year, 13 exploration wells have been completed, along with 10 wildcat wells and three appraisal wells. Six discoveries have been made; three in the North Sea, two in the Norwegian Sea and one in the Barents Sea.

Between 30 and 35 exploration wells are planned in the second half of the year, and drilling was in progress on six wells at the end of June. The total number of exploration wells for 2018 would appear to be around 30 in the North Sea, while there will probably be between eight and 10 both in the Norwegian Sea and in the Barents Sea.

Industry has also exhibited significant interest in recent licensing rounds. In mid-January 2018, 34 companies received offers for a total of 75 new production licenses in APA 2017. Thirty-nine companies applied for participating interests. Of the 75 production licenses, 45 are in the North Sea, 22 in the Norwegian Sea, and eight in the Barents Sea. Twenty-two of the production licenses are additional acreage for existing production licenses. APA 2018 was announced in May, and the deadline for applications is September 4, 2018. In June 2018, 11 companies were offered 12 new production licenses. Three are located in the Norwegian Sea and nine in the Barents Sea. Two are additional acreage for existing production licenses.

Still Much to Find

The report also shows that, after more than 50 years of activity, about 55 percent of anticipated oil and gas resources on the Norwegian Shelf have yet to be produced. Of these, just under half have not even been discovered. Undiscovered resources are put at 4 000 million standard cubic meters of oil equivalent. The NPD expects roughly two thirds of the undiscovered resources to lie in the Barents Sea, with the rest divided between the North and Norwegian Seas.

For more information, including updates on subsea minerals, resource mapping, full-scale carbon capture and storage, and prequalification of players on the Norwegian shelf, visit www.npd.no/en/Publications/.

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Researchers: Wave Energy Levels Change Over Time, So Should Converters

Oyster wave converter, used for the study. Credit: Alain Ulazia, UPV/EHU

Alongside the Irish Centre for Ocean Energy Research, researchers from the UPV/EHU-University of the Basque Country have been exploring how ocean energy in Ireland has evolved during the last century.

Wave energy converters are specifically designed to produce the maximum output at the location where they are going to be placed. The design and adaptation is made on the basis of historical data, past wave height and period.

"However, the timescale taken into consideration tends to be quite short and, what is more, the year is regarded as typical in this period. So, the converters are adjusted on the basis of how they are expected to behave during that typical year," explained Alain Ulazia, lecturer at the UPV/EHU's Faculty of Engineering - Gipuzkoa in Eibar.

"Using a simulation, we calculated what response or behavior a converter would have displayed when faced with the level of energy recorded during the last century, divided into periods of 20 years, given that the converters have a useful service life of 20 years on average," he said.

"We found that, between the first time period and the last, the level of marine energy saw an increase of more than 40 percent, and the biggest increase took place in the last 20 years (18 percent)," highlighted the researcher.

"The converters did not take full advantage of all the energy they had available and, what is more, extreme events, such as periods of waves over seven meters high or phenomena like El Niño, became more frequent as the century progressed. As a result, the converters had to go more frequently into survival mode, or stop producing energy during these marine events," he said.

For more information, visit
WWW.EHU.EUS/EN/CAMPUSA

DOE to Fund Advanced Wind R&D

DOE's Wind Energy Technologies Office has released a Funding Opportunity Announcement (FOA) entitled "Advanced Wind R&D to Reduce Costs and Environmental Impacts." This FOA will provide up to $6 million in funding to support efforts aimed at catalyzing technical and operational solutions to reduce environmental compliance costs and environmental impacts of land-based and offshore wind turbines.

The FOA will support research under three topic areas:

• **Topic Area 1 ($2 million)**: Reducing costs and environmental impacts associated with bat curtailment at wind plants through optimized curtailment strategies that align curtailment with periods of highest risk.

• **Topic Area 2 ($2 million):** Developing advanced components and other instrumentation for advanced bat deterrent technologies.

• **Topic Area 3 ($2 million):** Developing offshore wind instrumentation for environmental monitoring and mitigation, such as tools that monitor blade collision or that mitigate the impacts of noise from siting and construction activities.

Concept papers will be due **August 15, 2018** and are required for submission of a full application for this funding opportunity.

The The full announcement can be found at WWW.HTTPS://EERE-EXCHANGE.ENERGY.GOV

Shell Secures Exploration Acreage Offshore Mauritania

On July 23, 2018, Shell Exploration and Production Mauritania (C-10) B.V. and Shell Exploration and Production Mauritania (C-19) B.V. ("Shell") signed two Production Sharing Contracts with the government of Mauritania for the exploration and potential future production of hydrocarbons in the offshore blocks C-10 and C-19.

"This move represents Shell's entry into the West African Atlantic Margin exploration basin, which has significant potential," said Andy Brown, Shell's Upstream Director. "We look forward to working with the government and people of Mauritania as we bring our expertise and technical capability to help develop the country's emerging energy sector."

Blocks C-10 and C-19 are located offshore Mauritania in water depths ranging from 20 to 2,000 meters. The total area of two blocks is approximately 23,675 square kilometers.

The Mauritanian Minister of Oil, Energy and Mining, Mohamed Ould Abdel Vetah, said: "Shell's new entry in the Mauritania offshore area represents an important added value to the exploration activities and will contribute to maintain the momentum for developing the energy sector in Mauritania."

Following the customary government approvals of the contracts, Shell will set up an office in Nouakchott and begin exploration activities, starting with reprocessing and analysis of existing seismic data and acquisition of new data.

Shell will operate the exploration program with a 90 percent interest. Société Mauritanienne des Hydrocarbures et de Patrimoine Minier, the national oil company of Mauritania, holds a 10 percent interest.

Additionally, Shell and the government of Mauritania have agreed in a Memorandum of Understanding to jointly evaluate further offshore exploration opportunities, examine new ways of meeting the country's domestic energy needs, and build capability in the energy sector.

Source: U.S. Energy Information Administration, Refinery Capacity Report

Blowout preventer. Photo courtesy National Offshore Industry Association (NOIA).

Study Identifies Strategies for Improving Reliability of Bolts Used in Offshore Drilling Rigs

A new study from the National Academies of Sciences, Engineering, and Medicine identifies strategies for improving the reliability of bolts used in offshore oil and gas drilling rigs.

Released in June 2018, the BSEE-sponsored study aimed to determine the optimal material properties and coating requirements associated with fasteners used in critical safety components and equipment in offshore oil and natural gas subsea operations, thereby mitigating the risks of critical offshore connector equipment failures.

Although no major oil spills have resulted from the failure of a bolt fastener, there have been minor oil releases and near misses caused by unexpected bolt failures. The study includes a summary of selected subsea bolt failures with emphasis on those fasteners that hold together critical pieces of safety equipment, particularly blow out preventers (BOP), and those that secure the pressure boundary in risers. The role of hydrogen in embrittling fastener materials is the subject of some discussion and analysis in the study.

The study does not recommend actions that BSEE should take, but it does provide a number of options that, if taken, would likely improve the reliability of subsea bolting. It also provides recommendations to the oil and gas industry that do not require regulatory action that would likely improve the reliability of subsea bolting.

The *High-Performance Bolting Technology for Offshore Oil and Natural Gas Operations* study can be ordered in print or downloaded for free at www.nap.edu/catalog/25032/high-performance-bolting-technology-for-offshore-oil-and-natural-gas-operations.

More information regarding BSEE's risk mitigation efforts for bolts can be found at www.bsee.gov/what-we-do/offshore-regulatory-programs/emerging-technologies/bolt-and-connector-failures.

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Major Milestone for Scotland's Beatrice Offshore Wind Farm

Beatrice, Scotland's largest offshore wind farm, started generating power for the first time on July 19. Following the successful installation of the first 7MW turbine, Beatrice Offshore Windfarm Limited has exported power to the National Grid for the first time. The installation of the first turbine heralds the start of the final stage of Beatrice's journey towards completion in Spring 2019.

Once complete, Beatrice's 84 Siemens Gamesa turbines will be capable of providing sufficient clean and sustainable power for the equivalent of 450,000 homes, making a significant contribution to the U.K.'s renewable energy targets.

Situated 13 kilometers off the Caithness coast, the £2.6 billion wind farm is not only one of the largest private investments in Scottish infrastructure, it is also the largest offshore wind farm in the world built using jacket foundations. The jackets are also the deepest water fixed foundations of any offshore wind farm, each weighing in at c.1,000 tonnes and being installed in water depths of up to 56 meters.

John Hill, Beatrice's Project Director, said: "We often talk about key milestones along a project's journey, and Beatrice has had quite a few to date, but to see the first turbine turning in the Moray Firth and to have reached first power safely, ahead of program and on budget is a fantastic achievement for everyone connected to the project."

U.K. Government Energy Minister, Claire Perry MP, said: "Through our modern Industrial Strategy we are generating more clean energy than ever before with an impressive 15 percent of U.K. electricity coming from wind last year – up from less than 3 percent in 2010.

Scottish Energy Minister, Paul Wheelhouse MSP, said: "Once fully up and running the £2.6 billion wind farm is expected to generate sufficient power to add £1.13 billion to U.K. GDP and support more than 18,100 years of full time employment." across the U.K.

"Scotland alone is expected to see expenditure of £530 million from the construction of the project, while Operations and Maintenance activity will provide a real boost to the economy of Wick over the lifetime of the project, as the harbor chosen for maintenance activity."

Beatrice Offshore Windfarm Limited is a joint venture partnership between SSE (40 percent), Copenhagen Infrastructure Partners (35 percent) and Red Rock Power Limited (25 percent).

ExxonMobil Increases Estimate for Guyana's Stabroek Block

ExxonMobil says it has increased its estimate of the discovered recoverable resources for the Stabroek Block offshore Guyana to more than 4 billion oil-equivalent barrels and has advanced its evaluation to support a third phase of development and consideration of two additional phases. The previous recoverable resource estimate was 3.2 billion oil-equivalent barrels.
www.offshoresource.com/news/oil-gas/exxonmobil-increases-estimate-for-guyana-s-stabroek-block

NOIA Supports Proposed Endangered Species Act Reform

The President of the National Ocean Industries Association (NOIA), Randall Luthi, issued the following statement regarding the Department of the Interior's proposed rule changes to the Endangered Species Act (ESA).

"In the 45 years since the passage of the Endangered Species Act (ESA), it has become interpreted more often as a procedural marathon as opposed to a species recovery sprint. Decades of regulations have lengthened the timeframes for decisions and many courts have slowed the removal of species from threatened or endangered lists, even if scientifically based population quotas were met and exceeded. Clarifying and simplifying the ESA process will help bring offshore species recovery into the 21st century. "Offshore operators and energy producers have a long history of building vibrant habitat in the offshore space, be it deep sea pipelines providing anchor areas for endangered or threatened corals or platforms establishing reefs for fish nurseries. This joint proposal between Interior and NOAA will make the management and protection of threatened and endangered species in the Outer Continental Shelf clearer and more efficient for both the regulators and the regulated industry. We applaud the Department for their willingness to examine and improve this process."

The proposed rule change can be reviewed at
www.fws.gov/endangered/improving_ESA/regulation-revisions.html

EIA: U.S. Refinery Capacity Virtually Unchanged Between 2017 and 2018

As of January 1, 2018, U.S. operable atmospheric crude distillation capacity totaled 18.6 million barrels per calendar day (b/cd), a slight decrease of 0.1 percent since the beginning of 2017 according to EIA's annual Refinery Capacity Report. Annual operable crude oil distillation unit (CDU) capacity had increased slightly in each of the five years before 2018. The full report is available at www.oceannews.com/news/energy/eia-u-s-refinery-capacity-virtually-unchanged-between-2017-and-2018

Region-wide Oil and Gas Lease Sale for Gulf of Mexico

BOEM will offer 78 million acres in the Gulf of Mexico for oil and gas exploration and development in a lease sale scheduled for August 15, 2018.
www.oceannews.com/news/energy/region-wide-oil-and-gas-lease-sale-for-gulf-of-mexico

Development Plan Submitted for the Rovuma LNG Project

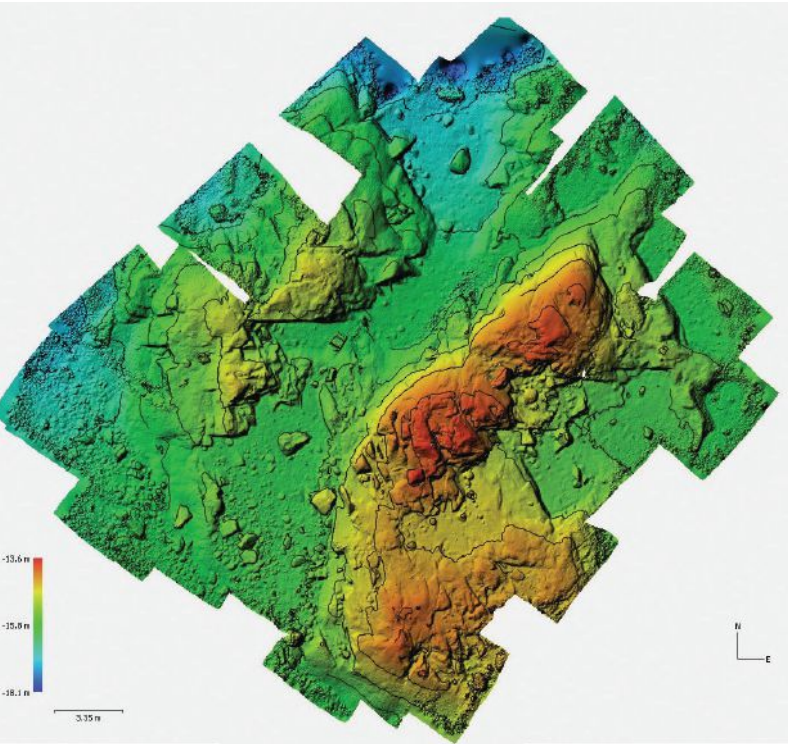
Mozambique Rovuma Venture has submitted the development plan to the government for the first phase of the Rovuma LNG project, which will produce, liquefy and market natural gas from the Mamba fields offshore Mozambique. ExxonMobil will lead construction and operation of natural gas liquefaction and related facilities, and Eni will lead construction and operation of upstream facilities.
www.oceannews.com/news/energy/development-plan-submitted-for-the-rovuma-lng-project

HIGH SPEED

PHOTO CAPTURE ON TWO 3000M AUVS CRUISING AT 1.5M/S

TAKING FULL COLOR, HIGH DETAILED IMAGES OF THE OCEAN FLOOR

BY LUKE ALDEN, MECHANICAL DESIGNER,
INTERNATIONAL SUBMARINE ENGINEERING LIMITED



Detailed bathymetry data of the ocean floor collected from photos alone. Georeferenced using the AUV inertial navigation system.

ISE has recently delivered two 3000-meter AUVs capable of capturing high-resolution color images of large sections of the ocean floor. This photo survey happens at standard 1.5 m/s survey speed and captures georeferenced images covering areas much larger than possible with ROVs or hovering AUVs in a single dive.

One dive results in 125,000 or more overlapping images that can be seamlessly blended into large orthorectified and georeferenced images, much like traditional aerial survey. Being able to cover such a large area this quickly has many uses, such as geological, biological or man-made features could be surveyed regularly and compared for changes.

TAKING PHOTOS UNDERWATER IS NOT EASY

There are many factors that make taking photos underwater difficult and most of these revolve around light. Water will naturally attenuate the light that passes through it by slowly absorbing and refracting it. Ten meters is enough distance to remove all the red wavelength. Orange and yellow quickly follow and no light is left after 150 – 200 meters. In addition, any matter suspended in the water column will scatter the light, preventing it from reaching its target.

To overcome these factors, the target needs to be as close as possible and to be brightly illuminated. A long exposure setting can be utilized when taking these photos to minimize the light needed; however, the Explorer AUV survey speed is fast at 1.5 m/s, and so the only option is to use as much light as possible. This AUV has a total of 300,000 lumens of LED light power to allow photos to be taken while cruising. With this much power the exposure time can be reduced to 5ms, removing motion blur due to vehicle movement. This much light allows for a photo survey altitude of 10 meters, depending on water clarity.

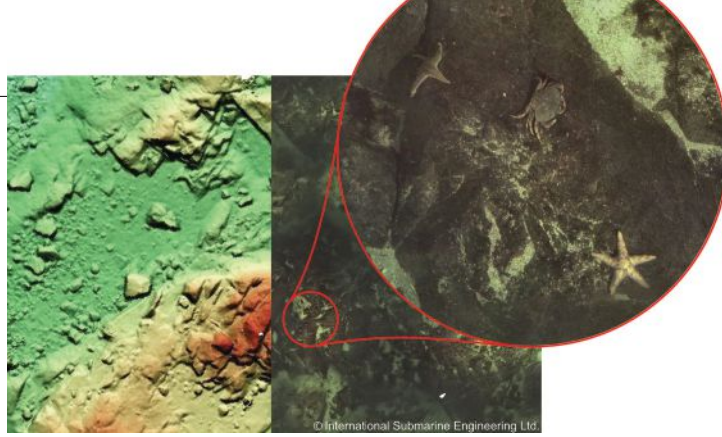
The ISE Explorer is full size survey AUV (at 0.69 meters diameter and five meters long) so the camera and LEDs can be placed in ideal positions: the LEDs forward and aft, the camera in the center, with a large spacing between the light sources and the camera. The LEDs are positioned as far away from the camera as possible and angled towards the center of the frame. This helps to minimize how much of the water column is illuminated, thus reducing how much light is scattered back towards the camera.

The camera installed has a large aperture and sensor size to reduce noise in the image as well as minimize the light required. It also uses the vehicle altitude feedback to adjust focus and has on board auto-exposure adjusting gain based on the results of the previous images.

Even when using these methods to maximize the amount of light available, it is still difficult to ensure that the illumination is even across the whole image. The edges of the image tend to be dark enough that it becomes difficult to discern detail while the center remains well exposed. This causes difficulty during the orthomosaic process and reduces the quality of the data. Using a post-processing technique, it is possible to balance out this illumination. As the lighting setup is consistent and the environment tends not to differ during the photo survey, masks can be used to adjust the color and brightness levels across the image. This not only flattens the illumination, it also removes noise from the sensor and helps to adjust for the attenuation of the light.

THE ISE EXPLORER AUV

The camera system is mounted to a standard ISE 3000-meter survey Explorer AUV capable of 24-hour missions or longer. These vehicles are easy to customize when integrating new



Both bathymetry data and orthomosiac data from 700+ photos of the ocean floor. 918 mega pixels in one image.

A standard 5000m Explorer AUV complete with sonar package, variable ballast system and under-ice tail configuration.

payloads with the standard configurations available.

As photo survey missions operate at an altitude of 10 meters or less it is important to have a vehicle that can react quickly enough to avoid the terrain it is surveying. With the ISE Explorer AUV's multibeam obstacle avoidance sonar, intelligent avoidance algorithms and high maneuvering authority, it can handle these altitudes and speeds. Its fore planes give it the ability to follow terrain quickly while still maintaining altitude. These fore planes also allow the Explorer to climb or dive by heaving rather than pitching. This means that the camera is always pointing straight at the seafloor, maximizing image quality.

The Explorer AUV has many configuration options. It is available in 3000, 5000 and 6000-meter depth ratings. It has an under-ice configuration option and the ability to extend the battery life from 24 to 48 or 72 hours. There are multiple payload options and clients will often switch payloads before missions depending on requirement—choosing between a variable ballast system, survey package or chemical analysis package.

GEOREFERENCED

Aerial photography has been used for many years to create orthomosaics of our planet's land masses. ISE uses similar techniques to stitch together images from the subsea camera with great results. Multiple overlapping images are fed into software along with altitude, depth and GPS coordinates for each photo. The software then finds unique features in each photo and searches for those features in other photos. With this information it is possible to compute where the camera was when it took the photo. The software can then create a 3D model of the ocean floor which it uses to orient the photos to the same axis, stretch and warp, and blend them together to export a large, highly detailed image from any angle. It can also produce data similar to bathymetry data, complete with contour lines, that would traditionally be created from sonar.

LOCAL SEA TRIALS

ISE conducted its sea trials of this Explorer AUV and camera system in Indian Arm fjord in British Columbia, Canada. The water in this area is highly turbid, 200-meter-deep and full of marine life, making it a very difficult medium for photography. To get high quality results, the Explorer AUV had to fly at an altitude of five meters with line spacing of two meters for the appropriate overlap. During sea trials we stitched 700 images together into one 918 mega pixel image.

THE FUTURE

ISE will continue to test cameras from multiple manufactures on its 3,000-meter R&D Explorer AUV vehicle. We plan to have multiple options for our clients as well as examples of the data quality that can be expected from them. We will also be testing laser systems for scanning subsea objects. Both techniques will be included in ISE's long-term R&D program for applications such as underwater docking, adaptive mission planning, on board data processing and more.

Making Resident ROVs a Reality

By Arve Iversen, ROV Operations Manager, Oceaneering

As global operators search for innovative and cost-saving subsea solutions, projects like the Oceaneering E-ROV system are proving that deviating from the norm has enormous potential.

Remotely operated systems enable operators to intervene faster, keep production online with more efficiency, and perform routine tasks with fewer deployments. The ever-expanding ability for the remotely operated vehicle (ROV) to work on the seafloor for extended periods of time while being supported from a remote onshore location has reduced the environmental impact and improved the safety of ROV operations.

In early 2017, Oceaneering was awarded a contract from Norwegian oil and gas major Equinor ASA (formerly Statoil), enabling Oceaneering to develop, manufacture, test, and mobilize its self-contained, battery-powered ROV (E-ROV) system. Recognizing the potential cost savings that the Oceaneering E-ROV system represents, Equinor was interested in confirming the viability of such a system.

ADVANTAGES OF RESIDENT ROVS

A resident ROV system, such as the E-ROV, has the potential to increase efficiency, reduce costs, and improve safety. The Oceaneering® E-ROV solution pushes the boundaries with a system that is capable of completing intervention tasks, operating in tethered or untethered mode, and taking advantage of modern advances in control technology. A resident system offers advantages that include:

- Increasing efficiency in completing operations;
- Reducing carbon footprints (fewer mobilizations/transportation requirements);
- Decreasing expenditures allocated to ROV intervention operations;
- Increasing interactions between pilots, customer personnel, and subject matter experts at dedicated mission support centers;
- Reducing costs associated with mobilizations of equipment and personnel;
- Achieving savings associated with time and cost when bundling operations; and
- Mitigating health, safety, and environmental (HSE) exposure for personnel and equipment.

LAYING A SOLID FOUNDATION FOR ADVANCED SUBSEA OPERATIONS

The E-ROV system includes an Oceaneering® eNovus ROV, which has an electric propulsion system that includes state-of-the-art control electronics and an intelligent diagnostic system. The E-ROV system also includes a cage-mounted 100-kW battery pack and a tether management system, as well as a communications buoy, which hosts an antenna mast to improve signal reception and battery power to support communications transfer. The buoy also includes a robust, highly engineered mooring system, providing a broadband data connection and suitable weight while addressing sea conditions.

Communications for the E-ROV system operates via a 4G network with low latency, enabling efficient communications and data transfers. All traffic uses an encrypted virtual private network (VPN) channel.

The E-ROV system uses an advanced communications setup to interface with an onshore Oceaneering mission support center via a 4G mobile broadband signal transmitted from the buoy on the water's surface, without the need for a surface vessel. Both the cage and ROV include advanced battery technology optimized to handle peak power consumption.

PROVING THE E-ROV CONCEPT

E-ROV system development, manufacturing, and pool testing were completed in early 2017 at Oceaneering facilities in Stavanger, Norway.

In June 2017, Oceaneering conducted an offshore pilot test at Equinor's Troll field in the North Sea. The E-ROV system was deployed using an inspection, maintenance, and repair (IMR) vessel, and was stationed subsea for three weeks, in which time it performed various operations, such as operating a valve on a Christmas tree.

Remotely, Oceaneering maintained continuous, uninterrupted control. The availability of a mature 4G network on the Norwegian continental shelf, provided by Equinor's service provider Telenor Maritime, enabled the system to take advantage of Oceaneering remote piloting and automated control technology.

Following this successful pilot operation, the E-ROV system was put to work on a different field offshore Norway, assisting during tophole drilling operations. The operator was required to transport drill cuttings 1,300 meters (4,265 feet) away from the well location, and the E-ROV system was tasked with proving that the transport system was working properly. The E-ROV system was stationed to observe the transport system. Deployed for one month, the E-ROV system completed this initial scope of work without incident in approximately eight days.

E-ROV SYSTEM'S WORK CONTINUES

The E-ROV system is rated at technology readiness level 6 (out of a scale of 7), which means that the technology has shown acceptable performance and reliability over a period of time.

Oceaneering's long-term goal is to provide an E-ROV system that is 100 percent electric; currently, the system uses hydraulic manipulators. At this time, electric manipulators do not measure up to the lifting capacity of hydraulic ones, but it is hoped that someday suitable electric systems can be found, tested, and utilized.

In the meantime, the E-ROV system has made great strides and has been recognized for its innovativeness. The Offshore Technology Conference selected the E-ROV system for the conference's 2018 Spotlight on New Technology Award in Houston this past May. The technology was also recognized by World Oil, winning the magazine's New Horizons Idea Award, which seeks to highlight game-changing products, technologies, or ideas that redefine the industry's thinking. Most recently, the technology won the 2018 Underwater Technology Foundation Subsea Award.

FUTURE POTENTIAL OF E-ROV SYSTEMS

There are several task types where an E-ROV system could also be used, such as well commissioning, which is a lengthy procedure with many tests involved. In these instances, an ROV vessel is typically on location, waiting to open and close valves. This can take hours, even days, between each time a valve needs to be operated (a task that takes only a few minutes), which is very ineffective when it involves an expensive vessel waiting. In contrast, a resident E-ROV system could be deployed and left on location while other well commissioning operations are performed. The E-ROV system would be stationed onsite to operate the valve when required.

Other inspection work could be carried out with the E-ROV system. For example, if a subsea template needs additional inspection, the E-ROV system could be deployed to conduct the inspection and, once finished, the system could be retrieved.

Additionally, if there are safety issues, such as a hydrocarbon leak or if an operator is worried about the potential occurrence of a hydrocarbon leak, the E-ROV system could be deployed to monitor the area. Another example where the system could be used is for drill support, perhaps not with a buoy, but with an umbilical topside.

CONCLUSION

The E-ROV system challenges operators to think differently and creatively, and to ultimately deviate from the traditional tether-based, vessel-controlled operations on which they have previously relied.

The development of a subsea, resident ROV system represents reductions in vessel requirements, mobilizations, personnel-onboard needs, and lifting requirements. All of these reductions have positive impacts on protecting the environment, de-risking operations, and supporting safe working practices.

By combining our decades of Oceaneering ROV experience and remote piloting and automated control technology, the dependency on a surface vessel to complete ROV intervention and maintenance operations is dramatically reduced. This not only lightens the financial burden of operational expenditure (OPEX) activities, but also addresses logistical challenges.

Safety is increased as the E-ROV system supports operations that require fewer mobilizations of both equipment and personnel. Additionally, the benefit of increased interaction between subject matter experts, remotely based pilots, and customer personnel based at an onshore Oceaneering mission support center is an intangible that delivers vast benefits during execution. Oceaneering remote piloting and automated control technology (RPACT) enables full ROV piloting via virtual connection technologies, such as vessel-to-vessel radio frequency (RF), satellite/internet, or a subsea optical link.

The E-ROV system could also deliver a reduced response time in the event of an emergency. When a work class ROV is already subsea, a resident E-ROV system could be quickly deployed to expedite an intervention during the emergency and to mitigate any possible negative effects stemming from the situation.

The innovative Oceaneering E-ROV system increases operational efficiency and combines the best of our subsea technologies to deliver an industry-leading, resident ROV solution. With its proven performance capabilities, the E-ROV system represents a game-changing technology that expands operations in all kinds of challenging subsea environments.

Kongsberg GeoAcoustics Extends Small Survey Vessel Product Line to Include Sub-Bottom Profiling

Kongsberg GeoAcoustics Ltd launched its 'GeoPulse Compact' sub-bottom profiler system as both a compact over the side (OTS) mounted version and a towed version at Oceanology International this year. The product is now available as an option for their unmanned surface vessel and their compact survey vessel.

The GeoPulse Compact sub-bottom profiling system features digital processing and waveform selection technology, which enables the appropriate pulse-shape, power signature and configuration to be selected for the job in hand. Depending on the survey task, the user can choose waveforms in the frequency band of 2-18kHz, optimiszing resolution and sub-seafloor penetration.

The GeoPulse Compact is highly flexible, integrating the best features of continuous wave "Pinger" and frequency modulated "Chirp" type systems but with much lower power requirements than other systems running from as little a 10V dc power supply to operate.

The GeoPulse Compact USV allows for both autonomous surveying or remote control of the vessel while transmitting a live data feed back to the shore station over a radio LAN modem link. The typical range of operation using remote control is up to two kilometers from the base station and the vessel if fitted with forward facing HD cameras providing a real-time view of the vessel's course. Position information is derived from a Seatex GNSS compass. The vessel can operate in extremely shallow water for prolonged periods of time allowing for sub-bottom surveys to be conducted in shallow lakes and rivers which were previously inaccessible.

The CSV can now be fitted with either a stand-alone GeoPulse Compact or integrated with a GeoSwath. The standalone version has the transducer mounted on a retractable pole between the two hulls which can be raised when the vessel is out of the water; a ruggedised PC is used to display and record the sub bottom traces in SEG Y format for subsequent processing.

By integrating the GeoPulse Compact with the GeoSwath CSV the surveyor can record bathymetry, side scan imagery and sub bottom information all from a three meter long vessel operating in very shallow water. The GeoSwath system is mounted on the retractable pole between the hulls and the GeoPulse Compact is deployed via a small over the side mount. Both systems are controlled from the same ruggedized PC which is ergonomically placed for the operator to use while controlling the vessel.

For more information, visit
WWW.KM.KONGSBERG.COM

KONGSBERG

Nexans Wins Major Subsea Umbilical Contract for Troll Phase 3

The Troll oil and gas field is the most prolific field on the Norwegian continental shelf (NCS), with more than half of its reserves still remaining after over 20 years of production. The initial development was carried out over two phases. Now Equinor is starting Phase 3 development to recover the large amount of gas resources in the western part of the field. Nexans will play a vital role in the Troll Phase 3 project by supplying Equinor with the complex umbilicals required to power and control the subsea systems.

Phase 3 of the Troll project covers the development of the Troll West structure, which lies in water depths of approximately 330 meters and is located 25 kilometers north-west of the Troll A platform. The subsea production systems will comprise two subsea templates or manifolds, as well as nine trees. Each manifold is expected to have four well slots. A total of eight production wells will be drilled and tied-back to the Troll A platform in order to recover the gas reserves. First gas is expected from the project in the second quarter of 2021.

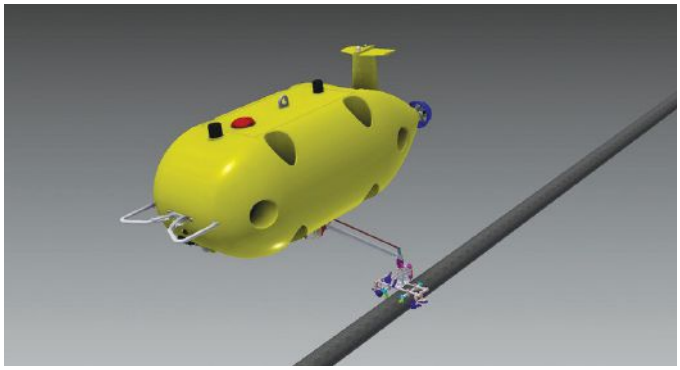
For the Troll Phase 3 development Nexans Norway will design, manufacture and supply static umbilicals that include high voltage power elements, high-pressure hydraulic lines, low-pressure hydraulic lines, a MEG (methanol and glycol) service line for chemical injection, a spare line and fiber-optic communications – all within a single cross-section. A 20-kilometer umbilical will link the Troll A platform to Template W1, while a seven kilometer umbilical will then link Template W1 to Template W2. The contract also includes the supply of connections, terminations and other umbilical accessories.

Nexans offered Equinor a total 'made in Norway' approach to the contract with the electrical and fiber optic elements manufactured at the Nexans Norway facility in Rognan, North Norway, while the complete umbilical system will be developed, manufactured and tested at Nexans Norway plant in Halden, Norway.

Nexans is scheduled to deliver the Troll Phase 3 umbilicals in the first quarter of 2020.

For more information, visit
WWW.NEXANS.COM

Kawasaki Testing AUV Equipped with Robot Arm



AUV equipped with robot arm for subsea pipeline inspection

Kawasaki Heavy Industries, Ltd. has reached a basic agreement with The Underwater Centre (TUC), a marine testing and training facility in Fort William, Scotland, on conducting a verification test of a prototype AUV equipped with a robot arm for subsea pipeline inspection. The test, scheduled for October 2018, will be the first such test in the world.

Aiming at commercialization in FY 2020, Kawasaki is currently developing an AUV capable of underwater charging and transferring of inspection data to the mother ship—features that allow for longer deployment time—while autonomously locating and tracking pipelines at close range, including those buried under seabed sediment.

In November 2017, Kawasaki successfully completed a verification test at TUC for automated underwater docking of a prototype AUV to its charging station, involving contactless charging and large-capacity optical communication.

For the upcoming test, leveraging on synergies of its technologies, Kawasaki plans to use a prototype AUV equipped with a robot arm with an attached inspection tool unit (currently under development), to achieve autonomous locating and tracking of subsea pipelines. The test will focus on verifying the robot arm's capability to absorb the movement of the AUV due to tidal currents, and on verifying that the inspection tool unit can continuously track a pipeline under those conditions.

The agreement also states that TUC will be collaborating with Kawasaki on future development of underwater vehicle technology. The agreement will advance Kawasaki's commitment to further strengthening their partnership with the Scottish Government and TUC, in order to drive the development of technologies forward for AUVs and other underwater vehicles.

For more information, visit
WWW.GLOBAL.KAWASAKI.COM/EN/

Seatools Delivers *Bravenes* FP-ROV to Van Oord

Subsea technology company Seatools has completed the delivery of a highly automated fall pipe ROV on behalf of its client Van Oord. The ROV will serve Van Oord's new subsea rock installation vessel *Bravenes*. The 450-kW rock installation ROV successfully underwent extensive sea trials and is ready to be deployed for SRI campaigns.

The ROV positions the fall pipe above the target (e.g., a pipeline) and with high accuracy facilitates rock installation in over 1,000 meters water depth. Like all other Seatools fall pipe ROVs, the ROV features an advanced dynamic positioning system enabling the vehicle to pursue a pre-programmed track with great precision. The ROV is equipped with the latest version of Seatools' ROV DP technology, which accomplishes the highest possible levels of rock installation efficiency. This allows Van Oord to achieve a minimum of rock spillage and cost-effectively execute rock installation operations.

The ROV control system was taken to the next level by the introduction of an automated thruster tuning functionality. This feature enables automatic tuning of the hydraulic propulsion system required by wear over time or after component replacement (e.g., hydraulic motors or thruster valves). The automated tuning functionality, which is activated by the push of a button, yields considerable time savings when compared to periodic manual tuning.

From the outset, Seatools and Van Oord combined their respective technical and operational expertise. Complemented by a thorough FMEA analysis, their excellent teamwork resulted in an ROV system architecture that features unprecedented redundancy levels and comes with a solid backup strategy. As a result, the ROV remains capable of performing rock installation operations even if a sub-systems like the HPU motor were to fail.

For more information, visit
WWW.SEATOOLS.COM

SEAEXPLORER GLIDER SETS ENDURANCE RECORD WITH A SEA-BIRD GLIDER PAYLOAD CTD

With 18 percent of its batteries still remaining, scientists from the Laboratoire d'Océanographie de Villefranche (LOV) pulled a record-setting SeaExplorer glider from the French Riviera. The unmanned underwater vehicle (UUV) had just completed a mission to set a world record for the longest journey (in both distance and duration) by an underwater glider on a single battery charge: 60 days and 1,183 kilometers.

Unlike many other gliders, the SeaExplorer draws power from rechargeable Li-Ion batteries, opening doors for low-cost, fast turnaround missions.

Launched on September 5, 2013 from Cavalaire-sur-Mer, the SeaExplorer voyaged to Corsica and conducted several alternating trips between Nice and Calvi. On November 5, 2013, LOV scientists recovered it.

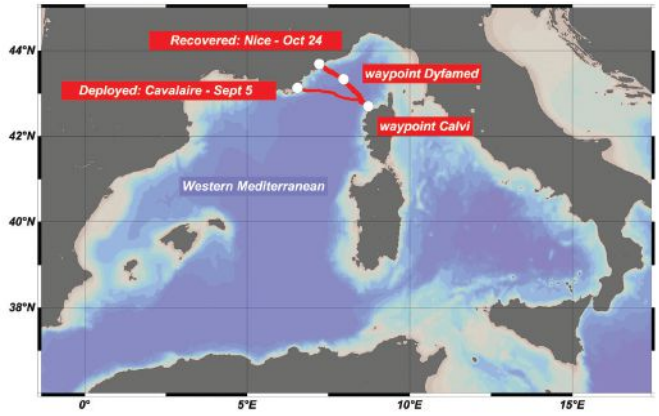


Fig 1. The SeaExplorer's 1,183 km journey in the Mediterranean Sea, with alternating voyages between Nice and Calvi.

Glider Payload CTD

Paired with a Sea-Bird Glider Payload CTD (GPCTD) and 43F dissolved oxygen sensor, the glider conducted over 1,168 profiles of high-resolution conductivity, temperature and depth (CTD) data, despite a strict power budget. The GPCTD was configured for "continuous sampling mode," running a pump continuously and collecting a CTD+DO data point at 4-second intervals during the glider's flight.

Evolved from the technology behind the fleet of Argo float CTDs, the Sea-Bird Scientific GPCTD is a low-power CTD designed for autonomous vehicles. Its streamlined T-C intake sail sits outside of the glider hull to reduce the CTD's footprint on the glider's flight and provide dynamic accuracy for moving autonomous vehicles. It includes a modified SBE 5 pump and an optional 43F Dissolved Oxygen sensor, connecting all sensors in a shared flow path for proper data alignment. The high-resolution data it gathered compared well with concurrent shipboard profiles.

Power Consumption

The SeaExplorer's rechargeable battery powers the glider's flight and sensor payload, allowing it to average 0.5 knots. Unlike most other gliders, which utilize alkaline or lithium batteries, the success of the SeaExplorer's endurance trials paves the way for cost-effective autonomous deployments with a rechargeable Li-Ion battery, while retaining the necessary deployment endurance levels for glider applications.

In the configuration used in the Mediterranean Sea, the GPCTD consumes approximately 265 mW (approximately 3.36 Watt-hours/day at 50 percent duty).

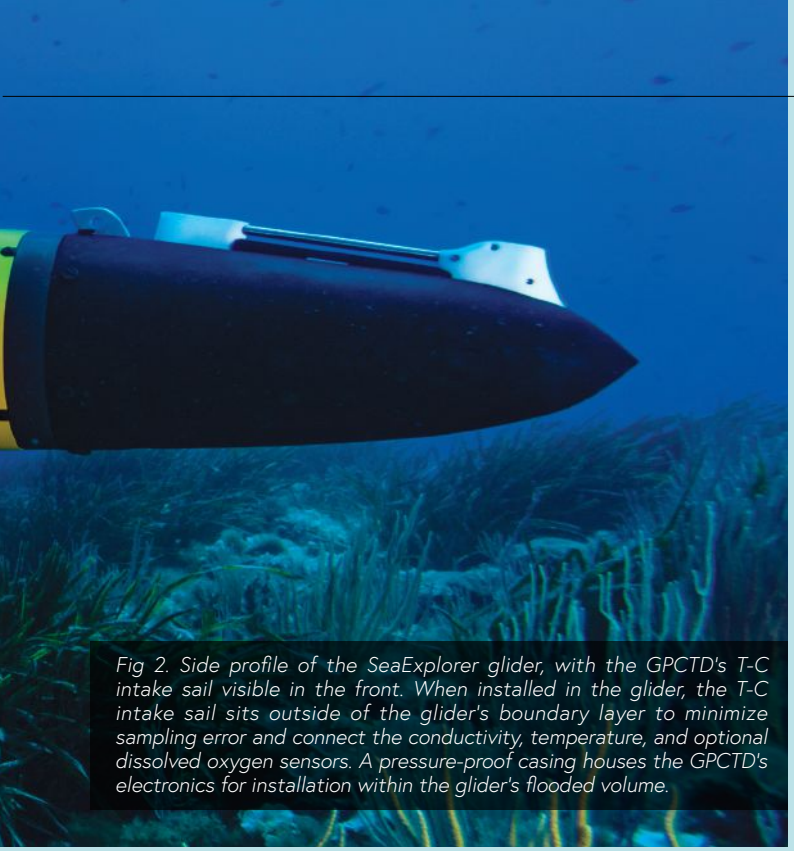


Fig 2. Side profile of the SeaExplorer glider, with the GPCTD's T-C intake sail visible in the front. When installed in the glider, the T-C intake sail sits outside of the glider's boundary layer to minimize sampling error and connect the conductivity, temperature, and optional dissolved oxygen sensors. A pressure-proof casing houses the GPCTD's electronics for installation within the glider's flooded volume.

TASK	Power Requirement
Running the pump / sampling Conductivity, Temperature, and Pressure:	175 mW
Sampling Oxygen:	90 mW
Transmitting data in real time to the glider controller:	15 mW
TOTAL	**265 mW**

Table 1. Breakdown of the power requirements for a continuously sampling GPCTD + 43F Dissolved Oxygen sensor. The GPCTD requires an external power supply of 8-20 VDC. Power calculations assume 10.0 V.

To put the GPCTD's power requirements into perspective, one alkaline D cell could operate the CTD in this configuration for 75 hours of continuously pumped data collection, making it an ideal CTD for autonomous glider deployments. In comparison, the larger SBE 19plusV2 (designed for shipboard profiling) can provide approximately 60 hours of profiling with nine alkaline D cells.

Data Quality

Continuous sampling with the GPCTD allows for application of dynamic data corrections (e.g., response filtering, alignment, and thermal mass correction) associated with collecting data on a vehicle that is moving through gradients.

Despite a strict power budget, the SeaExplorer was able to obtain high-resolution data that compares well with concurrent data obtained via traditional shipboard profiling.

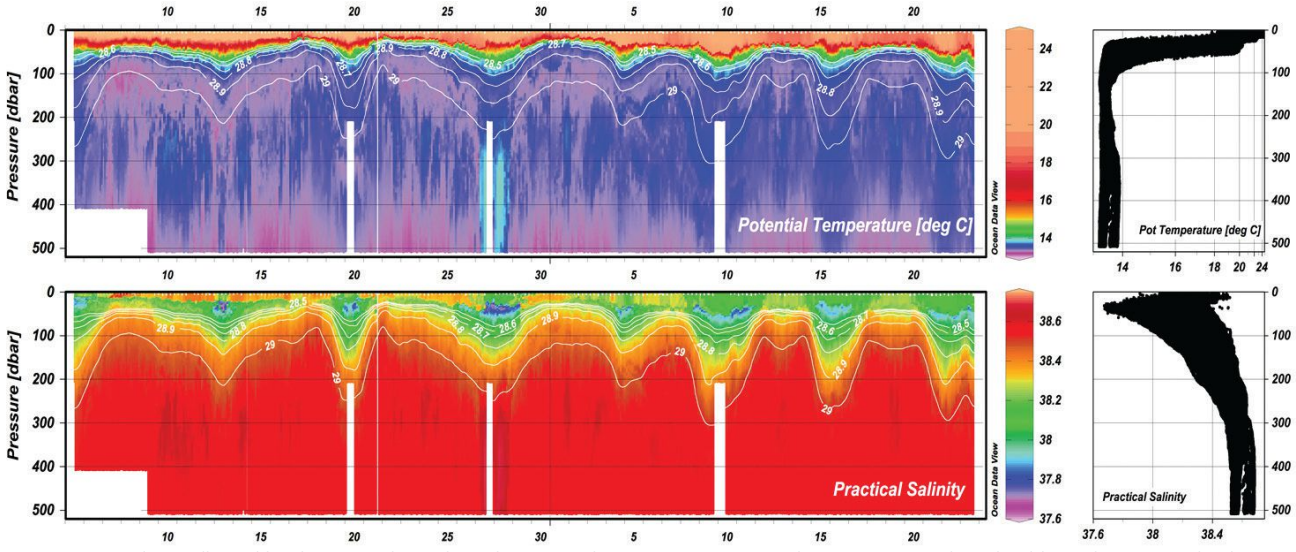


Fig 3. CTD data collected by the SeaExplorer along the Nice-Calvi section transects. Subsequent sea-trials with additional sensor payloads (including a WET Labs ECO Puck measuring chlorophyll-a, turbidity, and CDOM) obtained data of comparable quality.

Conclusion

The endurance achievement in the Mediterranean Sea provides a testament to the SeaExplorer platform and associated CTD technology. The GPCTD provides a low-power, high-resolution CTD solution to autonomous glider applications, as evidenced by the SeaExplorer's successful mission. Future advancements in the field will increasingly provide researchers with more affordable options for obtaining high-quality autonomous data, reducing operating costs associated with replacement batteries, technician time, and instrument down-time.

Russian Cruiser Found After 113 Years Could Hide Gold

Shinil Group reported on July 15, 2018 that it had found the *Dmitrii Donskoii*, a Russian armored cruiser ship that was sunk near Ulleungdo Island of South Korea in a battle that took place 113 years ago. The South Korean salvage firm used two manned submersibles to spot the wreck and confirm its identity. South Korean news reports have claimed that it held gold reserves from other Russian ships damaged in the Battle of Tsushima. Others doubt that the gold would have been stored on a ship in imminent danger.

The exploration team found a large amount of iron boxes in the stern and will take measures to preserve them. It is within these boxes where some believe lost gold could be stored, if it exists.

The stern of *Donskoii* was first discovered at 1.3 kilometers off Ulleungdo Island at a depth of 434 meters. *Dmitrii Donskoii*, the first-class armored cruiser of the Russian Baltic Fleet, sailed the oceans for 20 years. In May 1905 it participated in the Battle of Tsushima, where 38 Baltic ships and 89 Japanese ships battled. *Dmitrii Donskoii*, a 5,800-ton ironclad cruiser, was one of the 38 main Baltic fleet vessels that departed from the Baltic Sea.

The Shinil Group exploration team used two Nuytco DeepWorker's to explore the wreck and found that it matched the *Donskoii's* sail plan. A second exploration was conducted on July 15, and the team photographed the stern, which confirmed the ship name as *Donskoii*.

In addition to the clear images of the stern, there were 203 milimeter cannons and 152 milimeter long-distance guns, a number of machine guns, anchors, two stacks, three masts, wooden decks and armor, all of which helped confirm its identity.

The bottom of *Donskoii* is about 40 degrees on the slope of the seabed with its stern 380 meters below the water level, and its bow is at 430 meters. One-third of the stern is bombarded and the hull is severely damaged. However, the upper deck of the wooden hull is almost untouched. The armor on the side of the hull is also well preserved, while the anchors, guns and machine guns remain in place. In addition, all three of the masts and the two chimneys are broken, there was also a partial attacked trail of marking on the sides.

The exploration team of the Shinil Group is under the leadership of JD Engineering, a marine exploration company in Korea, and assisted by Nuytco, a Canadian marine exploration company. The team closely analyzed and compared the images and photos of *Donskoii*, taken on July 14 and 15, with the hull plan, and released the data externally on the 17th.

£10 Million in Contracts for M2 Subsea

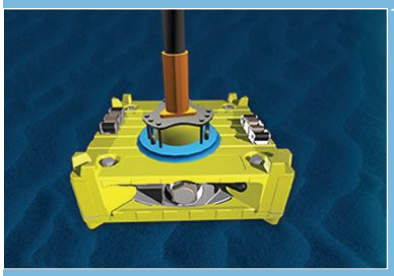
M2 Subsea, a global independent provider of ROV services, has secured contracts worth more than £10 million over the past six months. The company, which has bases in Aberdeen, UK and Houston, Texas, has successfully conducted more than ten projects across the oil and gas and renewable markets. The firm also secured a contract for unexploded ordinance (UXO) identification for a UK offshore wind farm earlier this year. www.oceannews.com/news/subsea-intervention-survey/10-million-in-contracts-for-m2-subsea

USVs are a Hot Topic at China-Israel Summit

On July 2nd, the 4th China-Israel Innovation & Investment Summit was held in Zhuhai, China. Yunfei Zhang, the founder of Oceanalpha, stated that surface robots, represented by unmanned surface vessels (USV), will subvert the traditional operation in the marine field, while the core of unmanned boats is AI technology. Both Israel and China are actively developing USV technology. www.oceannews.com/news/subsea-intervention-survey/usv-causes-hot-discussion-at-china-israel-summit

OSIL Supplies Turbidity Monitoring Package for Harbor Expansion

Ocean Scientific International Ltd (OSIL) has provided construction company Dragados UK with a turbidity monitoring solution to report on the dredging activities of the Aberdeen Harbor Expansion Project. www.oceannews.com/news/subsea-intervention-survey/osil-supplies-turbidity-monitoring-package-for-harbor-expansion

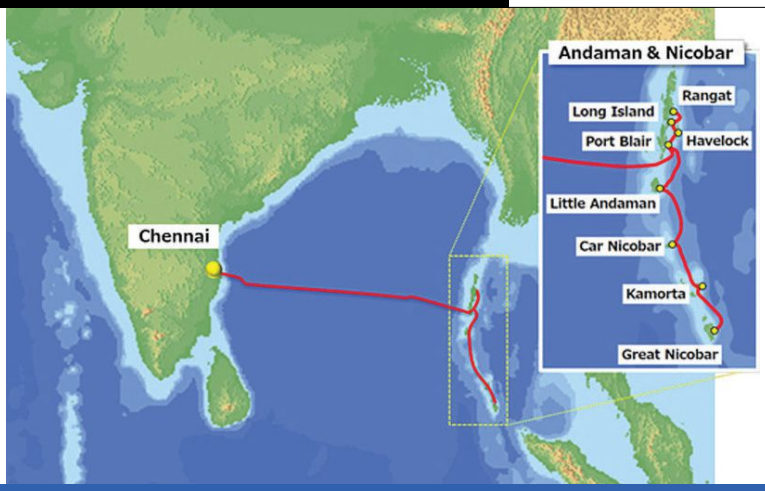


Seabed Geosolutions Awarded 4D Monitoring Survey Contract in GoM

Seabed Geosolutions has been awarded a series of 4D ocean bottom node (OBN) seismic monitoring surveys over multiple oil and gas fields in the U.S. Gulf of Mexico. The surveys, with a duration of around two months, subject to final scope of work, will commence in the third quarter of 2018. www.oceannews.com/news/subsea-intervention-survey/seabed-geosolutions-awarded-4d-monitoring-survey-contract-in-gom

Oceanscan Invests in Sonardyne Acoustics

International equipment supplier Oceanscan has added underwater acoustic positioning technology from Sonardyne International Ltd. to its rental fleet. www.oceannews.com/news/subsea-intervention-survey/oceanscan-invests-in-sonardyne-acoustics



NEC to Build the Bay to Bay Express and Submarine Cable System in India

The Bay to Bay Express Cable System (BtoBE) consortium, composed of China Mobile International, Facebook and Amazon Web Services, signed an agreement with NEC Corporation to build a high-performance submarine cable connecting Singapore, Hong Kong, and the United States.

Construction of the nearly 16,000-kilometer optical submarine cable is expected to be completed by the fourth quarter of 2020.

BtoBE, featuring multiple pairs of optical fiber, enables high capacity transmission of data across the Pacific Ocean with round trip latency of less than 130 milliseconds. BtoBE will further enhance and contribute to the much-needed expansion of communications networks between the Guangdong-Hong Kong-Macao Bay Area, San Francisco Bay Area, and Singapore.

Also Building Submarine Cable System in India

Bharat Sanchar Nigam Limited (BSNL), a Government of India Enterprise, and NEC Technologies India Pvt. Ltd. (NECTI) announced that a purchase order had been placed by BSNL for NECTI to design, engineer, supply, install, test, and implement an optical submarine cable system connecting Chennai and the Andaman & Nicobar Islands (A&N Islands). NEC Corporation, the parent company of NECTI, will manufacture the optical submarine cable and provide technical assistance during the turnkey implementation.

The contract is for a system that includes a segment with repeaters from Chennai to Port Blair and seven segments without repeaters between the islands of Havelock, Little Andaman (Hutbay), Car Nicobar, Kamorta, the Great Nicobar Islands, Long Island and Rangat. The total cable length will be approximately 2,300 kilometers and carry 100 Gbps optical waves.

For more information, visit
WWW.NEC.COM

Australia Singapore Cable Lay Completed

The cable laying phase of the Australia Singapore Cable (ASC) system is complete, with the final splice having been completed south-east of Singapore.

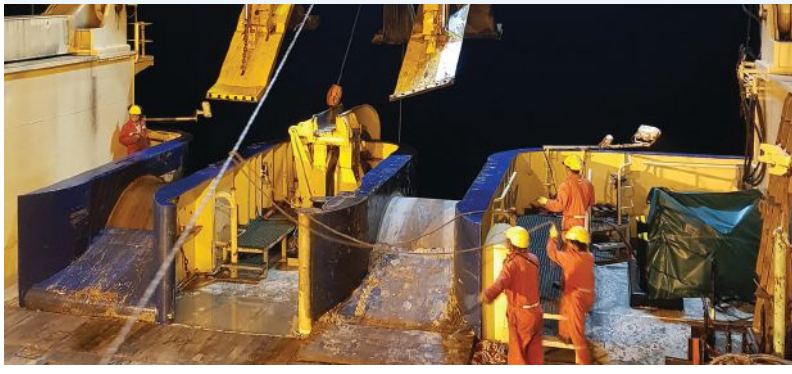
Vocus Group Managing Director and Chief Executive Officer Kevin Russell recognized the significance of the milestone.

"I'm thrilled to have reached this very important point which is a testament to the very positive and cohesive relationships between our project team and the team from Alcatel Submarine Networks (ASN)," said Kevin. "This final leg from Christmas Island to Singapore presented the greatest engineering and technical challenges and it's a great credit to the team that we on track in final configuration phase," said Kevin.

It's been a long journey for the Alcatel Submarine Networks cable-laying ship, *Ile de Re*, with the complicated lay from Christmas Island through the very challenging and heavily traversed Sunda Strait that splits the Indonesian Islands of Java and Sumatra. From here it has progressed to just off the Singapore coast where the ASC connects to Singapore via a 10 meter deep trench from 10 kilometer out from the cable station landing site and then through a horizontally bored pipe into shore.

Of the two cable ships that worked on ASC, the *Ile de Re* has had the more challenging, and time-consuming, task of deep dredging in a number of areas with a 40-tonne plough to bury the ASC to minimize the risk of damage from shipping and other marine activities. All whilst navigating some of the busiest shipping lanes in the world which heightens the operational risk.

With this phase having been completed on time and without any delays, the project team now swings into full configuration mode with electrical and technology systems now being installed, configured and tested as part of a rigorous make-ready phase.



Sea the difference.

Sea deep in shallow water.

The unmanned surface vehicle (USV) was utilized to locate a downed U.S. World War II military aircraft in the coastal marsh habitat of the Netherlands. The USV fit into very shallow areas where a conventional vessel would have been unable to navigate.

CSA provided an operator with our USV which was fitted with the client's equipment.

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INFINERA INTENDS TO ACQUIRE CORIANT

Infinera, provider of Intelligent Transport Networks, announced its intent to acquire Coriant, a privately held global supplier of open, hyperscale network solutions.

The acquisition significantly scales the company as the next wave of global network spending begins, creating one of the world's largest optical network equipment providers. The combination positions Infinera to capitalize on the next wave of global network spending as network operators transform their networks to transition from 4G to 5G, from Optical Transport Network (OTN) to packet and from closed to open network architectures. Infinera's vertically integrated business model provides the unique ability to unleash value for customers and investors as the company's combined network solutions power the world's largest network operators. Ovum forecasts optical network spending to reach $17.8 billion in 2022.

"Acquiring Coriant is a fantastic opportunity, strengthening our ability to serve the world's largest network operators, accelerating our ability to leverage vertical integration and reinforcing our commitment to our long-term business model," said Tom Fallon, Infinera CEO.

STRATEGIC AND FINANCIAL RATIONALE

• Compelling strategic logic: The scale economics of Infinera's vertically integrated business model deliver higher performance at lower cost for our customers and higher profit margins for our stockholders. The acquisition approximately doubles Infinera's revenue and expands the company's customer base to serve nine of the top 10 global network operators (five new to Infinera) and the top six global internet content providers (three new to Infinera).

• Financially attractive: The acquisition is expected to be substantially accretive in 2019. This accretion will come from $100 million of identified cost savings in both cost of goods sold and operating expenses. Total cost synergies of $250 million are expected through 2021, with the continuation of operating synergies and the introduction of vertical integration into the Coriant product line, resulting in a step-function increase in Coriant's margins. Infinera will be acquiring a debt-free balance sheet and expects cash flows to pay back transaction consideration within three years.

• Innovation to benefit customer networks: Coriant invested nearly $1 billion in research and development over the last five years to significantly advance its portfolio to address the growing demand for software automation and open, disaggregated platforms. Infinera recently upgraded its portfolio based on the innovative Infinite Capacity Engine (ICE4). Combining the strengths of both companies creates a powerful new portfolio to support our customers' transition from 4G to 5G, from OTN to packet and from closed to open network architectures.

SubCableWorld Shares Pacific Island Updates

The following is SubCableWorld's review of subsea cable news for the Pacific Region, particularly the islands of the South and Central Pacific. Activity in this region continues at a high level. There is an average of more than one major announcement per week.

JULY

- Hawaiki enters service
- FINTEL signs management agreement for Savusavu
- Cable laying for Natitua began
- Alcatel was announced as the supplier for the Coral Sea Cable

MAY / JUNE

- Fiji's government and local carriers signed an agreement for a domestic cable, called Savusavu, connecting the main island of Viti Levu to the second largest island, Vanua Levu
- Japan protested a Russian plan to lay a cable to the disputed Kurile Islands
- Governments of Australia, the Solomon Islands and Papua New Guinea formally announced that they would build the Coral Sea Cable linking the three countries
- DOCOMO Pacific announced an investment in public health in the CNMI made possible by its ATISA cable
- Interchange announces contract in force with SubCom for ICN-2 cable linking Vanuatu and Solomon Islands
- OSI and Interchange announce partnership for ICN-2 project
- ADB announces agreements to help fund submarine cable connections to Kiribati, Nauru
- Final splice for Hawaiki
- Australian government announces that it will fund three-fourths of a new cable system (now called the Coral Sea Cable) linking Australia with PNG and Solomon Islands

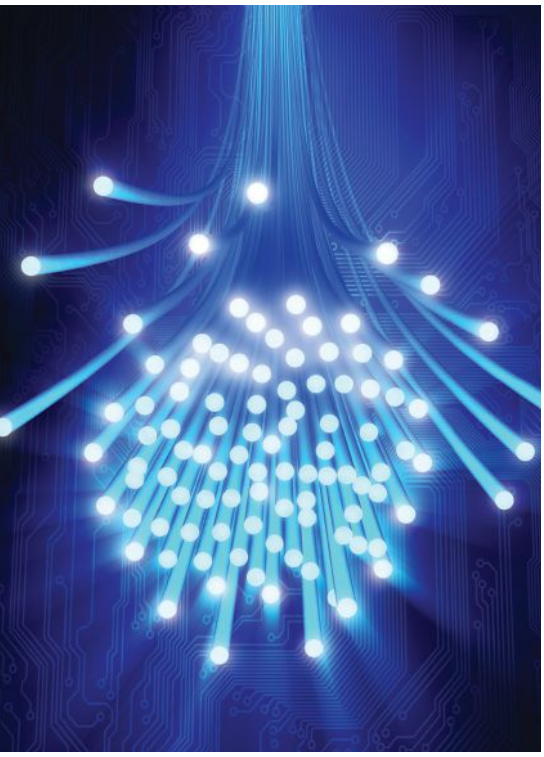
MARCH / APRIL

- Construction began on the JGA cable that will land in Guam
- Telin announced that the cable connecting Timor Leste would also link the west (Indonesian) side of Timor Island as well as Flores Island in Indonesia
- The governments of Australia and Papua New Guinea signed an MoU for a submarine cable connecting the two countries
- Hawaiki lands in American Samoa – the system's final landing
- Solomon Islands added to planned Australia-PNG cable
- Telkomsel and parent Telin announced that a new cable would connect Timor Leste
- Cable laying operations for the ASC cable began, including a landing in Christmas Island
- The first phase of the Tonga domestic cable system was completed

JANUARY / FEBRUARY

- Samoa Submarine Cable Company (SSCC) and TE SubCom announced an agreement to build a new cable depot in Samoa to service the South Pacific Marine Maintenance Agreement (SPMMA)
- Tui Samoa was officially inaugurated as expected on February 9
- The Samoan government said that supply tenders for the Manatua cable system would be requested soon
- It is not quite in the region that we began with in this monthly review, but it is an island in the Pacific – The Canadian government, along with CityWest and SRD announced plans to build a network of submarine cable around Vancouver Island off British Columbia
- Digicel announced that it was the first carrier to sign up for Tui Samoa, which had entered service earlier in the month
- Tonga was hit by the highly destructive Cyclone Gita, but Tonga's international submarine cable remained in operation and proved to be a tremendous benefit for the recovery operations
- The Australian government selected Vocus to study the design, construction and procurement of a submarine cable between Solomon Islands, Papua New Guinea and Australia
- Fiji picked Flexenclosure to supply a cable station for the Tui Samoa system
- FINTEL made a major capacity commitment to the Southern Cross NEXT cable system
- Kiribati and Tokelau announced their participation in the NEXT cable

SubCableWorld is a news and information service that changes the way the submarine cable industry is covered. To subscribe, visit www.subcableworld.com.



Google Selects TE SubCom to Design and Deploy Dunant Cable System

TE SubCom, a TE Connectivity Ltd. company and an industry pioneer in undersea communications technology, has announced that Google has selected the company as the supplier of its Dunant submarine cable system. The four-fiber pair cable system will span over 6,400 kilometers and will connect the east coast of the United States to Europe. The cable will add dedicated capacity to Google's global network and will enable interconnection to other subsea infrastructure in the region.

"We are proud to be working with Google on this important cable system and to be helping to increase internet performance for all," said Sanjay Chowbey, president of TE SubCom. "The Dunant cable system will be built using SubCom's industry-leading A1 cable family, which is optimized for projects compatible with higher DCR. As a leading supplier of submarine cable systems, we look forward to continuing to work with our global partners to create more accessible and faster internet access."

Named in honor of Henry Dunant, a Swiss businessman, social activist, first recipient of the Nobel Peace Prize, and founder of the Red Cross, the Dunant cable system honors his memory and commitment to humanitarian ideals. The cable will improve global connectivity and further improve Google Cloud's network. For more information, visit www.subcom.com.

MONTH IN REVIEW

Savusavu Cable Agreement Signed
The Savusavu submarine cable system Operations Management Agreement was signed between FINTEL and the Government of Fiji on June 26, 2018.

NKT Victoria Celebrates One-Year Anniversary
The cable-laying vessel *NKT Victoria* has had a busy first year at sea. She has installed 335 kilometers of cables for offshore wind and interconnector projects in countries such as Denmark, Belgium and the UK as well as completing a high-precision repair operation under rough conditions.

Nexans Appoints New CEO
The Board of Directors of Nexans, during its meeting of July 3, 2018 chaired by Georges Chodron de Courcel, decided to appoint Christopher Guérin as Chief Executive Officer. He took office on July 4, 2018.

Scientists Propose Using Cables for Monitoring Ocean Quakes
Scientists at the National Physical Laboratory (NPL) and Istituto Nazionale di Ricerca Metrologica (INRiM, Italy) have developed an innovative method of detecting underwater earthquakes, using undersea cables usually used for communication purposes. New research detected earthquakes using land-based and underwater fiber optic links of lengths up to 535 kilometers and ranging from 25 to 18,500 kilometers from the earthquake's epicenter.

Ulstein Verft to Build Cable Layer for Nexans
Nexans Subsea Operations has signed a shipbuilding contract with Ulstein Verft on the construction of a large, DP3 cable laying vessel. The vessel will be outfitted for power cable laying, including bundle laying, cable jointing and repair and cable system protection and trenching.

Ørsted Selects Tekmar Energy for Borssele I&II
Tekmar Energy (Tekmar®) announce that Orsted (the former DONG Energy) has selected their patented Cable Protection System (CPS) TekLink® Mecahnical Latch for their Borssele 1&2 Offshore Wind Farm Projects. Tekmar® also announced they have successfully won a place on Orsted's six-year framework for providing Cable Protection Systems on their future projects.

FCC OKs Transfer of HawaiianTel to Cincinnati Bell
The U.S Federal Communications Commission (FCC) has granted a series of applications filed by Cincinnati Bell Inc., Hawaiian Telcom Holdco, Inc., Hawaiian Telcom, Inc. (HTI), Hawaiian Telcom Services Company, Inc. (HTSC), and Wavecom Solutions Corporation requesting consent to transfer indirect control of Licensees to Cincinnati Bell. Cincinnati Bell announced last year a merger agreement with Hawaiian Telcom.

SubCableWorld

For more subsea telecom stories, visit SubCableWorld.com

Boeing's autonomous Echo Voyager XLUUV. In 2017, Lockheed Martin was awarded $43.2 million and Boeing $42.3 million for the design phase of the Orca XLUUV system and delivery of a technical data package. Boeing is working with Huntington Ingalls Industries [HII] on the Orca and its bid is influenced by the Echo Voyager UUV, while Lockheed Martin's design is based on its Marlin UUV.

Navy to Accelerate LDUUV and XLUUV Acquisitions

According to a Senate Report on the Department of Defense Appropriations bill for FY2019 (S. 3159), the U.S. Navy plans to accelerate its acquisition strategies for Large Displacement and Extra Large Unmanned Undersea Vehicles (LDUUV and XLUUV).

Concerning LDUUV acquisitions, the June 28, 2018 report states:

"The fiscal year 2019 President's budget includes $92,613,000 to initiate the fabrication of two Phase I prototype LDUUVs. Subsequent to the budget submission, the Navy informed the Committee of plans to revise its LDUUV acquisition strategy and accelerate the LDUUV program by removing Phase II from the acquisition strategy and transitioning the Phase I design to industry 5 years earlier than previously planned, which eliminates the need for Phase II funding.

"The Committee supports the proposed acceleration of the program; however (the Committee) is concerned that the revised program schedule may be unaffordable. Therefore, the Committee recommends reducing the scope of the Phase I effort and further accelerating the transition of the LDUUV design to industry. The Assistant Secretary of the Navy (Research, Development and Acquisition) is directed to provide the congressional defense committees, with the fiscal year 2020 President's budget request, an updated LDUUV acquisition strategy, and the Assistant Secretary of the Navy (Financial Management and Comptroller) is directed to provide updated cost estimates for the LDUUV program and to certify full funding in the budget request for the revised acquisition strategy."

Concerning XLUUV acquisitions, the report states:

"The fiscal year 2019 President's budget request includes $117,856,000 in various program elements for the development of Extra Large Unmanned Underwater Vehicles [XLUUV] and associated payloads in response to a Joint Emergent Operational Need [JEON] from U.S. Pacific Command. The Committee notes that two competitive design contracts were awarded by the Navy for Phase 1 of the program and that the Navy had planned to conduct a competitive selection for Phase 2 in 2018. Subsequent to the submission of the fiscal year 2019 President's budget request, the Navy revised its acquisition strategy and informed the Committee that the Navy now plans to award Phase 2 fabrication contracts to both vendors.

"The Committee understands that this requires $25,000,000 in fiscal year 2019 above the budget request and that additional funds will be required in fiscal years 2020—2023, which the Navy will include in the fiscal year 2020 President's budget request. The Committee agrees with the revised acquisition strategy to allow for greater competition and recommends $25,000,000 above the budget request in fiscal year 2019, as required. The Assistant Secretary of the Navy (Financial Management and Comptroller) is directed to certify, with the fiscal year 2020 President's budget request, full funding for the Navy's revised acquisition strategy."

Overall, the Senate Committee on Appropriations reported favorably on the bill and recommended its passage.

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Turbine Refurbish Contract Expected to Save Navy Millions

By Keegan Rammel and Matt Leonard, NSWC Philadelphia public affairs.

The U.S. Navy projects saving of more than $100 million over the next five years following a contract award to refurbish propulsion gas turbine parts for surface combatants, the command announced July 19.

Naval Surface Warfare Center, Philadelphia Division (NSWCPD), a Naval Sea Systems Command (NAVSEA) field activity, awarded the contract to leverage and expand existing affordability and innovation initiatives - key NAVSEA enablers to maintaining the Navy's ships and ensuring the necessary funds are available to build the next generation of naval vessels.

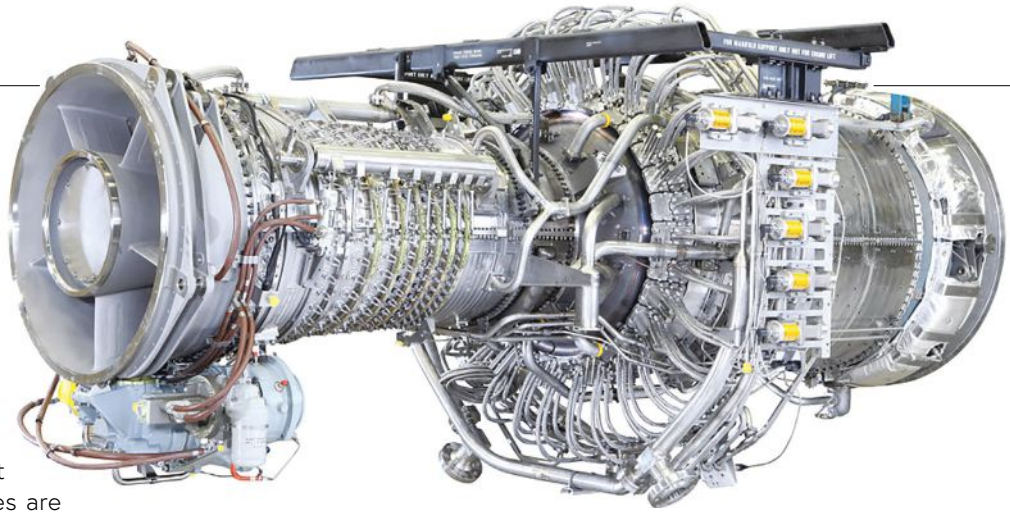
Previously, the Navy was required to use new turbine blades and nozzles, known as the engine's high pressure "hot section kit," during an engine's rebuild. A substantial cost increase of these new parts led NSWCPD to seek alternatives.

According to John Viercinski, NSWC PD surface combatant and gas turbine engineering team lead, the new kits cost over $1 million, while refurbished kits only cost approximately $200,000.

The contract allows the Navy to supply commercial and government repair vendors with refurbished high pressure turbine parts to create overhaul kits for two different configurations of LM2500 turbines. These engine configurations, the Single Shank Turbines (SST) and the Paired Blade Turbines (PBT), are responsible for the propulsion of all Navy destroyers and cruisers, as well as half of its littoral combat ships, a total of 372 engines.

The LM2500 SST is the main propulsion marine gas turbine (MGT) used in the Arleigh Burke class destroyer and the Independence-variant Littoral Combat Ship class. The LM2500 PBT is the main propulsion unit for the Cruiser class.

Over the course of a ship engine's lifecycle, heat and thermal wear cause the turbine blades and nozzles to lose their



An LM2500 SST turbine from General Electric.

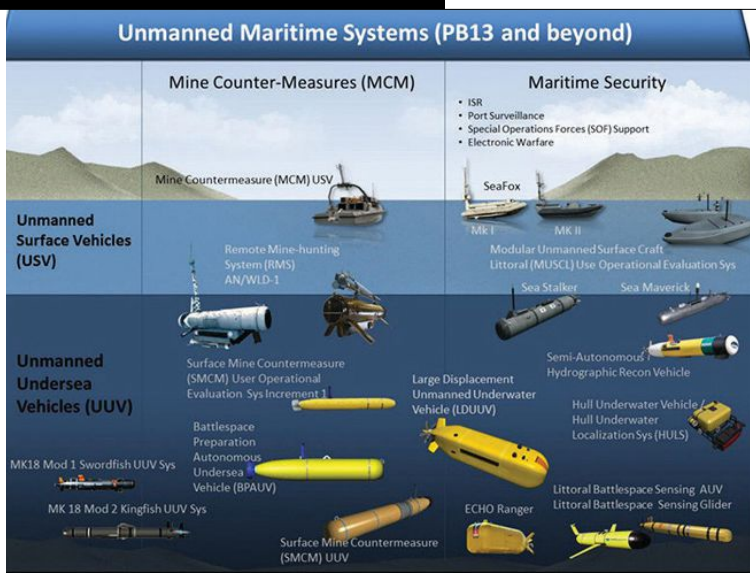
protective coating. Loss of parent metal for these turbine components is also possible. Turbine component degradation is one of the reasons engines are ultimately removed from ships.

At the end of an engine's service life the Navy removes the engine from the ship and replaces it with a ready-for-issue engine. LM2500 engines are overhauled at Naval Air Systems Command's (NAVAIR) Fleet Readiness Center Southwest (FRCSW). During the overhaul process, engines are completely disassembled and subjected to an extensive inspection and rebuild process, utilizing new and refurbished materials.

"We worked hand-in-hand with NSWCPD's Propulsion Systems Division to develop the acquisition strategy and refine the statement of work," said Contracting Officer Kevin Hann. "We worked with legal counsel to develop the source selection strategy."

The contract's biggest win is the ability to now to rebuild engines using refurbished hot section kits instead of purchasing those parts new.

"Based upon our pricing calculator for this contract, $27 million could produce 100 SST hot section kits and 50 PBT hot section kits," said Matthew Driscoll, the lead LM2500 mechanical engineer for NSWCPD. "That's a conservative projected cost savings to the taxpayers of $103 million over five years as compared to the new part cost."



Artificial Intelligence: What are the Challenges of Securing the Maritime Commons?

According to a new paper by Tuneer Mukherjee of India's Observer Research Foundation, the applicability of artificial intelligence (AI) to naval operations surpasses its usage in any other military domain due to the hostility, unpredictability and sheer size of the ocean environment. Evidence suggests that wherever AI systems have been deployed, they have made existing manned operations more effective. Future innovation in such technologies might lead to completely autonomous systems with lethal capabilities, provoking debates on ethical issues.

Mukherjee states that "In operating locales that need constant intelligence, surveillance and reconnaissance of the ocean environment, AI-supported systems can negate the hostilities of marine physics, i.e., hydrostatic pressure, ocean turbulence, thermal gradient, and ocean salinity, among others. Additionally, navies can employ these technologies to target, map, and even engage enemy vessels. All these factors make unmanned intelligent systems an indispensable asset in naval force structures. Moreover, the relatively 'uncluttered' marine environment might be the first battle-space that witnesses the deployment of fully autonomous weapons."

He adds that "Even as the new generation of AI-based combat technology looms on the horizon, endowing such systems with targeting autonomy will have to be subject to strict provisions of international law. In the specific context of AI-based naval operations, AI-supported systems with targeting abilities will need to be able to continuously distinguish between military assets and civilian vessels."

Mukherjee concludes that "The most important element of autonomous systems will be their ability to distinguish between multiple vessels simultaneously and maintain an acoustic signature database of commercial vessels. This will need the cooperation of commercial shipping companies, and rigorous testing of deep-learning algorithms, to validate the pattern recognition processes of these autonomous systems. While it is mentioned that autonomous vessels can undertake a variety of naval missions, their compliance with international maritime law and conventions needs to be pre-programmed into their systems to avoid their trespassing into demarcated exclusive economic zones. Most importantly, autonomous vessels engaged in loitering missions for long periods of time need to be powered by sustainable energy resources to ensure that their missions do not cause any harm to the marine environment."

To read the entire paper, visit www.orfonline.org/research/42497-a-i-in-naval-operations-exploring-possibilities-debating-ethics/.

Deep Ocean Engineering Providing Security and Military ROV Solutions

Military market requirements exceed the capabilities of off-the-shelf technology. For those applications, Deep Ocean Engineering's (DOE) team provides solutions that maximize technology transfer in order to generate robust and advanced new capabilities while minimizing development risk, lead-time, and cost.

The US Navy's EOD MU7 in San Diego uses its fleet of Phantom ROVs, which includes XTL and HD2 models, to assist its divers in locating and identifying submerged mine-like targets. The ROV locates and homes on the target using obstacle avoidance sonar, and inspects it using a high-resolution color zoom video camera. Parallel lasers projecting into the video image provide safe standoff distance and scaling information.

DOE delivered a Phantom HD2+2 to the FBI New York Underwater Evidence Search Team. This vehicle's maiden launch was as a search vehicle to the Cayuga Lake Search Project. The vehicle was also used to recover bodies from the New Melones Lake, evidence in a California crime case. The FBI project tasks included survey, monitoring and other initiatives associated with evidence gathering and research.

As many as 20 foreign military organizations use DOE's ROVs for diverse applications. For example, Phantom ROVs frequently are used by Sweden's Navy and Coast Guard (together they own 14 HD2s and three XTLs), and Spain's Guardia Civil for general underwater observation and object recovery. The Canadian Defense Fleet Diving Units and Hellenic Air Force both have used their Phantom ROVs to investigate and/or recover spent weapons and downed aircraft.

The Phantom® L6 is the newest in the next generation of underwater robotics pioneered by Deep Ocean Engineering.

U.S. Navy Launches The Future USS *Frank E. Petersen Jr.*

HII's Ingalls Shipbuilding division successfully launched the Arleigh Burke-class destroyer Frank E. Petersen Jr. (DDG 121) on July 13, 2018. HII photo.

The future USS *Frank E. Petersen Jr.* (DDG 121) was launched on July 13 at Huntington Ingalls Industries (HII) shipyard in Pascagoula, Mississippi.

The method for launching a ship includes a multi-day process that involves moving the ship from the land level facility to the dry dock which is then slowly flooded until the ship is afloat. With the ship in the water, final outfitting and production can commence.

"Serial production efforts on our Arleigh Burke class destroyers will benefit both the Navy and our industry partners as we meet the increasing need for operational assets," said Capt. Casey Moton, DDG 51 class program manager, Program Executive Office (PEO) Ships. "DDG 121 will be the 70th destroyer of its class to join the fleet."

The ship is being configured as a Flight IIA destroyer, which enables power projection, forward presence, and escort operations at sea in support of Low Intensity Conflict/Coastal and Littoral Offshore Warfare as well as open ocean conflict.

Equipped with the world's foremost integrated naval weapon, the Navy's Aegis Combat System Baseline 9, DDG 121 will provide Cooperative Engagement Capability, allowing for integrated air and missile defense. This system delivers quick reaction time, high firepower, and increased electronic countermeasures capability for Anti-Air Warfare.

HII's Pascagoula shipyard is also currently in production on the future destroyers *Paul Ignatius* (DDG 117), *Delbert D. Black* (DDG 119), *Lenah H. Sutcliffe Higbee* (DDG 123) and *Jack H. Lucas* (DDG 125) that were awarded as part of the five-ship multi-year procurement for fiscal years 2013-2017.

As one of the Defense Department's largest acquisition organizations, PEO Ships is responsible for executing the development and procurement of all destroyers, amphibious ships, special mission and support ships, and special warfare craft.

COMPLACENCY REIGNS IN COMMODITY MARKETS DESPITE RISKS

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

The crude oil market continues to recover, driven by healthy global oil demand associated with the synchronized worldwide economic recovery. Recently, the International Monetary Fund reaffirmed its global economic growth forecast of 3.9 percent for 2018. What has changed within the forecast is a slight reduction in the European Union and Japanese growth, but U.S. growth was maintained. Coupled with healthy economic growth in China and the rest of Asia, the global growth rate was unchanged. Importantly, this magnitude of global economic growth supports strong oil demand growth of 1.5 million barrels a day for 2018.

In August, the International Energy Agency will provide its first estimate for oil demand growth in 2019, a year some economists suggest may bring a recession. Although a speculative assumption, if a recession were to happen, we would expect oil demand growth to suffer. Growth is likely to remain strong during the first half of 2019 but weaken as the year progresses. This scenario might also signal weaker oil demand growth in 2020.

Current oil prices are weaker than shown in the accompanying chart, as geopolitical events are weighing on the market. The current pressure on prices reflects a belief that Saudi Arabia and Russia will boost their oil output to help ease the supply tightness created by politically disrupted flows from Libya and Nigeria. In addition, supply is being restricted by the deterioration in Venezuelan production given its ongoing economic and political turmoil. The final factor putting downward pressure on oil prices is the rumor that the U.S. government may release oil from the Strategic Petroleum Reserve to help drive down gasoline prices prior to the mid-term elections in November.

Although oil prices have fallen from over $70 a barrel into the high $60s, the market's fundamentals remain strong. That strength, coupled with the current market supply tightness, should prevent crude oil prices from falling much below current levels. The bigger question facing the industry is the amount of investment being committed to new exploration and development. Virtually every forecaster calls industry spending inadequate if the world is to avoid a supply shortfall that will drive oil prices sharply higher. We won't know more about future spending plans until later this year when oil companies release their capital budgets. Without clarity on future spending increases, expect oil prices to remain range-bound in the mid-$60s to mid-$70s a barrel.

Over this same four-and-a-half-year period, natural gas prices have struggled to rise in the face of strong supply growth. That growth has overwhelmed any benefits from rising gas demand, which explains why natural gas prices re struggling.

If we examine the accompanying gas price chart, it is clear that prices declined steadily from the start of 2014 until April 2016. The decline may have been magnified by the level from which prices started, which were lifted by a colder than normal winter. Other than price spikes caused by hurricanes that shut down supply from the Gulf of Mexico and spikes in response to severe cold weather when demand rises sharply, prices have been fairly steady in their decline. The price performance in that period was impacted by weak demand as industrial and residential consumption struggled to grow. Over this 27-month span, total U.S. gas production grew by 6.9 percent, while the American gas shale revolution boosted onshore production by 10.4 percent. Although the onshore gas subset grew faster due to the smaller number, actual physical volumes significantly outgrew the overall total.

Notably, the sharp rally in gas prices during the final three-quarters of 2016 was driven largely by the realization that total and onshore gas production was falling. This demonstrates that when commodity markets perceive supply shortages or falling production, it knows it takes higher prices to encourage operators to step up drilling and producing activity in order to boost supply.

The relationship between production and prices is key for understanding why natural gas prices have begun drifting lower since early 2017. Since then, total gas production grew by 12 percent, but onshore gas output rose 15.6 percent. In this case, supply growth came from more associated natural gas produced from the surging oil shale drilling in West Texas.

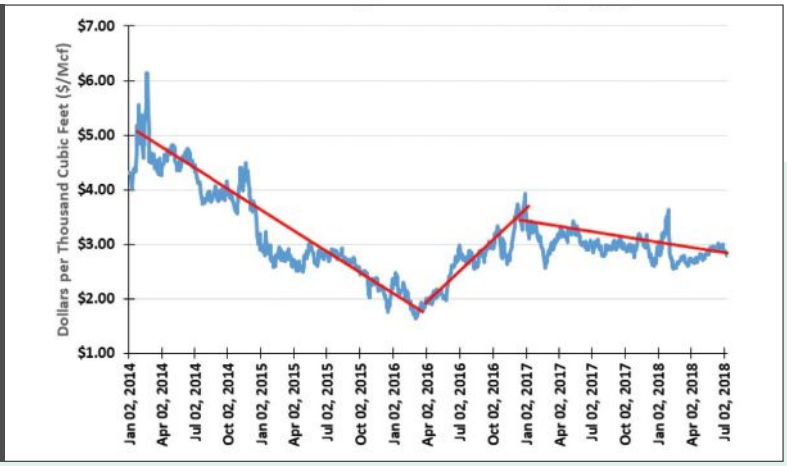
What is weighing on natural gas prices now is fear of greater supply growth. Markets wonder whether a lack of pipeline capacity in the Permian Basin will slow gas supply growth. At the same time, the market is looking to demand, with liquefied natural gas export growth becoming an important new demand force. The LNG export surge, however, will not come for another year, so there is little demand help coming from that sector in the near term.

The hurricane season has traditionally been a worry for gas producers striving to sustain gas supply from the Gulf of Mexico, but this tropical storm season is projected to be normal with many storms likely to stay in the Atlantic Ocean and away from our offshore gas production. The other consideration shaping supply growth perceptions is the dramatic output from onshore shale formations. This supply source reduces the risk to gas prices from any tropical storm cutting our supplies, thereby lifting gas prices sharply.

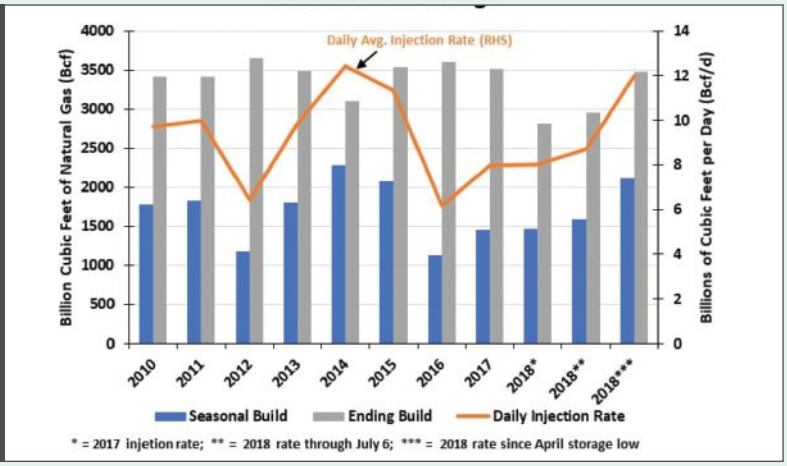
Gas storage is recovering from its recent low. The rebuilding of storage is happening rapidly, largely driven by the shale-related supply growth. If the daily injection rate since the absolute bottom in storage last April continues, total gas storage will reach a comfortable level by the start of the 2018-2019 winter season. That prospect continues depressing gas prices.

Despite all the fundamental and geopolitical factors at work in the global crude oil and domestic natural gas markets, commodity prices are subdued. We have little insight into geopolitical developments, other than to acknowledge they exist and could impact prices. Otherwise, the commodity markets are fairly complacent. That often signals change is coming. The problem is knowing what may change.

1. NATURAL GAS PRICES STRUGGLE IN FACE OF GROWING SUPPLY



2. SEASONAL GAS STORAGE



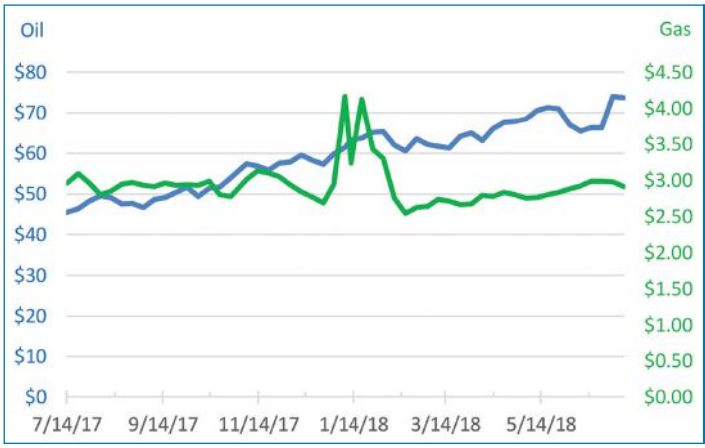
3. CRUDE OIL CYCLE REFLECTS CONTINUING RECOVERY

CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF JULY 16, 2018

In late June, WTI Spot prices surpassed the $70/barrel mark again, after falling back in June. Prices reached the highest point in 2018 at $74.03 during the week of June 29 and closed at $73.73 on July 6, the most recent date for WTI Spot pricing that the Energy Information Agency had made available as of press time. By mid-July, however, there were indication that prices were trending down again, with CNN reporting that the sell-off was due to reports suggesting Saudi Arabia and the United States are racing to prevent an oil shortage caused by sanctions on Iran.

While there were some dramatic price spikes during the cold winter weather, natural gas prices have barely moved from the beginning of the year to the middle of June. Henry Hub spot price for July 6 was $2.91/Million BTU, down only $0.04 from the start of the year.



WEEKLY WTI CRUDE & NATURAL GAS SPOT PRICES

Last 52 Weeks

Cushing, OK WTI Spot Price

$73.73

$65.35 previous month

TRENDING UP

Henry Hub Spot Price

$2.91

$2.92 previous month

TRENDING UP

KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF JULY 16, 2018

THE DOW JONES INDUSTRIAL AVERAGE AND S&P 500 have been relatively stable in the past month.

The Dow Jones Industrial Average and S&P 500 have at times swung wildly in 2018. Of the 25 weeks from the beginning of the year until mid-June, nine weeks saw gains or losses greater than 500 points. Yet for all of that volatility, the Dow closed on July 16 down 141.68 from where it stood at the beginning of the year. The S&P 500 has seen similar swings and a similar result, closing on June 18 only 81.76 points higher than on the first of the year. The PHXL Oil Services Index (OSX) saw a dramatic increase in May as oil prices rose, but dropped back as prices dropped again. The OSX closed at 152.68 on July 6, down from a high of 163.08 in mid-May.

SELECTED EQUITY INDEXES

CUMULATIVE PERCENTAGE CHANGE

Last 52 Weeks

25,064.36

Up **364.15** from previous month

TRENDING UP

DJIA

152.68

Up **2.20** from previous month

TRENDING DOWN

OSX

2,798.43

Up **35.86** from previous month

TRENDING UP

S&P 500

DT-3060 EHLWR
Slip Ring Winch

The DT-3060 multi-purpose winch is designed to support deepwater bottom sampling, water sampling, and hydrographic survey. The winch has a capacity of: 7,000m of .45" cable or 3,000m of .68" cable with a bare drum line pull of 7,500 @ 0-200 FPM.

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SCIENCE & TECHNOLOGY

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Int'l Cable Connectivity Symposium
Providence, RI
October 14-17
www.iwcs.org

AWEA Offshore Windpower
Washington, DC
October 16-17
www.awea.org/events/event.aspx?eventid=50111&navItemNumber=8237

Ocean Energy Europe
Edinburgh, UK
October 30-31
www.oceanenergy-europe.eu/event/oee-2018/

Offshore Energy
Amsterdam, The Netherlands
October 22-24
www.offshore-energy.biz

Pacific Marine Expo
Seattle, WA
November 18-20
www.pacificmarineexpo.com

RENEW
Lisbon, Portugal
October 8-10
www.centec.tecnico.ulisboa.pt/renew2018

OCEANS'18
Charleston, SC
October 22-25
www.charleston18.oceansconference.org

ITST
Lisbon, Portugal
October 15-17
www.itst2018.org

BlueTech Week
San Diego, CA
November 5-9
www.bluetechweek.org

WindTech Summit
Porto, Portugal
October 28-29
windtech.global

OilComm & FleetCom
Houston, TX
October 3-4
2018.oilcomm.com

Clean Gulf
New Orleans, LA
November 13-15
2018.cleangulf.org

Autonomous Underwater Vehicle Symposium
Porto, Portugal
November 6-9
www.auv2018.lsts.pt

MTS Dynamic Positioning
Houston, TX
October 9-10
dynamic-positioning.com

International Workboat
New Orleans, LA
November 28-30
www.workboatshow.com.

Arctic Technology Conference
Houston, TX
November 5-7
www.otcnet.org/arctic

Teledyne Marine Technology Workshop
Cannes, France
October 9-11
www.teledynemarine.com/events/TMTW2018

Wave & Tidal Energy
Valdivia, Chile
November 20-23
www.waveandtidal.cl

Rio Oil & Gas
Rio de Janeiro, Brazil
September 24-27
www.riooilgas.com.br/?lang=en

Baltic Clean Technology
Szczecin, Poland
October 17-18
www.baltic-clean-technology.com

WindEnergy Hamburg
Hamburg, Germany
September 25-28
www.windenergyhamburg.com/en

WindEurope
Hamburg, Germany
September 25-28
www.windeurope.org/summit2018

Telecoms World
Dubai, UAE
September 17-18
www.terrapinn.com/conference/telecoms-world-middle-east/Telecoms-World-Middle-East.stm

ADIPEC
Abu Dhabi, UAE
November 12-15
www.adipec.com

Oi China
Qingdao, China
October 23-25
www.oichina.com.cn/en/Home

China Offshore Oil & Gas
Beijing, China
October 30-31
www.giccgroup.com/cos

AWTEC
Taipei, Taiwan
September 9-13
www.awtec2018.com

MAST Indo-Asia
New Delhi, India
October 28-30
www.mastconfex.com/indoasia2018/

Submarine Networks World
Singapore
September 24-26
www.terrapinn.com/conference/submarine-networks-world

RemTech Expo
Ferrara, Italy
September 19-21
www.remtechexpo.com/index.php/en/

Power Week Asia
Singapore
November 12-16
www.power-week.com/Asia

Cyber Security for Maritime
Singapore
November 12-15
www.equip-global.com/cyber-security-for-maritime-summit-2018

AORES
Perth, Australia
November 20-22
www.aores2018.com.au

Power Week Africa
Johannesburg, South Africa
September 10-14
www.power-week.com/Africa

CALENDAR

AUGUST
EDITORIAL: ROV and AUV Technology
FOCUS: Cameras, Batteries, Lights and Imaging Sonars; Vehicle Sensor Suites

SEPTEMBER
EDITORIAL: Offshore Wind Installation and Maintenance; Offshore Supply & Emergency Vehicles
FOCUS: Offshore Support; Turbines; Offshore Wind Inspection Services

OCTOBER
EDITORIAL: Offshore Communications; Subsea Telecom; Subsea Inspection, Monitoring, Repair & Maintenance
FOCUS: Marine Communications; Cable Installation Services

NOVEMBER/DECEMBER
EDITORIAL: Year in Review; Commercial Diving and Salvage; Ocean Observing Systems; Ocean Science & Exploration
FOCUS: Acoustic Modems, Releases and Transponders; Diving Equipment and Services; Salvage; Buoyancy Materials

SHOW DISTRIBUTION

AUGUST
Submarine Networks World - September 24-26 *
MTS Dynamic Positioning - October 9-10
OCEANS '18 - October 22-25

SEPTEMBER
WindEnergy Hamburg - September 25-28
AWEA Offshore Wind - October 16-17
Teledyne Marine Tech Workshop - October 9-11 *
Offshore Energy - October 22-24
Ocean Energy Europe - October 30-31
Pacific Marine Expo - November 18-20 *

OCTOBER
Offshore Well Intervention - November 6-8 ^
Clean Gulf - November 13-15

NOVEMBER/DECEMBER
TBD

* Digital Distribution
^ Pending

Reorganization Plan Could Realign Numerous Federal Agencies

A plan to reorganize the U.S. federal government, which was released by the Trump Administration on June 21, 2018, outlined 32 ideas for streamlining or reorienting federal offices, most of which will require congressional approval. Select proposals are presented below:

Army Corps of Engineers

Proposals include moving the Army Corps of Engineers Civil Works (Corps) out of the Department of Defense (DOD) and into the Department of Transportation (DOT) and Department of the Interior (DOI) to consolidate and align Corps civil works missions with these agencies. Under this proposal, the Corps commercial navigation functions would move to DOT, whose mission already includes Federal responsibility for all other modes of transportation. All other activities, including flood and storm damage reduction, aquatic ecosystem restoration, hydropower, regulatory, and other activities, would move to DOI.

National Marine Fisheries Service

Another proposal would merge the Department of Commerce's (DOC) National Marine Fisheries Service (NMFS) with the Department of the Interior's (DOI) U.S. Fish and Wildlife Service (FWS). This merger would consolidate the administration of the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) in one agency and combine the Services' science and management capacity, impacting Federal fisheries and wildlife policy and service to stakeholders and the public, particularly on infrastructure permitting.

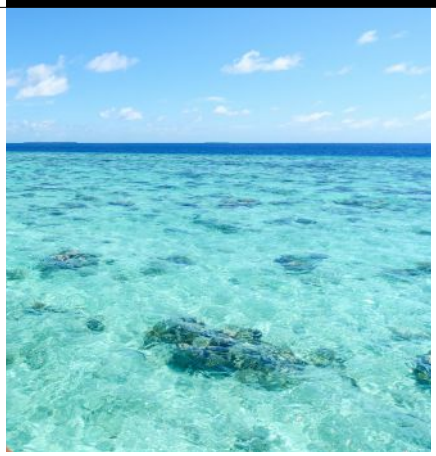
Department of Transportation

A third proposal would reorganize the Department of Transportation (DOT). The proposal would spin-off Federal responsibility for operating air traffic control services and locks along the Saint Lawrence Seaway, integrate into DOT certain coastal and inland waterways commercial navigation activities and transportation security programs, and reassess the structure and responsibilities of DOT's Office of the Secretary.

Department of Energy

A fourth proposal would consolidate the Department of Energy's (DOE) applied energy programs into a new Office of Energy Innovation. It would also establish a parallel Office of Energy Resources and Economic Strategy, which would focus on solutions that support U.S. energy access to resources and infrastructure. Finally, it would maintain the Office of Cybersecurity, Energy Security, and Emergency Response, which would protect energy infrastructure from increasingly sophisticated threats and ensure energy restoration following disasters.

The full 32-page government reorganization proposal is available at www.whitehouse.gov/omb/management/government-reform/.



Trump Issues Executive Order on National Ocean Policy

On June 19, 2018, President Trump signed an Executive Order Regarding Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States. The Executive Order is intended to advance the economic, security, and environmental interests of the United States through improved public access to marine data and information, efficient Federal agency coordination on ocean related matters, and engagement with marine industries, the science and technology community, and other ocean stakeholders, including Regional Ocean Partnerships.

President Trump's Executive Order revokes and replaces Executive Order 13547, issued by former President Obama, a.k.a. "The National Ocean Policy," which established the National Ocean Council, consisting of 27 Federal agencies, departments, and offices.

Read the full Executive Order on the White House website www.whitehouse.gov/presidential-actions/executive-order-regarding-ocean-policy-advance-economic-security-environmental-interests-united-states/

Andrew L. "Drew" Michel

ON&T Advisor Elected to OEC Hall of Fame

The 2018 Ocean Star Offshore Energy Center (OEC) Industry Champions Hall of Fame has welcomed four new members, including Drew Michel, a member of the ON&T Advisory board. An interview with Drew is included in our August issue (see page 10).

Andrew L "Drew" Michel, a U.S. Navy veteran, came to the offshore industry in 1966. Building on his USN education and experience, he was instrumental in the development and deployment of some of the game changing life support, communications and underwater video systems that made it possible for divers to safely move the industry into the deeper waters of the Gulf of Mexico, at that time. Though never having worked as a diver, he was inducted into the Commercial Diving Hall of fame for his contribution to diver safety.

Drew's early underwater video work led to the realization that small ROV systems, previously exclusively military technology, could further enhance diver safety and advance the industry beyond diver depths. His further development and improvements of these earliest ROVs became the forerunners of the robust ROV systems common around the world today. He is considered a pioneer and internationally recognized author, lecturer and general authority on ROV systems and operations and has received many awards for innovative engineering and unique ROV operations.

His work has resulted in his being promoted, at a very early age, to vice president in a division of a fortune 50 company, then the ten-year development of his own company that was sold to another publicly traded company. He spent five years as a VP of that company before retiring to spend the remainder of his working life as the ROV subject matter expert for major operators.

He is a life member, fellow and past President of the Marine Technology Society; served as chair of the MTS ROV Committee for 20 years and is a senior life member of the Institute of Electrical and Electronic Engineers (IEEE).

The Hall of Fame recognizes those persons and technologies that took the industry to sea. Previously recognized: famous firefighter "Red" Adair; Brown & Root founders George and Herman Brown; Ralph Thomas McDermott, who founded the offshore drilling and platform construction company J. Ray McDermott; rig designer and drilling contractor Alden J. "Doc" Laborde; and oil company tycoon Dean McGee.

The other new 2018 OEC Hall of Fame members are:

- Sara Akbar, recognized for her distinguished career in the oil and gas industry and as the first woman to hold a senior position in the oil and gas industry in the Middle East;

- Eve Howell, recognized for her contributions to discovery and development of numerous significant offshore oil and gas fields; and

- Peter Lovie, started Engineering Technology Analysts, Inc. (ETA), and pioneered innovative jackup, subsea processing, and floating production designs.

Marine-i Announces the Winners of Inaugural New Horizons Awards

Marine-i, which is part-funded by the EU and was set up to boost Research and Innovation in the marine sector in Cornwall, U.K. and the Isles of Scilly, has announced the winners of its first New Horizons Awards. This industry awards scheme was created to spotlight exceptional business talent and innovation in the marine technology sector in the region. The presentation to the three winners was made by Richard Noble OBE, who famously smashed the world land speed record, at a special event hosted at China Fleet Country Club, Saltash.

The Business Growth Award was won by marine contractor KML Ltd. The Marine-i judges were very impressed with the exceptional growth that KML has achieved and the way that it has grasped new business opportunities. These include securing Falmouth Wharves to create a base for KML and other marine businesses to grow.

KML Ltd Managing Director, Diccon Rogers, receiving the New Horizons Business Growth Award.

The Technology Innovation Award went to ARC Marine, which is the first eco-engineering company in the U.K. that specializes in artificial reefs. Their outstanding innovation is Reef Cubes. These combine to form a robust and simple interlocking modular system that is ideal for restoring complex marine environments.

The Cornwall First Award was presented to Triskel Marine, who is one of the leading innovators in hybrid propulsion systems. Triskel's pioneering work has attracted worldwide interest and, as a result, has helped to promote Cornwall as a leading region for marine technology innovation.

Full details on the Marine-i programme can be seen at www.marine-i.co.uk.

OPEC Releases 2019 Oil Market Outlook

According to OPEC, the world economy is expected to expand by 3.6 percent in 2019, which reflects a moderate slowdown, mainly due to the expected monetary tightening, in particular in the US, to some extent in the Euro-zone, and less so in Japan. In major emerging economies, performance will range from slight growth in India, supported by government spending, to a slight deceleration in China as a consequence of the country's continued financial tightening. Russia will remain broadly steady while Brazil will pick up slightly.

Potential Impact of Tariffs

The re-emergence of global trade barriers has thus far only had a minor impact on the global economy. The 2019 forecast considers no significant rise in trade tariffs and that current disputes will be resolved soon. The increase in global trade has been a significant factor lifting world economic growth to higher levels in both 2017 and 2018. Hence, if trade tensions rise further, and given other uncertainties, it could weigh on business and consumer sentiment. This may then start to negatively impact investment, capital flows and consumer spending, with a subsequent negative effect on the global oil market.

World Oil Demand

World oil demand in 2019 is forecast to grow by 1.45 million of barrel per day (mb/d) year-over-year (y-o-y), compared to 1.65 mb/d in 2018. Non-OPEC oil supply for 2019 is forecast to grow by 2.1 mb/d y-o-y, broadly unchanged from 2018. The forecast suggests that demand for OPEC-15 crude is expected to average 32.2 mb/d in 2019, down by around 0.8 mb/d from 2018. Therefore, if the world economy performs better than expected, leading to higher growth in crude oil demand, OPEC will continue to have sufficient supply to support oil market stability.

For the full OPEC Oil Market Outlook, visit www.opec.org.

ACOUSTIC SYSTEMS

APPLIED ACOUSTIC ENGINEERING LTD

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Fax: +44 (0) 1493 440720
E-mail: gavinwilloughby@appliedacoustics.com
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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Tel: 228 868 6632
Email: high_techinc@bellsouth.net
Website: www.hightechincusa.com
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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Ocean Sonics designs and manufactures the icListen, a compact self-contained easy to deploy digital hydrophone. As the world leader in gathering ocean sound, Ocean Sonics combines very high signal performance with innovative ease of use, to give customers the best digital hydrophone technology available. It's a compact, all-in-one instrument capable of processing data while collecting in real-time.

Creating Acoustic Arrays is now simple. Connect two or more icListen hydrophones together and they self-synchronize, operating as one. Ocean Sonics offers a wide range of geometries, including vertical, horizontal, autonomous, very small geometrical arrays, or spread out over many kilometres.

RTSYS

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Website: www.rtsys.eu

- Acoustic Monitoring: EASDA14, Embedded Multichannel Passive Acoustic Recorders
- WiFi remote Buoy: BASDA14, Multi-sensor & Rechargeable Acoustic Buoy accessible in Real-time
- Sediment Characterization: INSEA, Acoustic Velocimeter for Sediment Characterization

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

TELEDYNE RESON

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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.

ROWE TECHNOLOGIES, INC.

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

Rowe Technologies designs and manufactures state-of-the-art Acoustic Doppler Current Profilers (ADCPs) and Doppler Velocity Logs (DVLs), applicable to an array of current measuring and navigational deployments for world-wide use, in oceans, lakes, and rivers. Rowe Technologies 7,100 ft2 facility is headquartered in San Diego California and was founded in 2009 by Dan and Steve Rowe, the sons of Fran Rowe who is the originator of the Acoustic Doppler Current Profiler (ADCP) and co-founder of Teledyne RDI. Rowe Technologies highly experienced, innovative staff has over 250+ years of Doppler system development experience and is on the preponderance of ADCP patents.

BUOYS

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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

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Fax: +1 207 221 5718
E-mail: sales@deepwb.com
Website: www.DeepWaterBuoyancy.com
Contact: Dan Cote, Sales Manager

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Website: www.vitrovex.com
Contact name: Steffen Pausch

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E-mail: cortland@cortlandcompany.com
Website: www.cortlandcompany.com
Contact: Marco Cano

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We manufacture custom EOM cables assemblies for various subsea applications which include CTDs, hydrophones, magnetometer, tow cables, ocean bottom, ROV cables, and other custom application. Our global presence and industry-leading design engineers, manufacturing facilities, and management teams, work together to implement integrated solutions with unsurpassed reliability that support the needs of customers worldwide. Visit us online at cortlandcompany.com

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

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

CONNECTORS

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BIRNS, Inc. has been serving the subsea industry since 1954, and is an ISO 9001:2008 certified global leader in the design and manufacturing of high performance connectors, custom cable assemblies and lighting systems. With a NAVSEA PRO-020 certified molding facility, the company leads the industry with sophisticated connector lines, including exceptional 6km-rated electrical, electromechanical, coaxial, electro-coax, optical, electro-optical and electro-opto-mechanical hybrid options. BIRNS provides the industry's highest volume of cost-effective hydrostatic and helium pressure testing, and has a wide range of ABS Product Design Assessment (PDA) certified fiber optic and electrical penetrators. BIRNS also delivers brilliant LED and tungsten-halogen marine, chamber, security and commercial diving lights trusted in the world's most extreme environments.

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

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

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

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Website: www.teledynemarine.com

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

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Website: www.hydroleduc.com

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

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NKE INSTRUMENTATION

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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.

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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.

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Website: www.saivas.no
Contact: Gunnar Sagstad

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

SUBSEA TECHNOLOGY

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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

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Website: gdmissionsystems.com/underwater-vehicles/bluefin-robotics
Contact: Adam Mara

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

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

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

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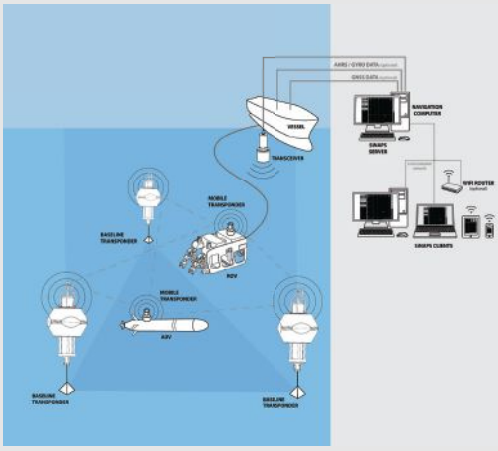

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