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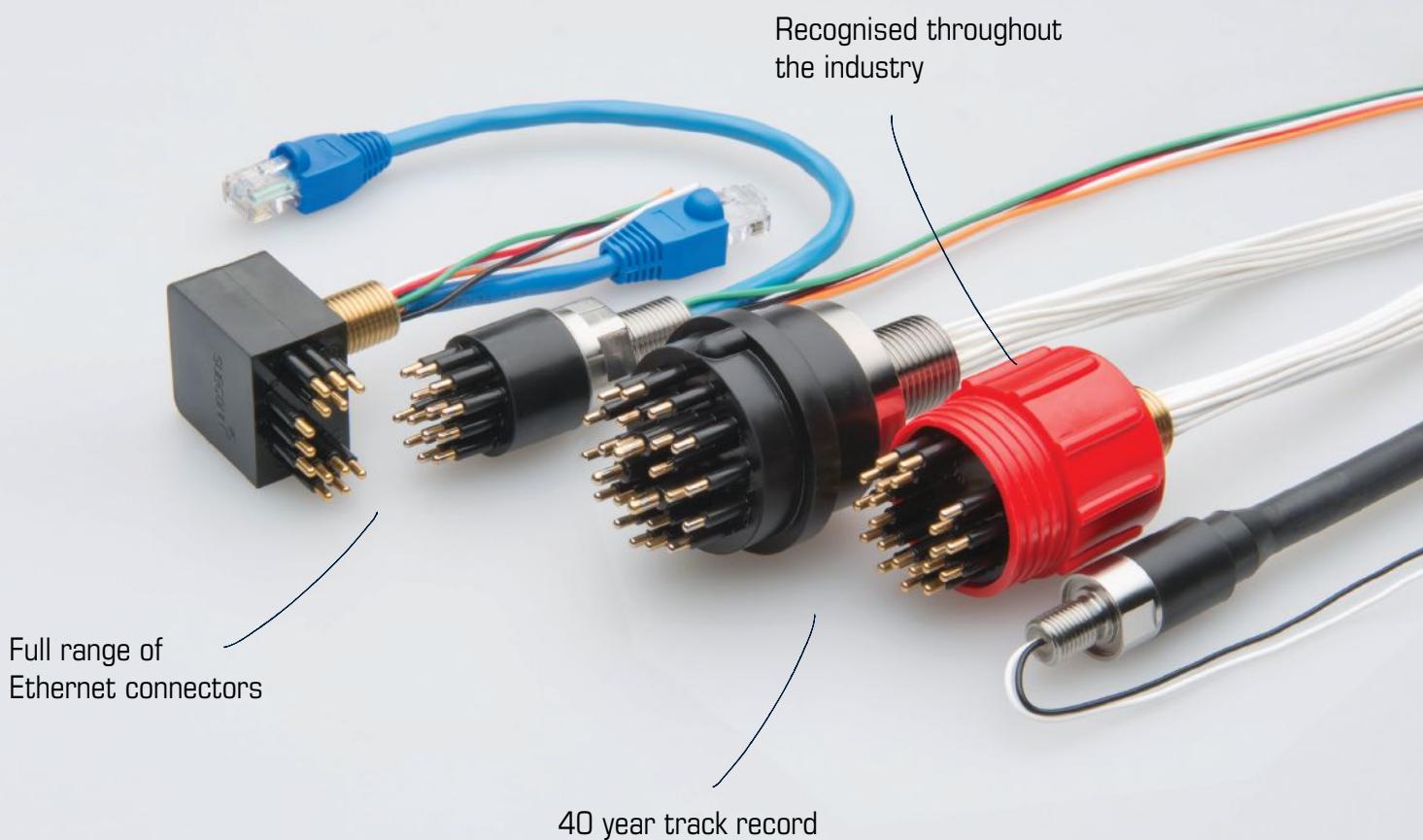
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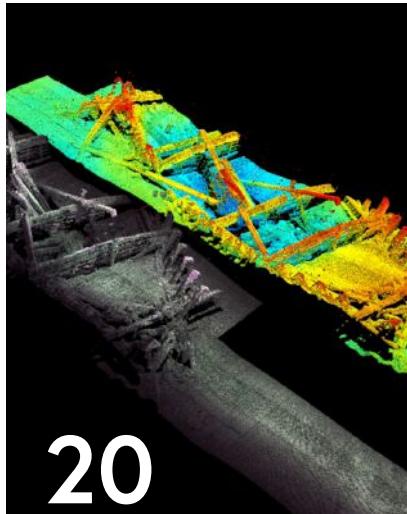
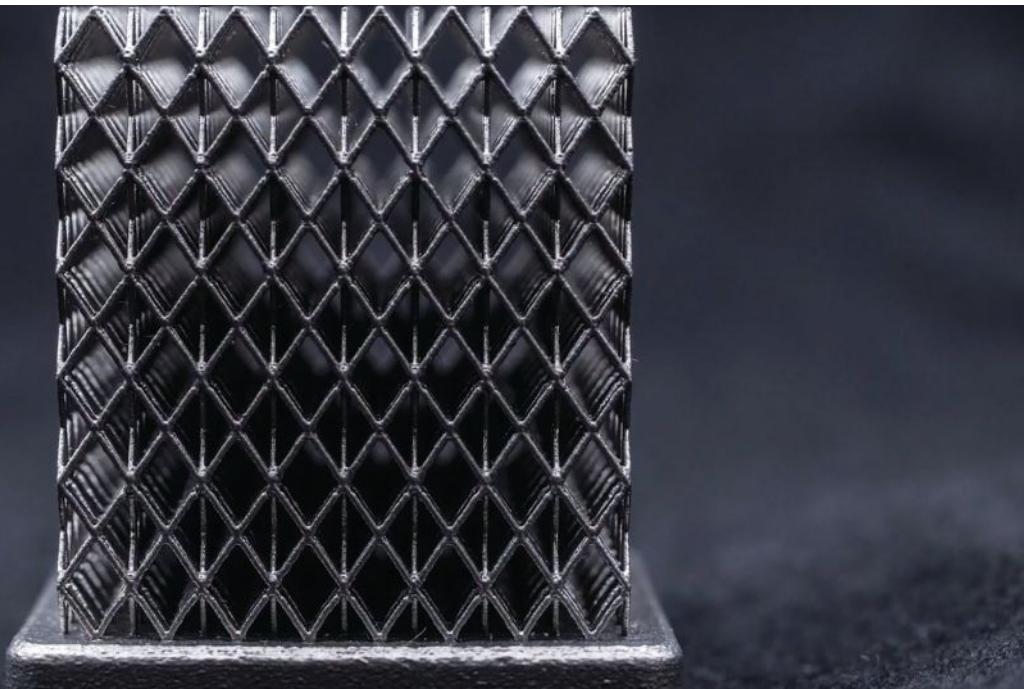


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ON THE COVER:

Swire Seabed's light construction vessel, Seabed Constructor, is the host vessel for Ocean Infinity's comprehensive seabed exploration system, which includes a fleet of eight autonomous underwater vehicles (AUVs).

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EDITORIAL

BY IGOR PRISLIN,

*Chief Analytics Officer / Vice President,
BMT Scientific Marine Services, Inc.*



The Importance of Data in Ocean Industries

With an ever-increasing interest in our oceans, data in ocean industries is the key to understanding the drivers and risks associated with operating in this harsh environment. Vast amounts of structured and unstructured data have been gathered over many decades in oil and gas, as well as in areas of vessel transportation and oceanographic exploration.

From development of new ways of extracting energy from the ocean to sustainable fishing, and recreational activities, it is expected that the pool of data in ocean industries will grow exponentially. Information acquired from such rich data sets by using modern analytics and data distributed cloud-based technology will lead to a deeper knowledge of our oceans.

In today's technological revolution, data are generated from high-tech physical sensors, as well as by humans in graphical and numerical forms: from subsea to surface level and far above us with remote sensing satellites. These measured data, when combined with numerical models, provide local, regional and global coverage of the oceans, ocean facilities and activities in the industry.

Identification and characterization of important ocean processes requires effective in-situ measurement at appropriate temporal, spatial and through-depth scales, together with rigorous data quality control and awareness of instrument limitations. It is generally an expensive undertaking to make measurements in the ocean. Therefore, good quality, historical measured data represent a valuable and important asset that needs to be well managed and widely used to best effect.

Advanced numerical modelling techniques that are constantly validated and calibrated against good quality measurements, enable simulation of long-term historical datasets at

the locations not covered with measured data, allowing us to assess inter-annual variability and, to some extent, longer-term changes.

Intelligent usage of processed measured data and model simulation provides abilities to derive 'fit for purpose' hindcast and forecast data to assure safe operations, avoid damage to the environment and reduce risk on all levels.

Historically, it was a challenge to manage these large data-sets, but with the modern data management technologies through private and public clouds, this becomes more affordable and sustainable. The challenge with the data in ocean industries is no longer about collecting the data, it's how to digest such large data sets and to synthesize and distribute information in an easy to understand format for users, so they can be valued rather than simply being regarded as 'noise' or irrelevant.

As we further embrace this digital revolution, advances in machine intelligence such as machine learning and deep learning networks will undoubtedly play a critical role in helping us to better understand our oceans.

About the author: Dr. Prislin earned his Ph.D. in Ocean Engineering at Texas A&M and MS in Naval Architecture at University of Zagreb, Croatia. His professional interests have been oriented towards oil and gas energy sector. His experience ranges from teaching, hydrodynamic model testing, numerical simulations, field data analyses, and more recently data analytics - all related to ships and offshore platforms.

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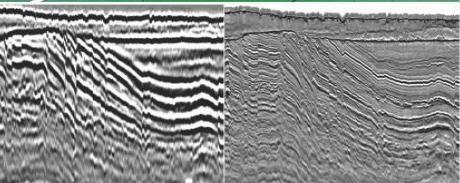
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TRANSFORMATIVE MARINE MANUFACTURING:

HOW THE UNIVERSITY OF NEW BRUNSWICK (UNB)
BECAME A WORLD LEADER IN 3D METAL PRINTING

Having already disrupted the aerospace and medical industries, additive manufacturing—widely known as 3D printing—is becoming commercially viable across a growing number of applications. Because it can be used to create shapes and part complexity that would be impossible using traditional methods, it has a disruptive potential for the marine industry as well, which is why Irving Shipbuilding Inc.—joined by Lockheed Martin Aeronautics—invested in building the Marine Additive Manufacturing Centre of Excellence (MAMCE).

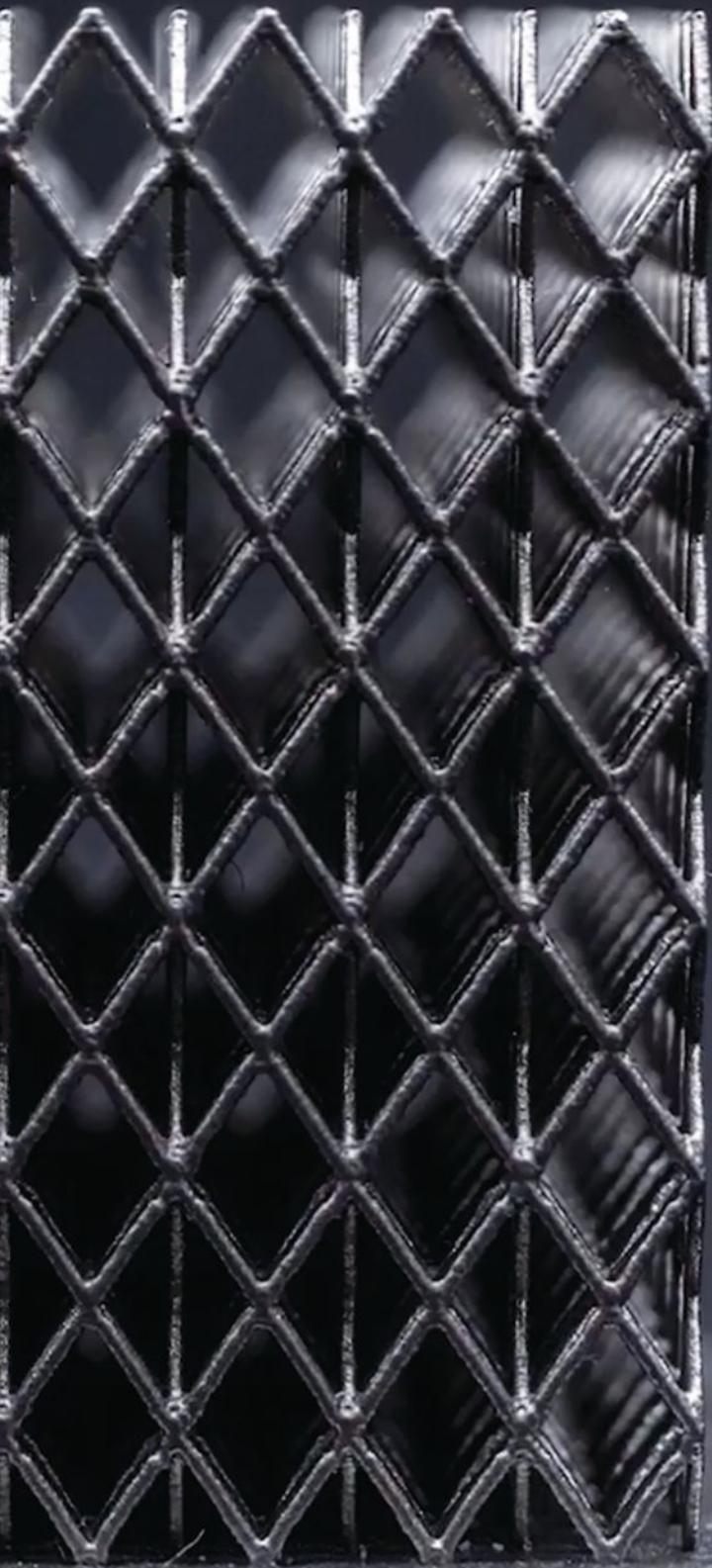
Housed within the University of New Brunswick's (UNB) Faculty of Engineering, MAMCE is the first facility in Canada to combine additive manufacturing research, workforce training, and commercialization. Metal printing capability will be in Saint John, NB, in a commercial setting operated by Custom Fabricators and Machinists (CFM). ON&T interviewed Dr. Mohsen Mohammadi, MAMCE's Director of Research and Development to learn more about this leading-edge program.

IN MARINE APPLICATIONS, WHAT ADVANTAGES DOES 3D METAL PRINTING HAVE?

If we look at it from a holistic view, 3D metal printing can revolutionize the marine supply chain. This technology is a new tool that complements other available techniques that are currently used to fabricate parts, tools, fixtures and more. 3D metal printing should be added to the supply chain in order to address the current challenges of marine fabrication, such as time and efficiency, to overcome hesitance in adopting new technologies.

3D metal printing can improve marine fabrication by consolidating parts that traditionally would require the joining of four or five separate parts. This can lead to the formation of parts with more uniform properties and fewer points of failure in the part and the fabrication and assembly of the part. 3D metal printing can also offer parts with increased complexity with no cost associated. Since this technique is a layer-by-layer, bottom-up method, very complex shapes can be manufactured using the same technique used to make a simple block.





In 3D metal printing, parts no longer need to be carved, cut, or welded together. Instead they are manufactured in one piece, making them less susceptible to stress. Furthermore, 3D metal printing can be used to introduce new design paradigms by developing engineered metamaterials that are not only stronger, but lighter, thereby increasing fuel efficiency.

All in all, metal 3D printing can change the marine supply chain by making it more efficient and addressing the limitations of subtractive manufacturing.

WHAT OTHER INDUSTRIES WILL MAMCE PARTICIPATE IN?

Although MAMCE was conceived around supporting the marine industry, we are open to working with other industries that benefit the Atlantic provinces (Newfoundland, New Brunswick, Nova Scotia and Prince Edward Island). These include: food processing, pulp and paper, manufacturing, defense and security, and aerospace industries.

HOW DOES MAMCE SUPPORT THE COMMERCIAL SPACE?

MAMCE offers 'toll' printing services and product design support. The customer comes with product and they want it printed or modified; then they can pay for services. If the customer is developing a new product, then MAMCE operates on a cost recovery basis up to the point that the printed parts are going to be used commercially, either sold or to generate income. At the point of commercialization, the pricing switches to revenue generating with our commercial partner CFM.

WHAT ARE SOME OF THE PROMISING AREAS OF 3D METAL PRINTING THE CENTER PLANS TO ADDRESS?

MAMCE aims to introduce metal 3D printing to the marine industry by conducting both applied research and fundamental studies on different aspect of metal additive manufacturing. Therefore, a detailed research plan has been developed in order to assure the appropriateness of mechanical and physical properties of metal 3D printed parts for the marine industries. MAMCE will focus on developing new recipes in order to laser melt new powder alloys including wrought aluminum alloys and different bronzes. The laser powder bed melting process works at the laser spot size of 50 micrometers and in fractions of a second.

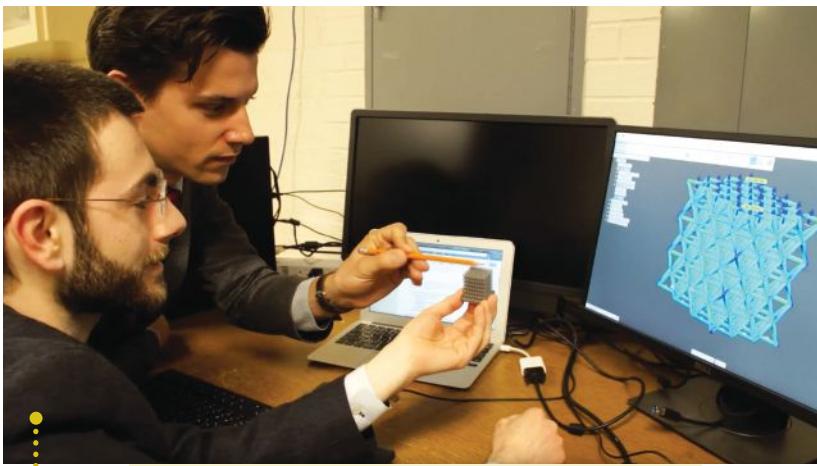
By working with process parameters and the freedom that a metal 3D printer offers, new materials with better corrosion, impact, fatigue, and high temperature properties will be developed for the marine sector. In addition, MAMCE will develop computer modeling framework to predict the behavior of metal 3D printed parts under different laser melting parameters, so that we can develop new metal characteristics to improve part performance.



An example of complex lattice structures that are impossible to make using conventional fabrication methods. Photo courtesy of UNB/MAMCE.



The University of New Brunswick is developing the expertise necessary to support additive manufacturing in Atlantic Canada to support the Marine Industry. Photo courtesy of UNB/MAMCE.



Computer modeling software is being developed at UNB to predict the metal properties based on the laser parameter settings. Photo courtesy of UNB/MAMCE.

WHAT IS THE BIGGEST CHALLENGE TO COMMERCIALIZING 3D METAL PRINTING?

The main challenge is awareness and understanding. What can metal printing do and what can't it do? Most people have heard of it, but their idea of metal printing ranges from fad to Star Trek replicator. One underestimates its potential and the other sees a magic box.

How do you ensure the highest possible quality for your manufactured parts?

The highest quality of the manufactured parts come from three pillars:

1) The right equipment to print metallic parts and post process them to the required tolerances;

2) Trained personnel to design experiments and builds, run the metal 3D printers, perform post-processing methods, and know the right characterization techniques; and

3) the right equipment to test and inspect the produced parts both destructively and non-destructively, characterize the properties, and further ensure their quality. 3D metal printing is seldom stand-alone; we are supported by our partner CFM with conventional machining and testing experience.

In terms of equipment: instruments to test the quality of a powdered metal, a universal mechanical testing machine, along with different corrosion and fatigue apparatus, can help to destructively inspect the quality of a printed

metallic part. Building and improving on the current standard procedures is part of the MAMCE mandate.

WHERE WILL THE 3D METAL PRINTING WORKFORCE COME FROM?

Workforce development will have two parts: training researchers, engineers, and highly qualified personnel to design for additive manufacturing, and training technicians to run the metal 3D printers.

The workforce development is represented by: Nova Scotia Community College (NSCC), New Brunswick Community College (NBCC), and Collège Communautaire du Nouveau-Brunswick (CCNB). Courses are in development to train the next generation of engineers and technicians on what metal 3D printing is and how to use it in an industrial setting. In addition, new faculty members, visiting professors, and teaching appointees are currently being hired to strengthen the training program. The community colleges in close collaboration with the University of New Brunswick will provide the technical training to the operators to run the machines, who setup and run the printers. In most cases, parts printed in a machine require post processing around connections and threads or to get to the right tolerances, which the same operators will handle.

WHAT IS POST PROCESSING?

Most parts printing on a 3D metal printer will require some post processing. This typically includes polishing, or smoothing connection points or adding threads. We

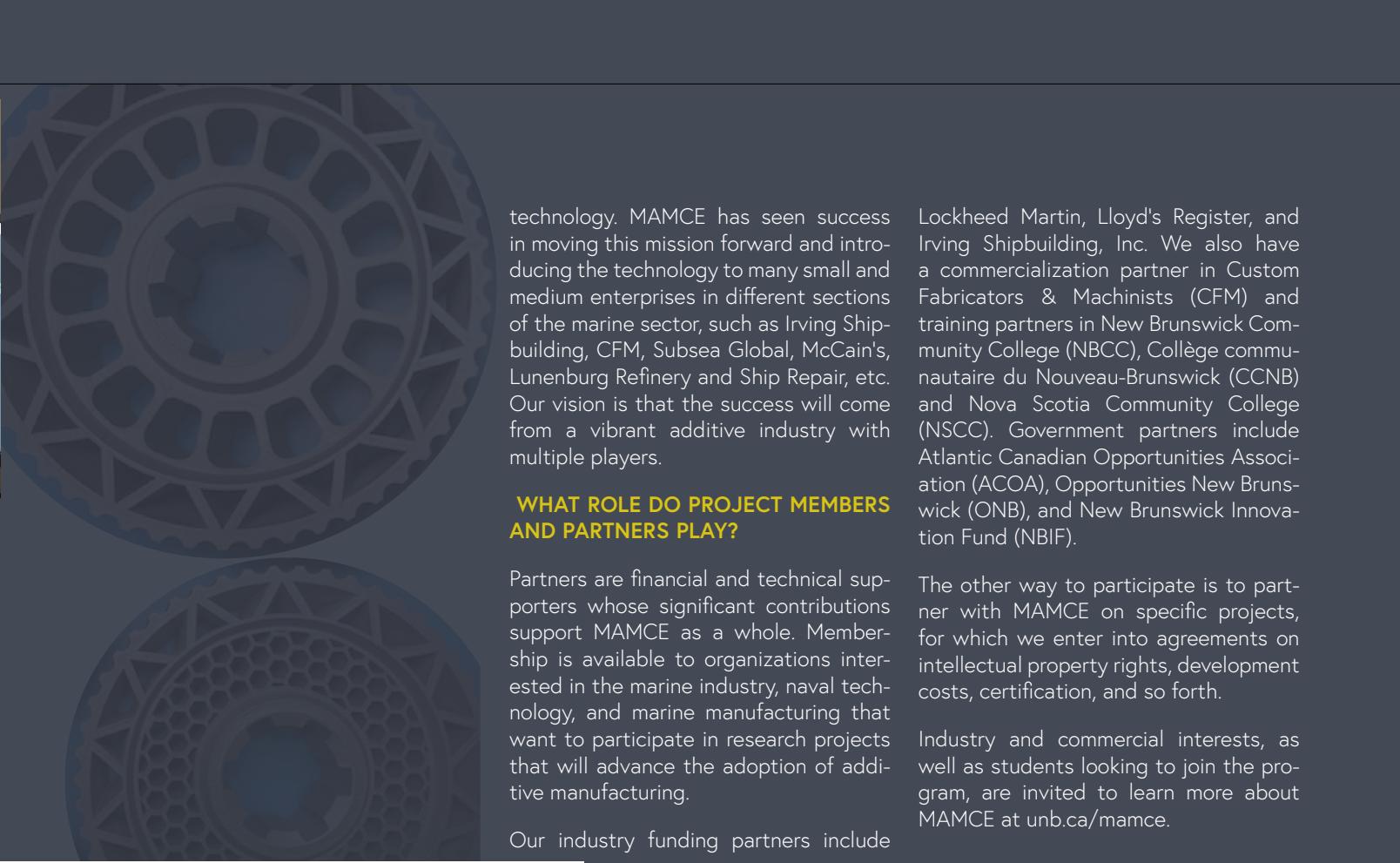
are fortunate to be partnered with CFM who has 5-axis machining capability and the software to interact with the printer files to integrate the post processing requirements into the original print design.

HOW DO YOU ENVISION THIS CENTER BUILDING BUSINESS OPPORTUNITIES FOR NEW BRUNSWICK?

MAMCE has a detailed plan to promote business opportunities in New Brunswick and beyond. The plans include educating industries in the region since most of the metal fabricators do not know about this new technology or do not have sufficient information about its capabilities. Thus, in order to help the local businesses, several sessions have been held to introduce the advantages and capabilities of the technology to designers, technicians, and engineers. More sessions like this will happen in near future in order to inform a bigger group of industries with the capabilities of this technology.

In addition, MAMCE has been working with local companies involved in marine propulsion, ship repair and shipbuilding to come up with innovative designs for new parts and applications. We have also been working on projects for the pulp and paper industry, as well as fundamental research valuable to the aerospace industry. Early discussions with energy companies have been initiated and relationships are being developed.

The vision is to bring down the barrier so that more industries can know about the technology and can practice with



technology. MAMCE has seen success in moving this mission forward and introducing the technology to many small and medium enterprises in different sections of the marine sector, such as Irving Shipbuilding, CFM, Subsea Global, McCain's, Lunenburg Refinery and Ship Repair, etc. Our vision is that the success will come from a vibrant additive industry with multiple players.

WHAT ROLE DO PROJECT MEMBERS AND PARTNERS PLAY?

Partners are financial and technical supporters whose significant contributions support MAMCE as a whole. Membership is available to organizations interested in the marine industry, naval technology, and marine manufacturing that want to participate in research projects that will advance the adoption of additive manufacturing.

Our industry funding partners include

Lockheed Martin, Lloyd's Register, and Irving Shipbuilding, Inc. We also have a commercialization partner in Custom Fabricators & Machinists (CFM) and training partners in New Brunswick Community College (NBCC), Collège communautaire du Nouveau-Brunswick (CCNB) and Nova Scotia Community College (NSCC). Government partners include Atlantic Canadian Opportunities Association (ACOA), Opportunities New Brunswick (ONB), and New Brunswick Innovation Fund (NBIF).

The other way to participate is to partner with MAMCE on specific projects, for which we enter into agreements on intellectual property rights, development costs, certification, and so forth.

Industry and commercial interests, as well as students looking to join the program, are invited to learn more about MAMCE at unb.ca/mamce.



After the printing process is complete the build plate is raised, and the loose powder is removed. In this case, test samples have been printed to confirm density and strength. Photo courtesy of UNB/MAMCE.



Used within a highly corrosive pulp and paper application, a 3D printed impeller is fitted within the pump housing for verification, before installation. Photo courtesy of UNB/MAMCE.

NEW DETAILS ON DISCOVERY OF SAN JOSE SHIPWRECK

WHOI Developed & Operated Technology Crucial to Successful Search

The Woods Hole Oceanographic Institution (WHOI) recently obtained authorization by Maritime Archaeology Consultants (MAC), Switzerland AG, and the Colombian government to release new details from the successful search for the three-century old San José —a 62-gun, three-masted Spanish galleon ship that sank with a cargo believed to be worth billions of dollars. The ship, which is often called the "holy grail of shipwrecks," went down with a treasure of gold, silver, and emeralds in 1708 during a battle with British ships in the War of Spanish Succession.

The legendary wreck was discovered off the coast of Cartagena, Colombia, on Nov. 27, 2015, by a team of international scientists and engineers during an expedition aboard the Colombian Navy research ship ARC Malpelo led by MAC's Chief Project Archaeologist Roger Dooley. It was found more than 600 meters below the surface during a search initiated by MAC and approved by The Colombian Ministry of Culture. The search was supervised by Instituto Colombiano de Antropología e Historia (ICANH) and Dirección General Marítima (DIMAR).

"In order to ensure a successful search, we retained the services of Woods Hole Oceanographic Institution, which has an extensive and recognized expertise in deep water exploration," said Dooley. "This partnership was key to the discovery of the San José."

WHOI played a crucial role in both the search and discovery of the final resting place of the San José, which had remained a great mystery to marine archeologists, historians, governments, and treasure hunters for decades. Specifically, the institution provided and operated an autonomous underwater

A newly released gridded mosaic of images taken by the REMUS 6000 shows the complete wreck site. (Mosaic by Jeff Kaeli, Woods Hole Oceanographic Institution)



REMUS 6000 being deployed off the Colombian Navy research ship ARC Malpelo. (Mike Purcell, Woods Hole Oceanographic Institution)

vehicle called REMUS 6000 to survey an area off Colombia's Barú Peninsula.

"The REMUS 6000 was the ideal tool for the job, since it's capable of conducting long-duration missions over wide areas," said WHOI engineer and expedition leader Mike Purcell.

Finding high-profile wrecks is nothing new for REMUS, which played an instrumental role in finding the wreckage of Air France 447 in 2011. The airplane had crashed in 2009 several hundred miles off the northeastern coast of Brazil and landed deep in the ocean on some of the most rugged seafloor terrain on Earth. REMUS was also used to map and photograph the Titanic wreck site during a 2010 expedition.

The San José discovery carries considerable cultural and historical significance for the Colombian government and people because of the ship's treasure of cultural and historical artifacts and the clues they may provide about Europe's economic, social, and political climate in the early 18th century. The Colombian Government plans to build a museum and world-class conservation laboratory to preserve and publicly display the wreck's contents, including cannons, ceramics, and other artifacts.

REMUS was initially deployed off the Malpelo to survey an approved area in June 2015. The overall search area was divided into search blocks, and in the initial blocks surveyed, the shipwreck was not found. Unfortunately, the entire area of search blocks could not be completed in this first expedition due to time constraints. In November, the WHOI team along with MAC and under the supervision of ICANH and DIMAR, returned to

the search area determined by previous historical research to finalize the survey in the blocks that had not been completed.

"During that November expedition, we got the first indications of the find from side scan sonar images of the wreck," said Purcell. "From those images, we could see strong sonar signal returns, so we sent REMUS back down for a closer look to collect camera images."

To confirm the wreck's identity, REMUS descended to just 30 feet above the wreck where it was able to capture photos of a key distinguishing feature of the San José—its cannons. Subsequent missions at lower altitudes showed engraved dolphins on the unique bronze cannons.

"The wreck was partially sediment-covered, but with the camera images from the lower altitude missions, we were able to see new details in the wreckage and the resolution was good enough to make out the decorative carving on the cannons," said Purcell. "MAC's lead marine archaeologist, Roger Dooley, interpreted the images and confirmed that the San José had finally been found."

"Once again, WHOI's expertise in AUV technology and operations has resulted in an important discovery," said WHOI Vice President for Marine Facilities and Operations Rob Munier. "We are pleased to have played a part in settling one of the great shipwreck mysteries for the benefit of the Colombian people and maritime history buffs worldwide. We look forward to our continued involvement to answer the basic oceanographic research questions associated with the find."

The REMUS 6000 is owned by the Dalio Foundation and operated by WHOI under an operations and maintenance agreement.



The wreck was partially sediment-covered, but with the camera images from the lower altitude REMUS missions, the crew was able to see new details, such as ceramics and other artifacts. (REMUS image, Woods Hole Oceanographic Institution).

The Woods Hole Oceanographic Institution is a private, non-profit organization on Cape Cod, Mass., dedicated to marine research, engineering, and higher education. Established in 1930 on a recommendation from the National Academy of Sciences, its primary mission is to understand the ocean and its interaction with the Earth as a whole, and to communicate a basic understanding of the ocean's role in the changing global environment.



WHOI researchers (right to left) Greg Packard, Neil McPhee, Eric Hayden, Mike Purcell, Jeff Kaeli, Lt. Julio Monroy of the Colombian Navy, and David Oliver of Benthic Geoscience aboard the ARC Malpelo. (Image courtesy of Mike Purcell, Woods Hole Oceanographic Institution).



Aboard the Colombian Navy research ship ARC Malpelo (from right to left): Mike Purcell (WHOI), Dr. Ernesto Montenegro (ICANH director), Dr. Juan Manuel Vargas (General Counsel of Ministry of Culture) Captain of the MALPELO and Roger Dooley (Project director). Image courtesy of Maritime Archaeology Consultants.

For more information, please visit
WWW.WHOI.EDU



For nearly 50 years, Geometrics has been an industry leader in state-of-the-art airborne, land, and marine instrumentation. In keeping with that tradition, we recently released a revolutionary new magnetometer that will change and greatly enhance the way users collect data. Using Micro-Fabricated Atomic Magnetic (MFAM) technology, our new miniature magnetometer weighs less than a pound and uses only 2.5 watts of power, the equivalent of running on a smartphone battery for 2 hours. Despite its small size, our new magnetometer is capable of sampling at 1000 Hz, allowing users to collect high-resolution data, even at higher survey speeds.

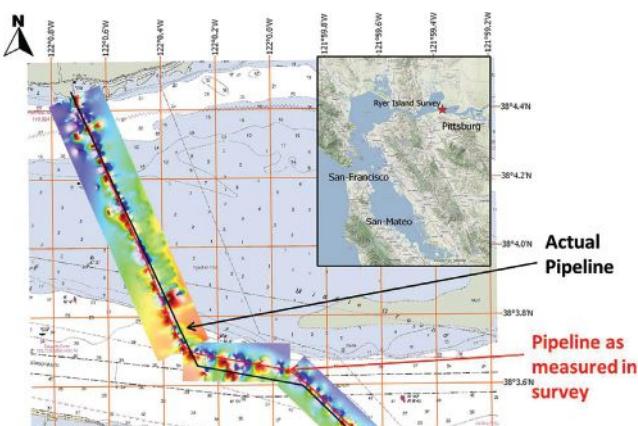
We are currently developing a drone-mounted magnetometer ideal for survey areas that are difficult to access. Such areas include shallow marine environments that are too shallow for traditional marine surveys, but too wet for land surveys: littoral zones, mud flats, or other marine environments. Additionally, the new MagArrow can be deployed from shore and does not require boat time, which can be expensive and limited by availability.

For those customers who need customized solutions, we also sell the MFAM miniature magnetometer, along with a development kit. Users have modified their miniature magnetometer systems in a variety of ways, such as adding magnetometers to their existing ROV or AUV systems or by creating an entirely new exploration tool. The MFAM miniature magnetometer sensor and electronics package are flexible and can be used in any environment where traditional magnetometers are used.

Our new MagArrow is ideal for tracking pipelines, locating wellheads, search-and-rescue operations, archaeological surveys, and geologic mapping. Customers have successfully

used the systems as pipeline and utility trackers, where the object of interest is buried in shallow water or marshy, difficult to access locations. The system is also an elegant solution in archaeological surveys, where data are gathered quickly and without disturbing the ground. The MFAM miniature magnetometer has many uses, but perhaps the most important is as a search and rescue tool. Data can be collected more than five times faster than with traditional surveys, making the MFAM miniature magnetometer the go-to choice for use in emergency situations.

Purchasing an MFAM miniature magnetometer is as easy as purchasing any of our traditional cesium magnetometers. Customers do not need to pursue ITAR licensing, though the MFAM technology is still under commerce control 6A006. We work closely with our network of international representatives and provide them with training and support on our latest products. Our representative network covers four continents and over 60 countries. We offer world-class service and support. With prior arrangement, we can be available 24 hours per day, seven days per week.



ASV Global and BMT Partner on Autonomous Navigation Research

ASV Global (ASV) is leading a new £1.2 million research project in partnership with BMT to enhance the safety and reliability of autonomous navigation. The project team will use deep learning machine vision systems trained with a unique combination of simulated and real-world data. Funded in part by Innovate UK, the project will enhance situational awareness, enabling the unmanned surface vehicles (USV) to operate in extreme and congested marine environments.

The Synthetic Imagery training for Machine Vision in Extreme Environments (SIMVEE) project will build upon ASV's existing, COLREG cognizant, autonomous collision avoidance and path planning capability. The project will use BMT's REMBRANDT simulator to train and validate ASV Global's vision algorithms to detect and classify objects at sea.

A key project output will be improved situational awareness for both the autonomy onboard and the remote human supervisor. The unique combination of real world and simulated data to train deep learning algorithms will improve the reliability of the existing system extending safe operations into complex



environments with a wide range of objects to detect, classify and avoid.

Utilizing data gathered by BMT's REMBRANDT ship maneuvering simulator as well as real world onboard camera data will allow the team to train the autonomy system with large quantities of data. This method provides a cost-effective solution to generating the data and accelerates the machine learning process. The project will not only allow USVs to operate in the same way as traditional manned vessels at sea but will also open up new use cases and applications with the added use of BMT's Search and Rescue Information System, (SARIS).



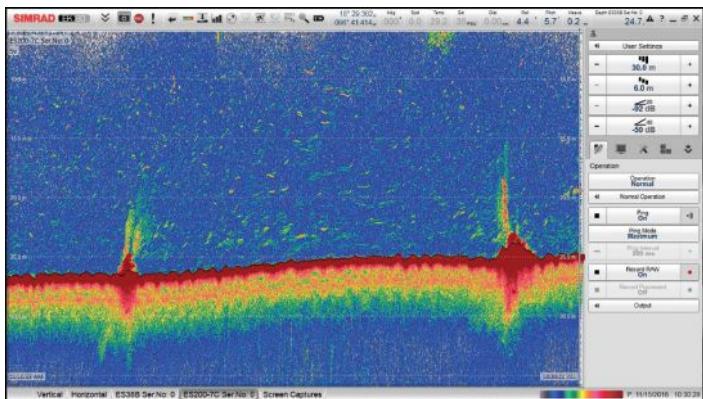
FULLY INTEGRATED LASER AND IMAGING SYSTEMS FOR AUV & ROV APPLICATIONS

Image: Cathx Ocean's 3D Colour Laser representation of a shipwreck

Black Sea Maritime Archaeology Project (MAP)

Find out more at www.cathxocean.com/systems Contact us for more info at info@cathxocean.com

CSA Implements Innovative Technology for Tracing Sewage Outfalls



CSA Ocean Sciences Inc. (CSA) is utilizing advance echosounder technology to examine sewage outfalls off the north coast of Puerto Rico, and has proven quite successful in terms of letting researchers "visualize" what's going on.

Since 1999, CSA has performed comprehensive environmental monitoring for the Puerto Rico Aqueduct and Sewer Authority (PRASA) as a subcontractor to CH2M to evaluate compliance with receiving water quality standards and describe environmental conditions around six offshore submarine discharges. Typical studies conducted by CSA and CH2M during the past 14 years include mixing zone studies, sediment sampling and testing, measurement of water column properties such as pH, dissolved oxygen, and currents, and water quality sampling of influent, effluent, and receiving water.

CSA implemented acoustic technology for an innovative mixing zone dye study for PRASA in which a SIMRAD EK60 scientific echosounder system (with split-beam transducers operating at 38 and 200 kHz) was used to observe the outfall plume in the water column prior to and during the course of the dye study. The EK60 echosounder system is the same system used on a number of National Oceanic and Atmospheric Administration (NOAA) research vessels performing fisheries survey work and is designed primarily to characterize fish and zooplankton

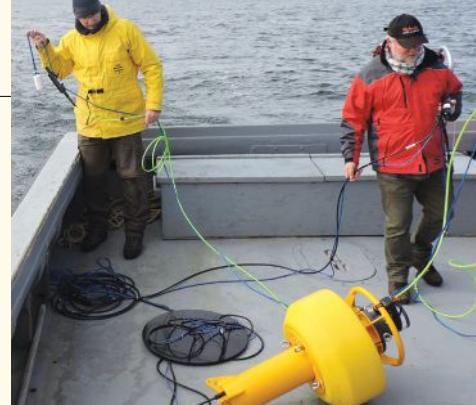
communities in the water column. Because the system provides a synoptic view of the water column, it is a useful and relevant tool for other applications in the marine environment. CSA has continued to use this approach, having done so as recently as last month.

During the recent PRASA study, echograms produced by CSA's innovative techniques helped CH2M scientists quickly visualize the outfall flow and determine the depths and other characteristics of the plume, as well as improve sampling of the plume features using ship-deployed water column sensors.

"Our clients at CH2M were pleased with the utility of the technology and the informative nature of the echogram imagery, and plan to include the imagery in their report to PRASA", relayed Ed Hughes, a CSA scientist with expertise in acoustic technology. "I was also pleased with the successful use of the acoustic technology in this particular application – it really helps in seeing the bigger picture."

The success of the innovative study resulted in adoption of the system for future sampling events to improve understanding of water quality associated with offshore sewage outfalls in Puerto Rico.

For more information on this and other CSA studies, visit
WWW.CSAOCEAN.COM



Ocean Sonics Releases Coastal Acoustic Drifting Buoy

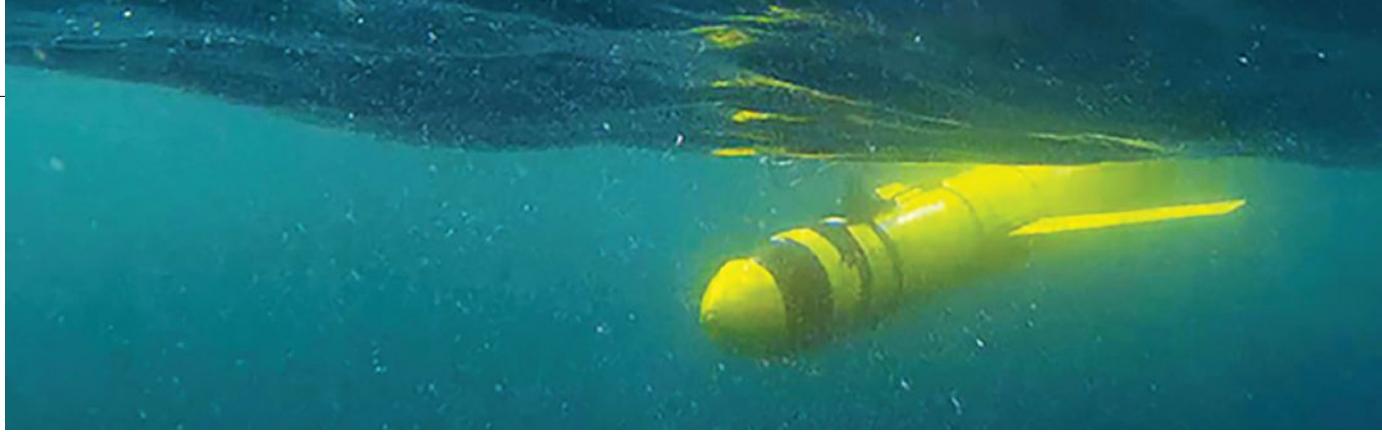
Ocean Sonics has developed a coastal acoustic drifting buoy. Practical uses include, but are not limited to, marine mammal monitoring, real-time noise measurement, environmental assessment and improving compliance with the Marine Strategy Framework Directive.

The buoy weighs 23kg and measures one meter in length and 0.5 meter in width, and is can be deployed by a single user without the use of a crane or additional equipment. Features include Wi-Fi for real-time set-up, status and spectral display, remote Wi-Fi access (up to 100m), GPS time sync, on/off switch for icListens and buoy and hydrophone synchronization within one microsecond.

This drifting buoy also possesses the ability to be moored and was designed to be acoustically quiet. While drifting, reduces flow noise, even in fast moving water. For example, the buoy mitigates the flow noise generated near tidal turbines to improve clarity and quality of recordings. The buoy captures the desired ocean sounds without interruption or interference from the buoy or, if stationary, its mooring. With configuration for up to six hydrophones and selectable cable lengths using smart cables, the buoy adapts easily to any project. Users can attach any of Ocean Sonics icListen Smart Hydrophone Array or another ethernet controlled system for coastal acoustic monitoring.

For more information, visit
WWW.OCEANSONICS.COM





A Seaglider being deployed into the ocean. Photo credit: University of East Anglia.

Growing "Dead Zone" in Gulf of Oman Confirmed by Seaglider AUVs

New research has confirmed a dramatic decrease in oxygen in the Gulf of Oman part of the Arabian Sea. The "dead zone" was confirmed by Seaglider autonomous underwater vehicles (AUVs) – which were able to collect data in areas of water previously inaccessible due to the piracy and geopolitical tensions.

Seaglider AUVs are about the same size as a small human diver but can reach depths of 1000 meters and travel the ocean for months, covering thousands of kilometers. Two gliders were deployed in the Gulf of Oman for eight months. They communicated by satellite to build an underwater picture of oxygen levels and the ocean mechanics that transport oxygen from one area to another. Where they expected some oxygen, they found an area larger than Scotland with almost no oxygen left.

The research was led by Dr. Bastien Queste from the University of East Anglia (UEA)'s School of Environmental Sciences, in collaboration with Oman's Sultan Qaboos University.

Dr. Queste said, "The Arabian Sea is the largest and thickest dead zone in the world. But until now, no-one really knew how bad the situation was because piracy and conflicts in the area have made it too dangerous to collect data. We barely have any data collected for almost half a century because of how difficult it is to send ships there. Our research shows that the situation is actually worse than feared – and that the area of dead zone is vast and growing."

Computer simulations of ocean oxygen show a decrease in oxygen over the next century and growing oxygen minimum zones. However, these simulations have a difficult time representing small but important features such as eddies which impact how oxygen is transported.

The team combined their Seaglider data with a very high-resolution computer simulation to determine how oxygen is spread around the north-western Arabian Sea throughout different seasons and the monsoons. They found that the dead zone moves up and down between seasons, causing fish to be squeezed in a thin layer near the surface.

"Management of the fisheries and ecosystems of the western Indian Ocean over coming decades will depend on better understanding and forecasting of oxygen levels in key areas such as the Gulf of Oman," added Dr. Queste.

'Physical controls on oxygen distribution and denitrification potential in the north west Arabian Sea' was published in Geophysical Research Letters on April 27, 2018.

The Seaglider AUV is a Kongsberg product.

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

An advertisement for SubCtech Subsea Technologies. The top section is titled "Ocean Engineering". It features the SubCtech logo and a "pCO₂ Analyzer" unit. Below this are sections for "Li-Ion Batteries" (with a "Subsea Inspection" image), "Added Value" (with a "Vehicle Batteries" image), and "Battery Systems" (with a "Battery Systems" image). Various logos for partners like Shell XPRIZE, clean seas, and OceanPack™ (FerryBox) are included. The bottom right corner shows the SubCtech ISO 9001 certification logo.



ILLUMINATING THE MYSTERIOUS WATERS OF THE DEEP

Cathx Ocean Assists in the Black Sea Maritime Archaeology Project (MAP)

By Chris Bailey, Applications Engineer, Cathx Ocean and Adrian Boyle, CEO, Cathx Ocean

What history lies preserved on the bed of the Black Sea, many thousands of feet below the surface? The answers are revealed through the use of laser data, subsea imaging and 3D modelling using photogrammetry.

Cathx Ocean is playing a key role in helping illuminate never before documented artifacts of maritime history, through participation in the Black Sea Maritime Archaeology Project (MAP).

The Black Sea MAP is a multidisciplinary maritime archaeological study aimed at uncovering the effects of sea level change on early human civilizations. This ambitious project surveys areas of the Black Sea where marine archaeologists say that large areas of land were inundated as the water level rose after the last Ice Age. However, while searching for evidence of lost lands, they found something else just as interesting. Dozens of sunken ships lay preserved in the cool, unoxygenated waters along the deep seabed. These vessels, some of which have been untouched for thousands of years, offer unprecedented insight into the lives of our forbearers.

PARTNERSHIP VISION

Operating from the Port of Burgas and encompassing the Bulgarian jurisdiction, the project is led by a team of maritime archaeologists and marine geophysicists. With potential depths of up to 4,000 meters being investigated, the team relies on detailed, precision images and laser data to review the site.

With this in mind, the project team enlisted the expertise of marine survey company MMT to undertake and manage the subsea inspection. Cathx Ocean supported MMT across a number of areas in this significant project. MMT assigned two vehicles to the mission, a Surveyor Interceptor ROV and a Schilling Work Class ROV, both featuring Cathx Ocean systems.

Cathx Ocean configured the systems to suit each vehicle's specific tasks and integrated them on board. The systems include laser profiling and high-resolution and video imaging components, featuring some unique capabilities. With a number of Cathx Ocean systems already commissioned by MMT (and having worked closely together in the past), this was a partnership worthy of the the largest of its type ever undertaken.

RAPID 3D COLOUR LASER MODELS

In projects such as the Black Sea MAP, where very close inspection is required, dense laser point cloud models offer enhanced levels of detail. To achieve the required resolution, Cathx Ocean systems record laser data at higher frequencies than standard to create a dense point cloud. Using the precision still images collected, the point cloud is then coloured and processed through Cathx Ocean Solid Colour software, delivering models with the realism of photogrammetry but with far greater scope for zoom. Cathx Ocean's unique laser technology makes high speed processing of the laser data possible, enabling the rapid development of 3D laser models to assist the archaeological team in its analysis.

HIGH-PRECISION STILL IMAGING

Lack of sufficient light is the primary obstacle when it comes to effective underwater imaging. Issues such as motion blur, particle scatter and occlusion can severely reduce the quality of traditional video and video stills. Until now, the standard solution has been to slow the vessel down in an attempt to capture clearer images. But this practice leads to less data being collected, longer vessel time and higher operation costs. Lack of light also requires long exposure times which highlight sediment in the water, yielding unclear and unreliable results.

Cathx Ocean high-resolution cameras with fast Canon EF lenses were specified for the Black Sea project. When combined with high-lumen outputs and short exposure times, motion blur and backscatter can be eliminated. Unique to Cathx Ocean, this 'Fast Fly' capability enables non-stop, high-speed, single-pass videos, stills and laser. The images collected in the Black Sea provide the archaeologists with a level of precision and quality that dramatically surpasses the standards associated with conventional cameras.

POWERFUL PHOTOGRAHMETRY

Photogrammetry is a powerful tool for archaeologists, helping them to build a complete picture of the site. It involves capturing many images of one area, taken from different angles, and processing them through photogrammetry software. Matching features are detected, and a proportionally correct model of the site is constructed.

Using 3D printing technology, the archaeologists can hold 3D models of the wrecks within hours of the images being collected. Photogrammetry models are particularly useful in providing a well-textured visualisation of large underwater objects. The precision imaging components within Cathx Ocean systems ensure that the archaeological team is supplied with the highest quality building blocks for the creation of these models.

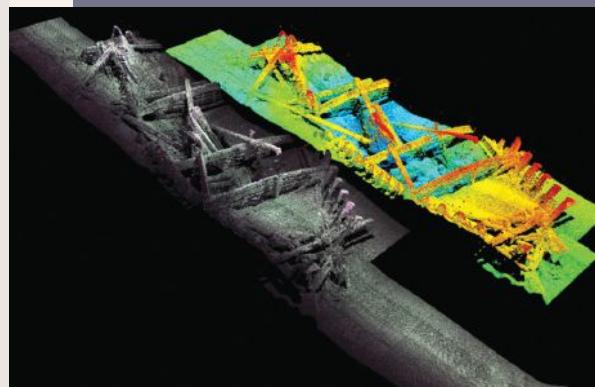
The Black Sea MAP, while still underway, has already been a resounding success—one in which Cathx Ocean systems and software have played a pivotal role. The precision images and laser data collected in the Black Sea present the archaeologists with a wealth of information from which to study the wrecks: UHD color images, from 3 to 30 hertz, give greater accuracy and allow real-time 3D laser models to be rendered in actual color, using the latest Cathx Ocean software.

The use of this advanced software means that co-registered spatial laser data and images enable the production of photogrammetry models, laser point clouds, and posed laser data. Also, camera positions extracted from photogrammetry and positional information contained within the image metadata itself mean that scale can be applied to models, without the need for external navigation sensors. The use of wide-angle cameras and high-lumen lights minimizes the number of images required, reducing data acquisition and processing time.

Cathx Ocean is a leading innovator in subsea imaging and measurement technology. The company provides systems, software, workflows and supports to clients around the world, helping them to collect and process data across many applications. Cathx Ocean partners with clients in a variety of industries, including oceanographic, energy and defense. Its ambition is to offer the best offshore service and support by making sub-sea operations more efficient, more cost-effective and safer.

The authors offer special thanks to MMT and Dr. Joakim Holmlund, Offshore Manager with MMT.

For more information, visit
WWW.CATHXOCEAN.COM
WWW.BLACKSEAMAP.COM
WWW.MMT.SE



3D color laser representation of a shipwreck. Still images captured using the Cathx Fast Fly Model Imaging system are used to color the laser points.



Detailed image of shipwreck captured using the Cathx Fast Fly Video Imaging system. This hi-res camera features an Ivanoff water corrected lens with a wide field of view. The combination of high-lumen outputs and short exposure times allow for elimination of motion blur and backscatter.



Cathx Ocean Imaging systems provide high-precision images enabling photogrammetry platforms to build detailed and accurate 3D photogrammetry models.

Saipem Starts Laying Norway's Longest, Largest Oil Pipeline

Installation of a pipeline to the Statoil-operated Johan Sverdrup field in the North Sea has begun outside Mongstad, north of Bergen, onboard the vessel Saipem Castorone. When finished it will become Norway's longest and largest oil pipeline.

According to the Norwegian company, the 36 inch pipeline, which will extend more than 280 km out to the Johan Sverdrup field once installed, is being pulled through a pre-drilled hole at the bottom of the Fensfjord into the oil terminal. When the Johan Sverdrup field produces at peak up to 600,000 barrels of oil will flow daily into Mongstad.

The total weight of the pipeline is 230,000 tonnes of steel and with coating the pipeline weight increases to approximately 360,000 tonnes.

Geir Bjaanes, responsible for subsea, power and pipelines for the Johan Sverdrup project, said, "The Castorone is now initiating pipelaying operations in the Fensfjord. The vessel will lay as much as 36,000 pipes – in total more than 400 km – when installing the oil and gas export pipelines for the Johan Sverdrup project. Assuming everything goes according to plan, the oil pipeline will reach the Johan Sverdrup field in July."

The costs for phase one of the Johan Sverdrup development have been reduced by more than NOK 35 billion since the plan for development and operation was approved by Norwegian

authorities. Of this, NOK 1.2 billion in savings come from rerouting the pipeline through the Fensfjord.

The original plan was to route the pipeline onshore 10 km from the oil terminal. At the time, it was not assessed as technically feasible to lay the pipe through the Fensfjord due to other existing pipelines in the area and possible subsurface instability.

Statoil commissioned a study in 2015 which showed that a subsea pipeline route was possible as long as infill support for existing pipelines was in place. After thorough preparations, the conditions have been put in place for the pipelaying operations now underway.

Lars Trodal, project manager for the Johan Sverdrup export pipelines, commented, "We have spent many years with Saipem planning these operations. At the same time, we're all very aware of the size of the task that we have ahead, with several months at sea with a significant installation scope before we reach the Johan Sverdrup field. The key is to follow the thorough plans that we've prepared and maintain our significant focus on HSE along the way."

Statoil's Johan Sverdrup is one of the five biggest oil fields on the Norwegian continental shelf. With expected recoverable resources of between 2.1-3.1 billion barrels of oil equivalent, it will be one of the most important industrial projects in Norway over the next 50 years.



The Saipem Castorone pipelaying vessel at Mongstad. Photo courtesy of Statoil, credit: Espen Rønnevik / Roar Lindefjeld / Woldcam.

FACTS ABOUT THE JOHAN SVERDRUP EXPORT PIPELINES:

- Will be the largest oil pipeline on the Norwegian continental shelf, both in terms of diameter (36 inches) and length (283 km).
- 36,000 pipes which in total amount to approximately 440 km of pipelines (oil pipeline – 283 km; gas pipeline – 156 km).
- Total weight is 230,000 tonnes of steel (with coating the pipeline weight increases to approximately 360,000 tonnes).
- The steel alone weighs 33 times the weight of the Eiffel Tower
- The oil pipeline measures 36 inches in diameter; the gas pipeline measures 18 inches in diameter.
- The oil pipeline will at its deepest point be 537 meters below the sea.
- Saipem Castorone (Pipelaying vessel): 330 meters long (excluding ramp/stinger), with a capacity of up to 702 people on board.



Picture of 36,000 pipes - making up more than 400 km of oil and gas pipeline - in storage at StordBase at Stord. Photo courtesy of Statoil, credit: Espen Rønnevik / Roar Lindefjeld / Woldcam.

Riptide set out to change the undersea vehicle market by combining best in class hydrodynamics, ultra low power processing, and game changing new energy technology, while significantly reducing vehicle costs. To accomplish this, we introduced the small, yet highly-capable micro-UUV.

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The EOWDC offshore wind farm, which will have the world's most powerful turbines, has been connected to the National Grid.

Final Turbine Installed for Aberdeen Offshore Windfarm

The final turbine for the European Offshore Wind Deployment Centre (EOWDC) has been successfully installed, with the project recording what is believed to be the world's fastest installation of a gigantic suction bucket jacket foundation. The May 26 turbine installation came just nine weeks after the first foundation for the 11-turbine EOWDC scheme off Aberdeen Bay was deployed in the North Sea.

The project survived numerous delays, including legal challenges from U.S. President Donald Trump (then private citizen) who claimed the turbines would ruin the views from his golf course at Balmedie.

Adam Ezzamel, EOWDC project director at Vattenfall, said, "This is a magnificent offshore engineering feat for a project that involves industry-first technology and innovative approaches to the design and construction. Throughout construction, the project team and our contractors have encountered, tackled and resolved a number of challenges. The erection of the final turbine is a significant milestone, and with the completion of array cable installation, we now move on to the final commissioning phase of the wind farm prior to first power later this summer."

"One of our 1,800 tonne suction bucket jacket foundation was installed in what we believe is a world record of two

hours and 40 minutes from the time the installation vessel entered the offshore site until deployment was complete. What makes this even more significant is that the EOWDC is the first offshore wind project to deploy this kind of foundation at commercial scale while it's also the first to pair them with the world's most powerful turbines.

"Full credit goes to the expertise of our project team and contractors who have worked collaboratively and vigorously to achieve this remarkable milestone in such a short timescale. As a flagship project for the North-east, the EOWDC helps underline the region's status as Europe's energy capital and reinforces Vattenfall's vision to be fossil free within one generation."

Suction bucket jackets form a key component of the EOWDC and underpin the facility's test and demonstration of innovation. Besides enabling faster offshore, they also keep noise to a minimum, as well as allowing easier decommissioning as the installation process is reversed. As such, the technology is expected to contribute to driving down the cost of clean power.

MHI Vestas Chief Operations Officer, Flemming Ougaard, said, "We're excited to see that the last turbine has been safely installed at Aberdeen Bay with our partner, Vattenfall. With clean power set to soon flow to the national grid from all

11 turbines, we very much look forward to operations and service at the new offshore wind park."

The ground-breaking 93.2MW EOWDC, which is scheduled to generate first power in the summer, will produce the equivalent of more than 70 percent of Aberdeen's domestic electricity demand and annually displace 134,128 tonnes of CO₂.

It features nine 8.4MW turbines along with two 8.8MW models which both represent an industry first in that they are the first of this power capability to be deployed commercially in the offshore wind industry. As a result, all turbines will enable the EOWDC to generate more clean energy.

The EOWDC utilizes 66kV transmission and cabling to transport the energy produced from the turbines to the onshore substation, which is expected to boost power transmission while improving efficiency and reliability. The implementation of this cabling should contribute to the offshore industry's cost reductions targets, improving lifecycle costs and lowering leveled cost of electricity.

For more information, visit
[HTTPS://CORPORATE.VATTENFALL.CO.UK/PROJECTS/WIND-ENERGY-PROJECTS/EUROPEAN-OFFSHORE-WIND-DEPLOYMENT-CENTRE/](https://corporate.vattenfall.co.uk/projects/wind-energy-projects/european-offshore-wind-deployment-centre/)

Oil and Gas Industry Urged to Support New Skills Strategy

A new report into UK oil and gas workforce dynamics indicates that more than 40,000 new people will need to be recruited into the industry over the next 20 years, including 10,000 in posts that don't exist today.

The UKCS Workforce Dynamics Review, by global energy skills body OPITO in partnership with the RGU Oil and Gas Institute, assesses the changing skills requirements for the industry over the next 20 years. The research will assist in providing a roadmap for a new skills strategy to ensure the sector is ready to take advantage of emerging roles and diversification opportunities.

Modelling different scenarios, the report shows that whilst total employment will fall over time, if the industry achieves its ambitions around Vision 2035 and the lower carbon transition, tens of thousands more posts can be safeguarded and around 10,000 people will need to be recruited in emerging digital roles that don't exist today in data analytics, data science, robotics and remote operations.

Key Findings:

- Over 40,000 people are expected to enter the industry over the next 20 years, including around 10,000 in new areas such as data science, data analytics, robotics, material science, change management and remote operations.
- Over 80,000 workers are likely to retire or leave the sector for other reasons by 2035.
- Following the downturn between 2014 and 2017, the industry lost over 70,000 direct and indirect jobs (a decline rate of 10 percent per year). On the basis that the industry can achieve the goals around Vision 2035 and the wider energy diversification, the industry should be able to sustain over 130,000 roles in 2035, compared to around 170,000 in 2017 (a decline rate of less than 1.5 percent per year).
- Closer collaboration is required between industry and training providers to up-skill and re-skill the workforce to enhance technology capabilities across the industry and ensure it is competing effectively with other sectors for the best candidates.
- A new skills strategy is now required to ensure the industry responds effectively to securing future talent requirements and achieving the best-case scenario to safeguard posts.

Representatives from operating companies and supply chain firms from across the UK took part in the data gathering exercise. The workforce data collected totaled 34,000 roles, representing 50% of the gross operated production in the UKCS. The review identifies common roles and categorizes them into broad job families to study potential impacts.

The full UKCS Workforce Dynamics Review is available on the RGU Oil and Gas Institute website at www.rgu.ac.uk/link/rwu-oil-and-gas-institute1.

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Shell Announces Major Deep-Water Exploration Discovery In Gulf Of Mexico

Shell Offshore, Inc. (Shell) announces a large, deep-water exploration discovery in the Norphlet geologic play in the U.S. Gulf of Mexico with its Dover well (100 percent Shell). The Dover discovery is Shell's sixth in the Norphlet and encountered more than 800 net feet of pay (244 meters). The discovery is located approximately 13 miles from the Appomattox host and is considered an attractive potential tieback. Shell's Appomattox host has now arrived on location in the U.S. Gulf of Mexico and is expected to start production before the end of 2019.

"Dover showcases our expertise in discovering new, commercial resources in a heartland helping deliver our deep-water growth priority," said Andy Brown, Upstream Director for Royal Dutch Shell.

"By focusing on near-field exploration opportunities in the Norphlet, we are adding to our resource base in a prolific basin that will be anchored by the Appomattox development."

Appomattox host platform is owned by Shell (79 percent) and Nexen Petroleum Offshore USA Inc. (21 percent).

Shell's major, deep-water hubs are well positioned for production expansion through near-field exploration and additional subsea tiebacks. The company expects its global, deep-water production to exceed 900,000 barrels of oil equivalent per day by 2020, from already discovered, established areas.

The well was drilled in Mississippi Canyon Block 612, located approximately

170 miles (273 kilometers) offshore southeast of New Orleans, in a water depth of 7,500 feet (2,280 meters) to a total vertical drilling depth of 29,000 feet (6,780 meters) measured depth.



Shell's Dover discovery was drilled by the Deepwater Poseidon, a new build rig, in the U.S. Gulf of Mexico.



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Seabased Teams up for Wave Park Pilot Project in the Canary Islands

Seabased, a Swedish wave energy company, is teaming with Infocom Connect to provide wave energy for commercial projects in the Canary Islands. The partnership will begin with a project for a pilot 5 MW installation to provide energy for a desalination plant, but could expand to address multiple energy needs, from automobile recharging stations to supplying the grid.

The Canary Islands have limited fresh water and must continually desalinate ocean water to maintain supply, which uses a lot of power. Much of this is done with diesel, but the islands are working to replace fossil fuels with renewable energy. Óscar Sanchez, Executive Manager of SBH Hotels and Resorts company, which is one of the largest private companies in the Canaries, is behind the wave energy desalination project. Sanchez's family also owns a desalination plant with a capacity of 5,000 cubic meters.

"We have slightly less than 3,000 square miles of land mass and it makes perfect sense to get our power from the waves," Sanchez said. "I see enormous potential of using wave energy not just for specific projects, like desalination, but ultimately to provide power for hotels and the grid itself, which should be less expensive than fossil fuels. There are many opportunities to fund these projects. We are moving quickly and I'm looking forward to seeing how this relationship can expand."

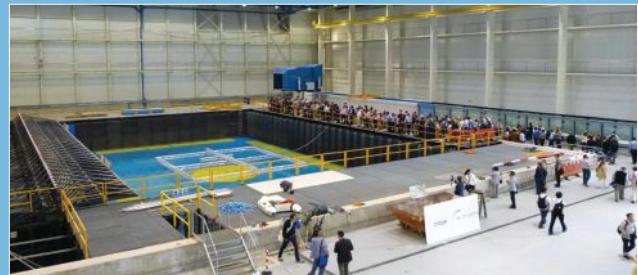
Infocom Connect, a telecommunications company that operates largely in the Middle East, Africa, and India, is moving into the renewable energy industry. They have deep relationships in parts of the world that are ideal candidates for wave energy because of the wave climate and limited options for renewable energy.

For more information, visit
WWW.SEABASED.COM



Image credit: Seabased

MONTH IN REVIEW



MaRINET2 Launches Program of Courses on Offshore Renewables

MaRINET2 has opened registrations for its first set of short duration courses. The courses will be focused on three areas: wave, wind and tidal. Topics include integrated tank testing, hydrodynamics of fixed and floating offshore wind turbine foundations, reliability and risk analysis of ORE technologies, as well as test and verification processes from tanks to the sea.

OGIC Economic Impact Report 2018

By 2023 OGIC funded projects are estimated to generate:



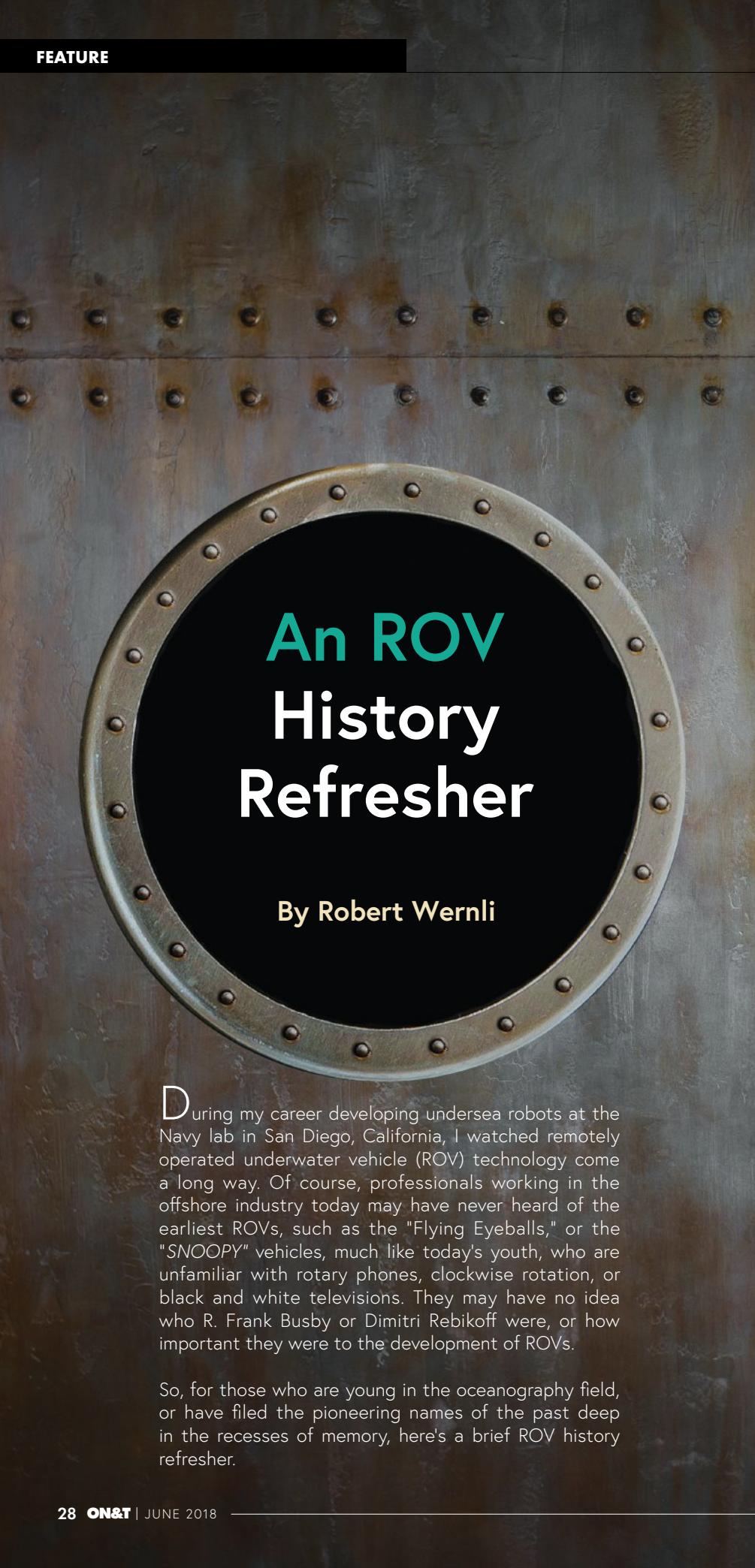
Oil & Gas Innovation Center (OGIC) Funded Projects Generate Jobs

The Oil & Gas Innovation Center (OGIC) reported on May 15, that more than 500 jobs will be sustained or created in Scotland over the next six years as a direct result of its support for research and development.



Petrofac to Support UK Wind Farm Projects

Petrofac has secured a long-term agreement with Transmission Capital to provide engineering services across six of its OFTO (Offshore Transmission Owner) assets. Under the five-year agreement, Petrofac has been awarded two subsea engineering work scopes on key export cables connecting the Lincs and Robin Rigg offshore windfarms with their onshore transmission systems. The FA will enable Petrofac to support future engineering requirements across all of Transmission Capital's OFTO export cables and substations in the Southern North Sea and Irish Sea.



An ROV History Refresher

By Robert Wernli

During my career developing undersea robots at the Navy lab in San Diego, California, I watched remotely operated underwater vehicle (ROV) technology come a long way. Of course, professionals working in the offshore industry today may have never heard of the earliest ROVs, such as the "Flying Eyeballs," or the "SNOOPY" vehicles, much like today's youth, who are unfamiliar with rotary phones, clockwise rotation, or black and white televisions. They may have no idea who R. Frank Busby or Dimitri Rebikoff were, or how important they were to the development of ROVs.

So, for those who are young in the oceanography field, or have filed the pioneering names of the past deep in the recesses of memory, here's a brief ROV history refresher.

DIMITRI REBIKOFF

Frank Busby, who published most of the early underwater vehicle directories, felt that the first ROV was probably built by Dimitri Rebikoff in 1953. Called the *POODLE*, it was a modified version of Rebikoff's diver transport vehicle *PEGASUS*. Used for archeological research, the vehicle was ahead of its time.

In those days, if one wanted something from the ocean, a diver could be used. Divers ruled the underwater world, along with manned submersibles. Rebikoff was a diving pioneer whose other inventions included multiple underwater electronic flash innovations. His interest in expanding the limits of human ocean exploration were obvious motivators.

CURV

The military, however, had a different challenge. It needed a system that could recover lost torpedoes or other objects from the depths of the ocean, using something other than a grappling hook/claw with a camera hanging from a barge. To solve this problem, the Navy awarded a contract to VARE Industries, Roselle, New Jersey, to develop the Mobile Underwater Vehicle System.

Not until serial number six, called the XN-3, was delivered to a U.S. Navy laboratory in 1961 did it become operational. However, even then, it was so unreliable that the laboratory stripped it down to the frame and rebuilt it as the Cable-controlled Underwater Research Vehicle (CURV), which is considered to be the first operational Work Class ROV.

In January 1966, a hydrogen bomb was lost in the Mediterranean Sea when a B-52 bomber collided with a KC-135 tanker near Palomares, Spain. The bomb was located at a depth of 2,900 feet (880 m) by the U.S. Navy submersible DSV Alvin. After Alvin was unsuccessful in recovering the bomb, the Navy brought in CURV-I, which attached grapnels to the bomb, but became entangled in parachute lines. The entangled bomb, parachute, and CURV-I were successfully raised together.

The CURV-I (1965) was now operational, and just in time, because in 1966 an atomic bomb was lost off the coast of Palomares, Spain. The bomb was eventually located in 2,850 feet (869 meters) of water, which was beyond the maximum design depth for the CURV. However, it survived the depths and managed to recover the weapon by getting entangled in the bomb's parachute. CURV and the bomb were recovered and the ROV became instantly famous.



H BOMB 1966

SNOOPY

With the CURV's success, the Navy continued to fund ROV developments, however, mostly for shallower waters. That funding started the development of the SNOOPY vehicles. Weighting around 50 lbs. in water and carrying a 4 lb. payload, SNOOPY (1972) was a small unmanned tethered vehicle developed for underwater observation. Its primary purpose was to function as a shallow-water mobile TV camera. It was equipped with two independently controlled hydraulic thrusters, automatically maintained depth control, an electrically controlled grabber, and lights for the on-board TV camera. Aiming the camera was accomplished by maneuvering the vehicle. The simple and rugged design offered a relatively economical and efficient means to make underwater observations at depths of about 100 feet.

The project was a resounding success, but providing propulsion power via hydraulics from the surface limited the operational depth of the small ROV, which inspired the next generation. The 150 lb. Electric SNOOPY (1974) remote observation ROV was capable of descending to 1500 feet, with electrical power down the umbilical. It was followed by the NAVFAC SNOOPY (1975), which also dove to 1500 feet, but weighed 300 lbs. and was powered by four hydraulic thrusters.

FLYING EYEBALLS

The fact that Navy funding was helping develop the early ROV technology was not missed by Hydro Products in San Diego. With Navy funding they developed their TORTUGA (1960s) vehicles, initially a water jet propelled vehicle, then with small propellers, to be launched from a submarine's torpedo tube. This was followed by the ANTHRO (c. 1970), which investigated anthropomorphic controls, using a "head coupled" video and audio feedback system. Essentially, the technology preserved normal human perception in an extreme environment. It could even be considered a precursor to virtual reality technology, albeit very primitive. Among the innovations these vehicles debuted was the use of clear acrylic plastic that allowed greater pilot visibility while also providing the strength to resist the crushing forces of the depths. Using the technology developed by such vehicles, Hydro Products began producing their commercial line of "flying eyeballs" that were branded RCVs.



The first truly commercial ROVs: Hydro RCV 225 (smaller device) and 150 (larger) with diver. From the historical files of the author.

THE RESCUE SEEN AROUND THE WORLD

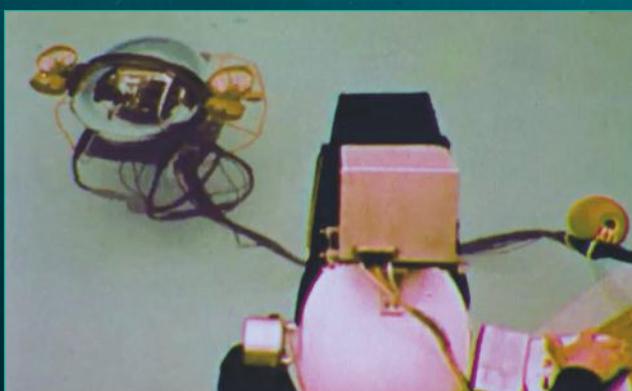
Development continued slowly and even by 1974, only 20 vehicles had been developed. Manned submersibles, which offered the operator the ability to perform work in situ, still ruled. Industry hadn't fully accepted the ROV technology and, of the 20 vehicles developed so far, 17 were funded by governments for scientific research or to support military tasks. The U.S. wasn't the only player: systems were also funded by France, England, Finland, Norway and the USSR.



• In 1973, the rescue of Roger Mallinson and Roger Chapman from Pisces III proved ROV technology on the public stage. From the historical files of the author.



• The Poisson Auto-Propulse (self-propelled fish) or PAP was developed by ECA in the 1970s for underwater mine detection. It had to operate silently, because the slightest noise could trigger a detonation. Sounds dangerous, but the first PAP is still in service for the French Navy, forty years after delivery. Photo courtesy of ECA.



• ANTHRO, a transparent hulled unmanned vehicle, provided remote viewing of the undersea environment. The operator's vision was coupled to the vehicle using a helmet. As the operator moved his head, the vehicle and its camera responded in like fashion. Images courtesy of U.S. Navy.



What the industry needed was something to put its capabilities on center stage. That opportunity came in 1973. The U.S. Navy's CURV vehicle had transformed into a "flyaway" system that could be flown around the world in an emergency. Near Cork, Ireland, the *PISCES III* manned submersible was trapped on the bottom in 1575 feet (480 meters) of water. Two men were aboard—Roger Mallinson and Roger Chapman—but they were losing oxygen, and saving their lives would require the deepest sub rescue in history.

It took 76 hours to fly there, deploy, and reach the site of the sinking. With only seconds of air left for the two occupants, a final recovery line was attached to the vehicle with a "Rube Goldberg" toggle bolt made on-site using a crescent wrench, two pieces of steel channel and some bungee cord. Finally, ROV technology had hit the front pages worldwide and acceptance was beginning.

ROVS ACCELERATE

During the next eight years, the development of ROVs accelerated, and by the end of 1982 over 500 vehicles had been developed. Prior to that time, 85 percent of the vehicles were developed using government funding. But for the 350 new vehicles developed and constructed during that period, 95 percent were funded by private industry. And, those numbers do not include the over 200 PAP-104s, manufactured by Societe Eca, Meudon, France, for mine countermeasures.

The rather inexpensive PAP-104 was battery operated and hugged the bottom by dragging a weight suspended below as it searched for the target. After delivering the explosive charge, the vehicle was recovered, and the charge detonated from the surface.

San Diego was becoming the center of ROV activity, with not only the local development of the vehicles, but most supporting technologies including cameras, cables, lights, etc. In addition to the product line that Hydro Products was developing, AMETEK, Straza Division, also in San Diego, developed the Deep Drone vehicle for the government. This was the beginning of AMETEK's SCORPIO line of vehicles. Another spin off of government developments was the RECON line of vehicles manufactured by Perry Offshore in Florida that were based on the U.S. Navy's NAVFAC SNOOPY vehicle design.

The U.S. Navy began to focus on deep vehicle technology that would provide them with the capability to recover objects at depths to 20,000 feet, which would cover 98 percent of the ocean. And, industry, primarily offshore oil and gas, began to focus on developing smaller, lighter and more reliable vehicles, a goal that was in proportion to the advancements made in the miniaturization of the onboard electronics.

Now, I don't want to forget the development of many, many vehicles around the world, especially those in support of the advancing offshore developments in the North Sea. To discuss all would take some time, and they were as diverse as their creative names, which included: *DART*, *SPIDER*, *SEA OWL*, *SAAB-SUB*, *AMPHORA*, *IZE*, *BOCTOPUS*, *SMARTIE* and *SEA SPY*.

A TECHNOLOGY WHOSE TIME HAS COME

As we entered the 1980s, the technology and acceptance of the ROVs, especially in the offshore industry, was accelerating rapidly. At that time, I had the pleasure of chairing the ROV Committee of the Marine Technology Society. Our committee was centered in San Diego, but we had a diverse international membership. And with the ROV and related technology located in San Diego, we decided to conduct the first conference dedicated to ROVs. So, the ROV '83 conference was initiated and held with the rally cry theme: "A Technology Whose Time Has Come!" And come it had.

The conference was highly successful and during the next decade was held six times in San Diego in addition to Aberdeen, Scotland; Bergen, Norway; Vancouver, BC; and Hollywood, Florida. Because of the acceptance and interaction of ROVs with the diving industry, and the use of manned submersibles, the conference adapted an umbrella title of Underwater Intervention. In 1993, the MTS conference was joined by what is now the Association of Diving Contractors International and moved to New Orleans where it is still held annually.

The worldwide growth of the ROV industry was increasing. There was only one industrial manufacturer of ROVs in 1970, and by 1984 there were 27. Although expanding internationally, 229 of the 340 industrial vehicles produced after 1975 were developed in North America by Hydro Products, AMETEK (Straza Division) and Perry Offshore in the U.S., and ISE in Canada.

So, what happened? Well, a couple of things. First was the dollar vs. the pound. With the expansion of the North Sea industry, much of the technology was transferred to the United Kingdom to support the oil patch operations. And, by the mid-eighties, the dollar and the pound had neared parity, so it was becoming cheaper to develop the vehicles in the UK than to build them in the U.S. and ship them overseas. And, the emergence of companies like Slingsby Engineering, Sub Sea Offshore and others increased the competition.

As a result, the only survivors of the big four in North America were ISE and Perry. ISE survived due largely to its diverse line of vehicles and "can do" attitude. Perry saw the future and teamed with its European competitors to establish a foothold in the North Sea. As for Hydro-Products and AMETEK, they eventually fell by the wayside. They are gone, but as you just read, their legacy lives on. RIP.

I hope you enjoyed this brief refresher for those of you who were not in the ROV arena prior to 1990. And for those old enough to remember, hopefully this took you back to some of the classics.

AUTHOR BIO: Robert Wernli, whose career has revolved around undersea robotics and work systems, is widely published in the field. The ROV Manual, 2nd edition, which he co-authored, is his latest technical publication. He is also an award-winning fiction author of undersea techno-thrillers. www.wernlibooks.com.



• The Navy's CURV-III ROV. This Cable-controlled Underwater Recovery Vehicle was designed to work to 7,000 feet, though for life-saving operations, it could descend up to 10,000 feet. Photo courtesy of U.S. Naval Undersea Museum.



• Remotely operated vehicle Deep Drone was a Navy-built ROV used for deep ocean salvage and emergency rescue missions in the 1970s and 1980s. It was the first in a series of three Deep Drone vehicles. Today the Navy operates the third-generation Deep Drone 8000. Photo courtesy of U.S. Naval Undersea Museum.



• Perry's RECON IV. From the historical files of the author.



Doggerland Exploration Continues

Seismic Data and DNA Sampling Are Raising Europe's Lost Civilization

The only lands on Earth that have not been explored in any depth by science are those that have been lost to the oceans. Large continental shelf areas, presently submerged, were dry land during the last glacial maximum and early postglacial time, but the end of the last Ice Age led to the inundation of vast landscapes that had once been home to thousands of people.

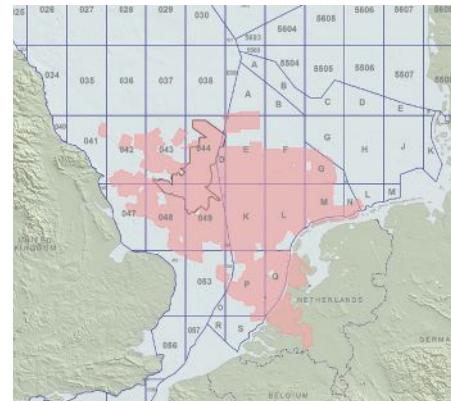
These lost lands hold a unique and largely unexplored record of settlement and colonization. Among the most significant examples are Sundaland, connecting the Malay Peninsula to Borneo, Java and Sumatra; Beringia, connecting Asia to America over the Bering Strait, and Doggerland, occupying much of the North Sea basin between continental Europe and Britain.

Such inundated landscapes cannot be explored conventionally. However, the Bradford-led Lost Frontiers project—with invaluable help from the oil and gas industry—created the first detailed topographic maps of Doggerland. The breakthrough came when members of

this project were able to show that extensive seismic reflection surveys carried out for other purposes, notably petroleum exploration, could be used to map the topography of ancient drowned and buried landscapes.

This led to the initiation of the *North Sea Palaeolandscapes Project* (beginning 2005), which has now mapped some 45,000km² of inundated prehistoric landscape, an area somewhat larger than the Netherlands. The mapping has been achieved mainly using 3D seismic data donated by PGS (Petroleum Geo-Services) from their *Southern North Sea Mega Merge*.

The *Mega Merge* combines more than 60 different surveys, carried out at different times and by various groups, migrated into a single data set. Analysis of the top slices of this huge 3D seismic data set has involved much methodological innovation and resulted in maps showing the rivers, lakes and hills, coastlines and estuaries, wetlands and salt marshes of a large part of Doggerland, sometimes in extraordinary detail. The seismic reflection data, provided at no cost



The *North Sea Palaeolandscapes Project* utilized 3D seismic data donated by PGS from their *Southern North Sea Mega Merge*, originally developed to provide a tool for researching sub- and supra-salt plays and to characterize existing offshore oil discoveries.

for research purposes, required the expenditure of several hundred million Euros to collect. The use of this data for a purpose that was not intended—the mapping of Holocene landscapes—is highly innovative, currently unique and constitutes extremely cost-effective research.

EXPLORING BROWN BANK

In April 2018, marine experts joined archaeologists in a two-year expedition to search for prehistoric, submerged settlements around the area of the Brown Bank within the southern North Sea. Teams from the University of Bradford, Ghent University and Flanders Marine Institute (VLIZ) are joining forces to carry out detailed geophysical surveys of the area, before extracting sediment cores that can be examined for evidence of human activity.

Archaeologists have long suspected that the southern North Sea plain – right in the heart of Doggerland – may have been home to thousands of people. Chance finds by trawlers and fishermen over many decades support this theory.

A concentration of archaeological material, including bone, stone and human remains, have been found within the area around the Brown Bank, an elongated, 30 km long sand ridge roughly 100 km due east from Great Yarmouth and 80 km west of the Dutch coast. The quantities of material suggest a prehistoric settlement may be close by.

Recent studies by researchers at Ghent University have narrowed the search. They have identified river systems running across the southern North Sea at the end of the last Ice Age. Using this information, they have pinpointed a particular area in the Brown Bank where they believe there was once a large lake, at the edge of which could once have been a settlement.

In the first phase of the project, the teams from Belgium and Britain started to explore the area using the Belgian research vessel *RV Belgica*. In mid-April 2018, they carried out geophysical surveys around the Bank to provide detailed mapping of the area. The team acquired 2D seismic-reflection data using a centipede SPARKER source, very high-resolution sub-bottom profiles by means of a SES-2000 quattro

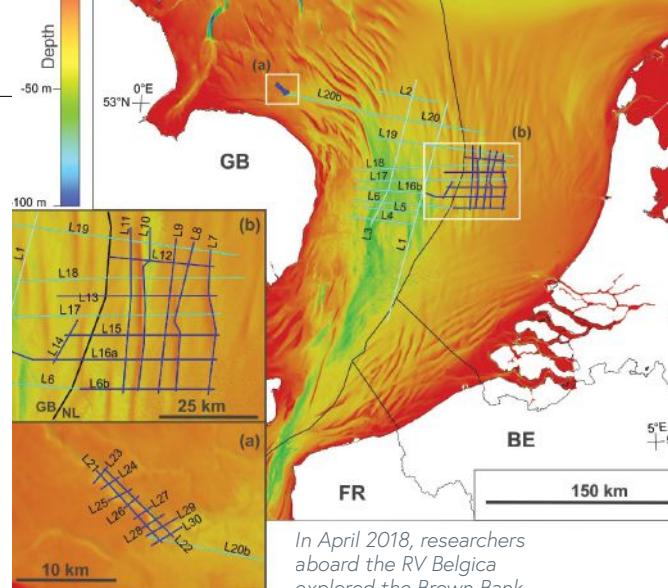
echosounder, and multibeam bathymetric swaths using the multibeam echosounder. Electrical propulsion and an average speed of four knots were maintained during data acquisition.

Areas of interest for video survey and grab sampling were also selected during the last couple of survey days, after a preliminary analysis of seismic data to locate sampling sites. Seismic reflection profiles were subjected to preliminary processing on board in the survey room. The researchers also had the option of interrupting the geophysical survey at any moment to collect video and/or grab samples. The results of this work will be used to identify promising areas for further examination.

It could take a while for results from this latest phase to be published, but Professor Vincent Gaffney from the University of Bradford said that locating a prehistoric settlement on the Brown Bank would be a major event: "Until now the majority of Doggerland has been terra incognita in archaeological terms. If we can begin to locate settlement across the, currently, empty map of the Doggerland, we would open a new chapter in archaeological exploration."

Dr. David Garcia Moreno from Ghent University said, "Confirmation of the location of a prehistoric lake near the Brown Bank and the characterization of the fluvial system associated with it would be a breakthrough. Such a discovery would have vast implications in our understanding of the palaeogeographic evolution of northwestern Europe since the last Ice Age."

In the second phase of the Brown Bank project, the team will extract sediment cores from these targets and analyze them to determine the environment of the landscape underlying the Brown Bank and to understand its potential for human settlement prior to inundation by the North Sea.



In April 2018, researchers aboard the *RV Belgica* explored the Brown Bank area of the North Sea, where they believe there was once a large lake, at the edge of which could once have been a settlement.

Dr. Tine Missiaen from Flanders Marine Institute said, "Submerged landscapes and human settlement in the North Sea did not stop at borders. International collaboration is indispensable to unravel this unique episode in Europe's prehistory. Only the integrated use of novel state-of-the-art techniques will allow us to map and reconstruct these drowned landscapes and settlements with unprecedented detail."

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JW FISHERS' PT-1; Pipe Tracking Made Easy for Land and Sea



What do modern day people and ancient Egyptians have in common? You guessed it; underground piping! It has been discovered that the very first metal piping can be traced back thousands of years to copper pipes buried and used by Egyptians to carry wastewater. The first manufacturers of modern metal pipes, however, first appeared well over a century ago in Great Britain.

Anyone who works with or near covered piping can attest to the importance of knowing exactly where existing pipes lie before undertaking dredging operations or when new pipes and cables are placed. But no matter what material is used to manufacture buried or undersea piping, keeping track of these complex systems has been a challenge from the very beginning. The Global Positioning System (GPS) constellation of satellites revolutionized efforts to combat this tracking issue.

For undersea pipes, regulations require they be buried from several feet to several meters under the bottom to prevent snagging by anchors and fishing. Additional and increasingly strict rules exist for piping in heavily polluted areas. This depth of burial makes it very difficult to locate these pipelines with conventional metal detectors as they are often beyond the device's detection range.

JW Fishers Mfg. has developed a solution to this increasingly challenging task in the form of the PT-1 Pipe Tracker. This "pinpointing" magnetometer is designed to detect variations in pipeline (couple or ends) to help aid in tracking and location. One geological survey company, Lighthouse, has successfully used JW Fisher's PT-1 Pipe tracker on a project in the Caspian region of Eurasia.

In 2017, the large survey company Lighthouse was subcontracted by a client to provide data on the shore-approach section of two 32 inch and one 16 inch export pipelines in the Caspian Sea. The objective of the survey was to align the landfall tie-in point, the nearshore section and, the land section. The main challenge faced by the project team was to identify a suitable pipe tracker that could operate both on shore and underwater while still producing reliable, high-quality data. After expert consultation, Lighthouse chose the right tool for the job and made JW Fishers part of their team with the PT-1 Pipe tracker.

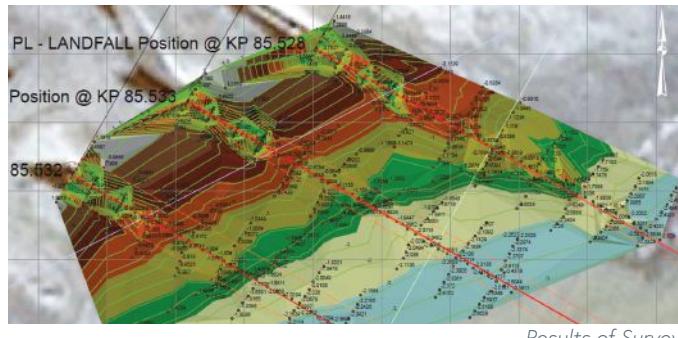
Position fixes were taken on the exposed section of the pipeline and measurements were taken directly over the target. The PT-1 Pipe Tracker helped the survey team to identify the pipeline and take fixes on centerline with high precision. The system enabled the project to be carried out safely, within prescribed specifications, and on-schedule. The multi-use nature of the PT-1 eliminated the need for separate land and water-certified systems. This produced a single data-output, drastically reducing data integration tasks and speeding up Lighthouse's ability to deliver precise data to its client both quickly and efficiently.

The dual usage of both land and underwater surveys makes the system more flexible for the end user, and there are very few cost-effective solutions on the market that can match the capability of JW Fishers' PT-1 Pipe Tracker. Lighthouse plans to continue using JW Fisher's systems in order to provide its clients with cost-effective survey solutions in the highly competitive offshore survey industry.

For more information, visit
WWW.JWFISHERS.COM



Near Shore Section



Results of Survey

Forum Delivers ROV to the University of Limerick

Forum Energy Technologies, Inc. has delivered a remotely operated vehicle (ROV) to the University of Limerick (UL) to support its research into subsea inspection and intervention campaigns on renewable energy sector infrastructure.

Designed and manufactured in-house at Forum's Kirkbymoorside Yorkshire facility, the Comanche 2,000 meter observation class ROV was selected due to its high thrust-to-drag ratio enabling it to operate in strong currents, typical conditions for the offshore renewables industry. The ROV is equipped to a high specification with precision positioning and navigation systems, camera and lighting systems and sonars. The systems will be used as a test bed for research to develop capabilities for inspection, maintenance and repair work on Marine Renewable Energy (MRE) infrastructure in the challenging strong wave and current conditions at MRE test-sites and offshore MRE sites in Ireland and further afield. The ROV system is home ported at Limerick Docks in the Republic of Ireland.

Researchers at UL's Centre for Robotics and Intelligence Systems (CRIS) further enhanced the system with UL-



developed advanced control software (OceanRings), precision navigation and flight control, state-of-the-art robotic imaging and sonar systems and fully automated manipulator systems.

The vehicle will be housed at Limerick Docks where experimentation, testing and demonstration will be carried out. It will also be mobilized on vessels at other ports in Ireland.

Kevin Taylor, Vice President for Subsea Vehicles at Forum, said, "We are very pleased to see the delivery and launch of Forum's Comanche ROV which will support the University of Limerick's renewables sector research team. The inspection and maintenance of subsea infrastructure is vitally important to the longevity and sustainability of subsea assets and this observation class ROV is a perfect fit for these types of projects. For more information, visit www.f-e-t.com.

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Shark Marine Technologies Inc. www.sharkmarine.com sales@sharkmarine.com Ph: (905) 687 6672

Okeanus Delivers Innovative ROV Launch & Recovery System

Okeanus Science & Technology, LLC, has delivered a self-contained, Rapid Mobilization ROV Launch & Recovery System to Phoenix International Holdings, Inc., in Largo, Maryland.

The fully integrated system, designed and built to launch and recover a free-flying remotely operated vehicle (ROV), contains a winch / levelwind assembly, self-erecting A-Frame, docking head / over-boarding sheave assembly and electro-hydraulic power unit, all mounted to a single skid. This innovative design allows the entire system to be placed into an ISO flat rack for ease of transport and deployment. To further facilitate rapid mobilization, the ROV is stored on the skid assembly during transport.

The winch assembly provides a full drum safe working load of 14,678 N (1,467 Kg, 3,300 lbs.) at a full drum line speed of 0.50 m/s (30 ppm, 100 fpm). The winch drum is capable of holding 939 meters (3,080 ft.) of 26 mm (1.03 in.) outside

diameter umbilical. The system A-Frame provides a safe working load luffing / overboard of 14,678 N (1,467 Kg, 3,300 lbs.), an over-boarding reach of 3,023 mm (119 in.) and width between legs of 1,930 mm (76 in.). The system docking head provides a cushion / latch assembly to secure the ROV and features swing in-out and rotate capability for safe launch-recovery.

The entire handling system, which was designed and built in accordance with ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities (2017), is powered by an Okeanus-supplied 18 kW (25 HP) electro-hydraulic power unit which is also stored on the skid assembly during transport.

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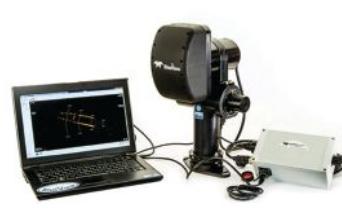
Zoom Capabilities - 12x optical zoom in 4K UHD and HD output formats. Visually lossless digital zoom up to 20x in 4k UHD and 24x in HD output formats.

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MONTH IN REVIEW



Inspiration for Stonehenge Undersea?

The Travel Channel will air Origins of Stonehenge on June 13 at 8pm EST, which shows how Teledyne BlueViews 3D Multibeam Scanning Sonars were used to find and map a network of undersea monuments believed to be the original inspiration for Stonehenge. Video at www.oceannews.com/news/subsea-intervention-survey/finding-the-origins-of-stonehenge-with-a-teledyne-blueview-3d-multibeam-scanning-sonar.



DeltaTek Attracts Operators During Subsea Innovation Field Trials

DeltaTek Global has announced two successful onshore field trials of its SeaCure subsea cementing system, resulting in subsequent offshore trials in live North Sea wells operated by Chevron and Siccar Point Energy. www.oceannews.com/news/subsea-intervention-survey/deltatek-attracts-operators-during-subsea-innovation-field-trials



Implementing Maritime Open Architecture Autonomy on Riptide UUVs

Riptide Autonomous Solutions and Draper have agreed to implement Maritime Open Architecture Autonomy on all Riptide unmanned undersea vehicles (UUVs) delivered to the U.S. Government, beginning in the second quarter of 2018. www.oceannews.com/news/subsea-intervention-survey/implementing-maritime-open-architecture-autonomy-on-riptide-uuv



Rovco to Launch Live 3D Subsea Technology

Rovco has secured a £1.2 million investment, enabling the firm to launch its advanced live 3D subsea survey system and triple its workforce. www.oceannews.com/news/subsea-intervention-survey/rovco-to-launch-live-3d-subsea-technology



Teledyne RESON SEABAT T50-R Extended Range Delivered to Greenland

R/V SANNA was modified to accommodate the new SeaBat T50-R Extended Range multibeam system. Greenland's Institute of Natural Resources will use the tool to assist scientific projects. www.oceannews.com/news/subsea-intervention-survey/teledyne-reson-seabat-t50-r-extended-range-delivered-to-greenland



The Underwater Center Under New Ownership

Industry and public bodies have collaborated to support The Underwater Centre, a subsea training and trials center located in the Scottish Highlands. The company will now operate as a not-for-profit funded and supported by operators, service companies and industry. www.oceannews.com/news/subsea-intervention-survey/the-underwater-center-under-new-ownership



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Global Offshore Oil & Gas Communications Report and Forecast Sees Growth Ahead

The "Global Offshore Oil & Gas Communications Market - Segmented by Solutions, Communication Network Technology, and Region - Growth, Trends, and Forecast (2018 - 2023)" report has been added to ResearchAndMarkets.com's offering.

According to the report, the offshore oil & gas communications market is projected to grow at a compound annual growth rate (CAGR) of 7.2 percent over the forecast period 2018-2023. The scope of the report includes solutions and communication network technology. The regions included in this study are North America, Europe, Asia-Pacific, Latin America, and Middle East and Africa.

Communications between offshore facilities and onshore locations some time back were limited to a two-way radio and daily reports. Oilfield workers stationed offshore were cut off from the rest of the world virtually. However, with advancements in communication technologies, the way the offshore industry works has been transformed.

Telecom-based Technological Growth to Drive the Market

Offshore communications have come a long way. Now the real-time communication networks not only allow for personal cell phone use and Wi-Fi connectivity, but also provide real-time transfer of offshore data to onshore offices. Allowing for totally subsea developments and remote unmanned, offshore industry works have been transformed by improved communication systems.

There are several communication technologies that can now work singly or in a system to solve offshore communications challenges. The most commonly chosen solution for offshore communications are satellite communications, which require a very small aperture terminal (VSAT) at the offshore site and are used many times for vessels that may be in extremely remote locations or on the move. With the help of microwave telecommunications technology, data is transported via wavelengths that measure less than one meter in length. These microwave solutions are chosen for locations that are within proximity to each other.

Fiber optical telecommunications are chosen for locations that are in high traffic areas, such as the North Sea or U.S. Gulf of Mexico. Even cellular telecommunications services can be accessible at some places offshore. U.S. Gulf of Mexico has cellular towers installed offshore that allow these cellular communications from rigs and platforms near the coast to onshore locations. All these technologies will lead to the growth of the offshore oil and gas communications market.

North America is Expected to Dominate the Market

North America is expected to be most attractive region and will hold largest market share in the offshore oil and gas communications market over the forecast period. This region is said to be the pioneer in this market as it is also the largest oil and gas producer, with companies seeking advanced digital solutions for offshore field operations. The U.S. accounts for largest market share in this region. Besides, capital spending on the oil and gas industry will increase in 2018, which will trigger the growth of the offshore oil and gas communications market.

Companies mentioned in the report include ABB Ltd., Alcatel Lucent S.A., Baker Hughes Incorporated, CommScope Inc., Rignet Inc., AT&T Inc., ERF Wireless Inc., Redline Communications Inc., ITC Global Inc., Harris CapRock Communications Inc., Hughes Network Systems LLC, Huawei Technologies Co. Ltd, SpeedCast International Limited, Tait Communications, Airspan Networks Inc., and Commtel Networks Inc.

For more information, visit

WWW.RESEARCHANDMARKETS.COM/RESEARCH/2VNFS7/GLOBAL_OFSHORE?W=4

IMO: Iridium and BeiDou Enter Maritime Safety Market

Satellite firm Inmarsat has seen its global monopoly over the maritime distress signal industry broken after the UN opened up the contract to rivals Iridium and BeiDou Navigation Satellite System.

The International Maritime Organization's (IMO) Maritime Safety Committee has agreed to add Iridium to the contract as supplier of distress signal equipment to the maritime industry. The IMO also agreed to adopt a "statement of recognition" proposed by the United States.

Iridium said the MSC's decision "ends a decades-long satellite industry monopoly" which saw UK-based Inmarsat as the only company authorized to provide satellite Global Maritime Distress and Safety System (GMDSS) services.

"This is a historic moment for the maritime industry and an honor for Iridium to be the second ever recognized provider for GMDSS services," said Bryan Hartin, executive vice president, Iridium.

"This is the dawn of a new era for mariner safety. We'll bring a new choice and upgraded capabilities for mariners along with our truly global coverage that will for the first time extend the reach of satellite-based GMDSS to even the most remote waterways."

Iridium said it plans to launch a service in 2020, while BeiDou could not be reached for comment. Inmarsat offered its congratulations to rivals, and announced the launch of its own new safety service. It already offers services to 160,000 vessels worldwide, which it provides at no charge.

"I would like to congratulate Iridium on achieving approval from the IMO to take their GMDSS proposals to the next stage," said Ronald Spithout, president of Inmarsat Maritime, "and also congratulate BeiDou Navigation Satellite System on their successful request for GMDSS evaluation by the NCSR sub-committee. We look forward to welcoming them both as GMDSS service providers in the coming years.

"Together, we must strive to maintain and enhance the exceptionally high



standards required by the IMO and demanded by the maritime industry as the lifeline for seafarers at sea."

For Iridium, the announcement came as it completed the launch of five NEXT satellites from Vandenberg Air Force Base in California. The satellites will form part of a 10-strong constellation which will provide aviation, maritime, land mobile, and internet of things connectivity, including Iridium's broadband offering Certus.

The \$3 billion NEXT project is scheduled for completion this year and will bring users an upgraded infrastructure using Iridium's L-band spectrum, but with higher throughputs and faster speeds, it claims.

Source: www.capacitymedia.com/Article/3808921/News/Inmarsat-loses-GMDSS-monopoly-as-Iridium-and-BeiDou-enter-maritime-safety-market

An advertisement for SIDUS featuring a diver in a yellow suit and green helmet, holding a light and a circular porthole. The background is a blue underwater scene. The SIDUS logo is at the top left, and the tagline "ENGINEERED to withstand your ENVIRONMENT!" is in the center.

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A close-up photograph of a black industrial-grade laser device mounted on a tripod. A bright red laser beam is visible, pointing towards the right side of the frame.

AI BOOSTS SPECTRAL EFFICIENCY IN SUBMARINE CABLE NETWORK PERFORMANCE

NEC Corporation has completed successful transmission tests that took place over a commercial subsea cable measuring more than 10,000 km using artificial intelligence (AI) and probabilistic shaping at a modulation of 64QAM.

In a joint research publication with Google, NEC demonstrated for the first time that the FASTER open subsea cable can be upgraded to a spectral efficiency of 6 bits per second per hertz (b/s/Hz) in an 11,000 km segment. This represents a capacity of more than 26 terabits per second (Tb/s) in the C-band, which is over 2½ times the capacity originally planned for the cable, for no additional wet plant capital expenditure. In doing so, the authors set a spectral

efficiency-distance product record of 66,102 b/s/Hz in a field trial performed together with live traffic neighboring channels.

The team achieved this result using near-Shannon probabilistic-shaping at a modulation of 64QAM, and for the first time on a live cable, artificial intelligence (AI) was used to analyze data for the purpose of nonlinearity compensation (NLC). NEC developed an NLC algorithm based on data-driven deep neural networks (DNN) to accurately and efficiently estimate the signal nonlinearity.

"Other approaches to NLC have attempted to solve the nonlinear Schrodinger equation, which requires the use of very complex algorithms," said NEC's Mr. Toru Kawauchi, General Manager, Submarine Network Division. "This approach sets aside those deterministic models of nonlinear propagation, in favor of a low-complexity black-box model of the fiber, generated by machine learning algorithms. The results demonstrate both an improvement in transmission performance and a reduction in implementation complexity. Furthermore, since the black-box model is built up from live transmission data, it does not require advance knowledge of the cable parameters. This allows the model to be used on any cable without prior modeling or characterization, which shows the potential application of AI technology to open subsea cable systems, on which terminal equipment from multiple vendors may be readily installed."

The field trial results were presented at the post-deadline session of the Optical Fiber Communication Conference and Exhibition 2018 in San Diego, California. The experimental demonstration of NLC achieved a generalized mutual-information (GMI) capacity gain of ~0.15 b/s/2-pol, which is equivalent to a capacity increase of 15 gigabits per second (Gb/s) in every 100GHz of fiber bandwidth. NEC plans to continue this AI-based research, with the dual aims of increasing system capacity while reducing the complexity of implementation.

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Installation of Cameroon-Brazil Cable System Begins

Cameroon Telecommunications (CAMTEL) has launched installation of the first submarine cable system to directly connect Africa and South America. Called South Atlantic Inter Link (SAIL), the optical fiber links Kribi, Cameroon and Fortaleza, Brazil.

According to CAMTEL, a cable-laying boat carrying 6000 km of submarine cable left the Norwegian coast on March 21 and landed in Kribi on May 16.

Next, the boat proceeded to installing the cable with the assistance of Huawei Mobile. Huawei expects to take 60 days to lay the 6,000 km-long SAIL, and has a target date for completing the installation at the end of August 2018. SAIL will operate at 32 Tbps using 100G technology.

Speaking about the project, Cameroon's Minister of Posts and Telecommunications, Minette Libom Li Likeng, said the project falls within the framework of the national program Broadband Network 2.

For CAMTEL's Managing Director, David Nkoto Emane, the project whose installation speed is 80 to 120 km per day, will propel Cameroon have its digital independence. He says it will place Cameroon among the twenty or so African countries to have submarine cables and whose national economy should derive significant benefits.

Fortaleza, Brazil is a landing station for more than a dozen subsea cables including MONET, the 10,556 km cable system owned by Algar Telecom, Angola Cables, Antel and Alphabet, which runs north to Miami and south to Santos in southern Brazil.



MONTH IN REVIEW

Seaborn Networks Selects EdgeConneX Buenos Aires Edge Data Center

Seaborn Networks, a developer-owner-operator of submarine fiber optic cable systems, has selected EdgeConneX's Buenos Aires Edge Data Center (EDC) as the Point-of-Presence (PoP) in Argentina for Seaborn's ARBR submarine cable. www.oceannews.com/news/communication/seaborn-networks-selects-edgeconnex-buenos-aires-edge-data-center

TE SubCom Announces Ocean Control Suite

By enabling automated control over all parts of a communications network, the Ocean Control suite offers extensive remote programmability and control of an entire communications network, both terrestrial and undersea. www.oceannews.com/news/communication/te-subcom-announces-ocean-control-suite

Vocus Names Kevin Russell as New CEO

Vocus has turned to industry veteran Kevin Russell to be its group managing director and chief executive officer, beginning May 28, 2018. www.subcableworld.com/newsfeed/international-carriers/vocus-names-kevin-russell-as-new-ceo

MTN Group Still Expects to Submit Applications for Initial Public Offering in 2018

According to a company spokesperson, MTN Group is perfecting the details of its proposed Nigeria Initial Public Offering (IPO), adding that they expect the IPO process to be concluded during 2018. www.subcableworld.com/newsfeed/fiber-optic-cables/mtn-group-still-expects-to-submit-applications-for-initial-public-offering-in-2018

Three Groups Shortlisted as Final GCX Bidders

Three groups have been shortlisted as final bidders for Global Cloud Xchange (GCX), the international subsea network that also has enterprise and data center operations in India. The final bids were originally due in mid-May, but GCX has delayed the process until the future of its current owner, Reliance Communications (RCom), is settled. www.subcableworld.com/newsfeed/fiber-optic-cables/report-three-groups-shortlisted-as-final-gcx-bidders

EMACOM and EllaLink to Connect Madeira to Mainland Portugal

EMACOM and EllaLink have signed a contract committing to connect the islands of Madeira with a dedicated fiber pair on the EllaLink Submarine cable system. www.subcableworld.com/newsfeed/fiber-optic-cables/emacom-and-ellalink-to-connect-madeira-to-mainland-portugal



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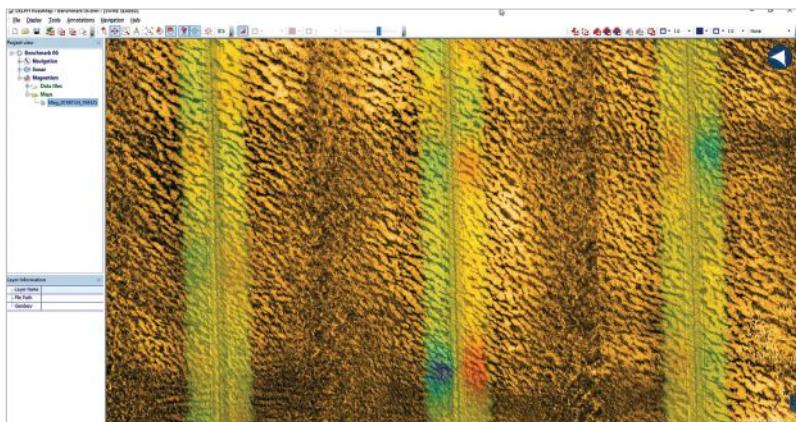
For more subsea telecom stories, visit SubCableWorld.com



DELPH SOFTWARE: ON THE HUNT FOR MISSING FLIGHT MH370

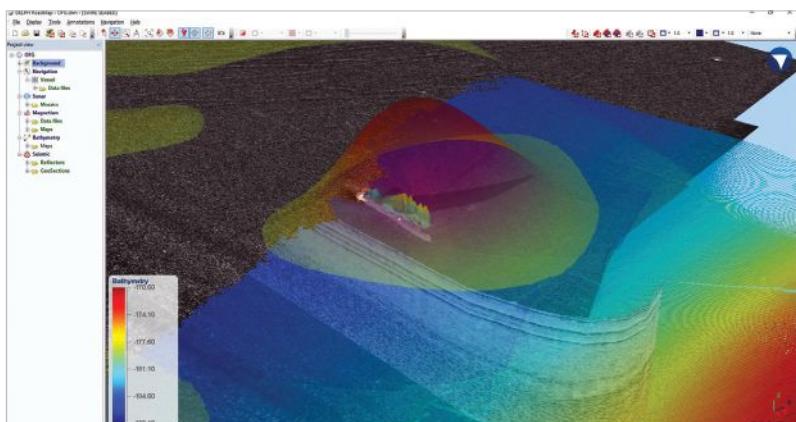
Surveying the oceans in the 21st century requires something new. For ultra-deep-water exploration, emerging countries need a cost-effective means to map their economical areas and subsea resources. In more shallow water as well, the space allocated to the development of renewable energies at sea requires major mapping capabilities that were only available in the oil and gas market a decade ago. Humanity is now aware that its future lies at sea.

Ocean Infinity - Seabed Constructor



DELPH Sonar and Magnetometer

In this view, iXblue Sonar division developed the Delph software suite that focusses on the acquisition and processing of geophysical data. From the tight integration of sensors to cartographic deliverables, Delph software handles the transformation from raw side-scan sonar, seismic and magnetometer data to mapping products in a very logical and ultra-efficient workflow. Soon adopted by major oil and gas contractors to boost their deliveries, a strong effort was made on the automation of every single task in order to better rely on computer power to work, thus maximizing the time available for geophysicists to work on their added value in data quality control and interpretation. Because no single sensor provides all the necessary information, quickly combining all survey data into a single 3D cartographic environment reduces the risk for errors and ensures a better understanding of the complete dataset.



DELPH - Multisensor

iXblue Delph software performance and optimized workflow has been a great improvement in various sectors where seabed data is a routine production line or when smaller size survey companies need to cope with the vast amount of data created in marine renewable energies surveys for windfarm development. In October 2016, Norway based subsea operations specialist Swire Seabed AS came to iXblue to evaluate the performance of its Delph software. Swire Seabed AS was indeed contracted by Ocean Infinity to process the huge data amount produced by their fleet of eight autonomous underwater vehicles (AUVs) that simultaneously map the seabed. Delph was already in use for various single-AUV projects where geophysicists are under pressure to cope with the data from every



dive before the next ones come on the deck. Swire Seabed AS was thus challenged to increase the survey efficiency by operating multiple AUVs while keeping a limited geophysical processing team on a single main vessel. After successful benchmarking and trials, Delph is now the processing solution onboard the Seabed Constructor vessel for dealing with the side-scan sonar, sub-bottom profiler and magnetometer data. While each AUV acquires data for more than 48 hours, there is much less time between the launches and recoveries on the vessel. All data must be processed in less than four hours with minimal human actions, leaving another 10 hours for geos to QC and interpret each AUV dataset. Automating the processing and data production tasks thus allows Swire Seabed to deliver fresh AUV data in less than 24 hours to their customers with an unpreceded coverage rate.

Since January 2018, Ocean Infinity and its partner Swire Seabed have been contracted to operate this multi-AUV solution in the Pacific Ocean to take over the search of missing flight MH370 that suddenly disappeared in March 2014. Not only is the Pacific the largest and least mapped ocean, but depths in such a wide area are high and extremely varying. A first search area of 60,000 km² was established and the search effort, still using conventional technology, lasted for three years with no hit. Ocean Infinity and its partner Swire Seabed now operate the Seabed Constructor and its fleet of eight deep-water AUVs and as many unmanned surface vehicles (USVs) for their positioning. Each AUV acquires side-scan sonar, sub-bottom profiler and magnetometer data that are processed by iXblue Delph software. The produced maps and interpretation are further integrated in an ESRI ArcGis server that streams the cartographic results to the end-client in short time. Operating multiple autonomous vehicles has a multiplier

effect that brings the complete survey solution to a whole new level. In terms of vessel architecture, a vast workplace is devoted to the multi AUV maintenance, launch and recovery, a carousel for deploying all USVs. The IT infrastructure must also cope with the terabytes of data generated and powerful terminals for the geophysicists to process and interpret full datasets. This being all optimized in the view of limiting the crew and rely as much as possible on surveying and processing automation that is now available. In less than a first survey week, Ocean Infinity reported that 4,500 km² out of the 25,000 km² of the primary search had already been surveyed and delivered. The Seabed Constructor now progresses to cover the remaining thousands of km² at great speed, providing high resolution data collected from the deep.

Jan Arvid Ingulfsen, Senior Advisor Survey & AUV Operations at Swire Seabed AS says: "Ocean Infinity's focus of efficient autonomous operations is a game changer in the seabed mapping area. The efficiency of using multiple AUVs challenges the whole market to be more cost-efficient in all aspects of the survey industry. When acquiring data up to 8 times faster than our competitors it is of vital importance we have software that are extremely efficient in handling all these data."

As the world moves on to artificial intelligence and automation of all time-consuming tasks, iXblue keeps on bringing innovative and powerful solutions that combine integrated survey platforms, sensors, and software that are market and user-oriented. The company brings cost-effective up-scaling capabilities to survey companies and meet with the 21st century challenge of mapping the entire underwater world.



Caption: Artist impression of the Russian Navy's ice-classed cable ship, Volga.

Russia Plans to Link Military Installations Via Trans-Arctic Fiber Cable

According to the Barents Observer, Russia plans to lay trans-Arctic fiber cable linking military installations in 2019. Starting in Severomorsk on the Kola Peninsula, the fiber optic line will provide state-of-the art tele- and data communication to all military bases and installations across the Arctic to Vladivostok.

Construction of the line starts next year, when special ice-classed cable ship Volga will be delivered to the north from Kerch shipyard on Crimea. A second ship, the Vyatka, will join the work expected to last until 2025. The two

special-purpose built vessels will lay the fiber optic cables at depth of up to 3,000 meters. Preparation work started at the beginning of the year, and the structural scheme for the subsea cable system is already ready.

Large amount of military communication will be transmitted in real-time, from Russia's border to Norway in the European Arctic to Vladivostok where the main base of the Pacific Fleet is located. More important, the fiber optic high-speed data communication cable will link all existing and future military installations along Russia's Arctic. That includes the north coast of Siberia, the Arctic archipelagoes where former Cold War military bases now are being re-commissioned one-by-one. Also, naval bases on the Kola Peninsula and in the Far East will be linked in real-time.

In total, the cable will stretch 12,700 kilometers on the seafloor across the Arctic.

Reportedly, the new cable technology to be used will be tested within the area of responsibility for the Northern fleet. An experimental cable with backbone network will stretch from the coast to island bases.

Quoting military expert Dmitry Boltenkov, the newspaper says, "The trans-Arctic cable will seriously increase defense capability of the country. In real-time, it will be possible to monitor the operational situation from Norway to China."

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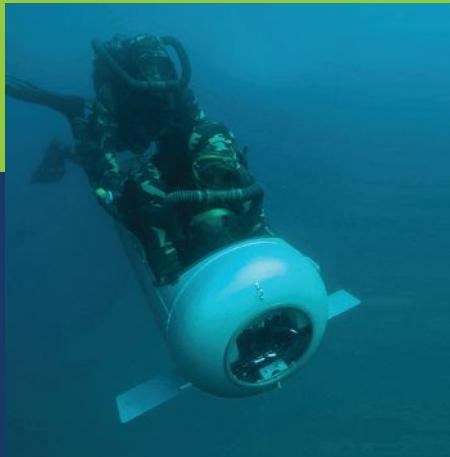
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CNO Announces Establishment of U.S. 2nd Fleet

Chief of Naval Operations, Adm. John Richardson, announced the establishment of U.S. 2nd Fleet during a change of command ceremony for U.S. Fleet Forces Command (USFF) in Norfolk, May 4.

Second Fleet will exercise operational and administrative authorities over assigned ships, aircraft and landing forces on the East Coast and northern Atlantic Ocean. Additionally, it will plan and conduct maritime, joint and combined operations and will train, certify and provide maritime forces to respond to global contingencies. Commander, 2nd Fleet will report to USFF.

"Our National Defense Strategy makes clear that we're back in an era of great power competition as the security environment continues to grow more challenging and complex," said Richardson. "That's why today, we're standing up Second Fleet to address these changes, particularly in the north Atlantic."

Second Fleet was disestablished in 2011 and many of its personnel, assets and responsibilities were merged into USFF.

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MacArtney Supplies Autonomous Winches for Naval Application on USVs

U.S. based aerospace and defense development and manufacture company Textron Systems Unmanned Systems has taken delivery of winch systems from MacArtney. The scope comprises design, manufacture, assembly, test and delivery of autonomous launch and recovery systems custom-engineered to adapt to specific customer requirements. The winches are designed to comply with the MIL standard 901D for shock and vibration. Emphasis has been put on tailoring the design and features to the conditions that they will be experiencing throughout their service lives.

Special Engineering and Design

The winches are designed and engineered for optimal durability. They feature a modular and compact design allowing for flexible system installation on USVs. The ultimate purpose of the vehicles is the autonomous use of sweeping, localization

and neutralization of mines and other explosive devices without human interaction.

The materials in the state-of-the-art winches include aluminium and special alloys which make them light-weight and corrosion resistant, which in terms of pull force/winch weight ratio will allow for added fuel capacity of the USVs.

"Delivering outstanding system performance by combining technology and experience, MacArtney considers the outcome of this customizable solution excellent as it is applicable for many purposes. The autonomous aspect and self-diagnostics of the solution are very important factors and a specific material request made by our customer," says MacArtney Inc. President Lars F. Hansen.

In addition to the mine countermeasure application, the USVs may target a wide range of commercial applications, too.

For more information, visit
WWW.MACARTNEY.COM



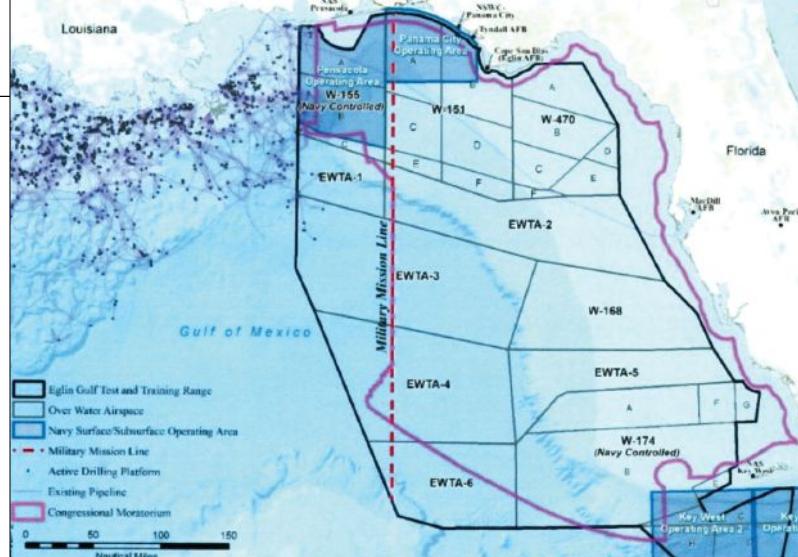
Common Unmanned Surface Vehicle (CUSVTM) Textron Systems

Report Details How Military and Energy Companies Coexist in Gulf of Mexico

The National Ocean Industries Association has announced that they welcome a report on Preserving Military Readiness in the Eastern Gulf of Mexico.

NOIA's statement said that the report, "not only provides a template for future coordination and consultation between the Department of Defense (DOD) and the Department of the Interior (DOI), but also is a starting point for a productive and cooperative relationship between the offshore energy industry and DOD. The report shows there is a lot of ocean out there and while there will be devils in the details, the overall message from the Pentagon should be interpreted as cooperation and coordination. In addition, as companies are allowed to explore and evaluate oil and natural gas plays, it is likely that areas of high potential will be more clearly defined and thus allow for additional military operations."

"The report identifies areas in the Gulf of Mexico where energy development activities can occur and as importantly, the very limited areas where DOD recommends they cannot. Military operations and energy development have co-existed and



Military scheduling areas and oil and gas development in the Eastern Gulf of Mexico.

thrived in many areas in the Gulf of Mexico for decades under a 1983 Memorandum of Agreement between DOD and DOI, as evidenced by the roughly one-third of current Gulf leases including military training stipulations and restrictions. The report concludes that, with similar stipulations and restrictions mutually agreed on by DOD and DOI, critical military operations and essential energy development can co-exist and thrive in the eastern Gulf of Mexico as well."

The full report is available at
WWW.NOIA.ORG/WP-CONTENT/UPLOADS/2018/05/USDRE-RTC-ON-MIL-MISSION-LINE-MORATORIUM-9MAY18-1.PDF



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The aircraft carrier USS *Theodore Roosevelt* (CVN 71), front, and the Ticonderoga-class guided-missile cruiser USS *Bunker Hill* (CG 52) are underway together during a sea power demonstration. *Theodore Roosevelt* and *Bunker Hill* are currently deployed in the Pacific Ocean. (U.S. Navy photo by Mass Communication Specialist 3rd Class Alex Corona/Released)

USS *Theodore Roosevelt* Completes 7-Month Deployment

Approximately 5,000 Sailors and Marines embarked aboard the aircraft carrier USS *Theodore Roosevelt* (CVN 71) returned to their homeport of Naval Air Station North Island, May 7, after a successful seven-month deployment.

Theodore Roosevelt departed San Diego, Oct. 6 and spent the deployment supporting Operations Inherent Resolve and Freedom's Sentinel, as well as maritime security cooperation efforts in 5th and 7th Fleet areas of operations.

The ship transited more than 56,000 miles, and made five port calls in four different countries, to include the United Arab Emirates, the Kingdom of Bahrain, the Republic of Singapore, and the Republic of the Philippines, as well as port calls in Hawaii and Guam.

Led by Rear Adm. Steve Koehler, commander, Carrier Strike Group (CSG) 9, the *Theodore Roosevelt* performed at a high level.

"Over the past seven months, the 6,000 Sailors and Marines of the TR Carrier Strike Group have performed superbly in every mission and in every task that was asked of them. This team has embraced a culture of excellence that comes directly from their routine professional approach to everything they do," said Koehler.

Theodore Roosevelt Sailors and Marines demonstrated more than just mission accomplishment on their deployment.

They also gave back to the countries they visited to enhance cooperation and cultural understanding. A total of 383 Sailors and Marines contributed more than 1,200 man hours during 19 community service projects.

"What Rough Riders have accomplished during this deployment was truly inspirational. Earning the privilege to be called the best one day at a time; every Sailor and Marine made what is very difficult look easy," said Capt. Carlos Sardiello, commanding officer *Theodore Roosevelt*.

Theodore Roosevelt partnered with more than 10 countries including Japan, South Korea, France, India, the Kingdom of Bahrain, and the Republic of Singapore to increase theater security cooperation through various maritime operations.

Approximately 70 aircraft from the squadrons of Carrier Air Wing (CVW) 17 flew 8,319 hours and 1,164 combat sorties and performed counterterrorism operations in Syria, Iraq, and Afghanistan.

Theodore Roosevelt also earned the 2017 Battle Efficiency "E" award for West Coast aircraft carriers, and became the

first aircraft carrier on the West Coast to earn the Jackie G. Brown Fleet Logistics Excellence award.

"This is just another way our Sailors have shown their top standing and ability to compete amongst the fleet's best aircraft carriers," said *Theodore Roosevelt* Command Master Chief Andrew Frederick. "Going into our maintenance period, I'm confident that we will come out an even better fighting force than we were during this deployment. I know that our Sailors and Marines feel excited to return home and finally reunite with their families."

USS Theodore Roosevelt is the flagship of Carrier Strike Group NINE. The TRCSG consists of the staff of Destroyer Squadron 23 and the squadrons of Carrier Air Wing (CVW) 17, which includes Strike Fighter Squadron (VFA) 113, VFA-94, VFA-22, Marine Fighter Attack Squadron (VMFA) 312, Electronic Attack Squadron (VAQ) 139, Airborne Early Warning Squadron (VAW) 116, Helicopter Sea Combat Squadron (HSC) 6, Helicopter Maritime Strike Squadron (HSM) 73 and Fleet Logistics Support Squadron (VRC) 30.

Electric Boat Expansion Makes Rhode Island History

Standing outside Electric Boat's Quonset Point facility and flanked by manufacturing workers, tradesmen and members of the Rhode Island Congressional Delegation, Governor Gina M. Raimondo announced a new infrastructure investment that will allow Electric Boat (EB) to accelerate the hiring of 1,300 new employees. Additionally, Electric Boat will begin construction to significantly increase the size of its facility at the Quonset Business Park - a project that will support more than 600 good-paying construction jobs. The expansion represents the second-largest Project Labor Agreement in state history.

Electric Boat is now manufacturing two Virginia-class submarines per year for the U.S. Navy, a production cadence not seen in decades. Further, EB was selected by the Navy to be the prime contractor on the Columbia class of submarines, which will require the company to expand its facilities, increase its supplier spending and hire new employees.

For more information, visit WWW.GDEB.COM



Aerial shot of Electric Boat's Quonset Business Park campus. Photo courtesy General Dynamics Electric Boat.

The EB expansion in Rhode Island is possible in part because of a \$14 million investment from the State to improve and modernize the Quonset Business Park. The state is also committing \$2 million in Rebuild RI tax credits and up to \$18 million in sales tax exemptions. These incentives will support a 1.3 million square foot expansion of manufacturing space - roughly half of which will be new construction - at Electric Boat's Quonset Point site with an expected capital investment by the company of \$792 million.

Electric Boat also announced that it will participate in the Supply RI initiative. Supply RI commits the state's largest employers to do more business with local vendors and contractors. Governor Raimondo announced the new Supply RI program in her State of the State address earlier this year. Electric Boat is the 12th employer to sign on.

MONTH IN REVIEW

KBR to Provide Combat-Ready Equipment to Marines Worldwide

KBR, Inc.'s global government services business has been awarded a contract modification by the U.S. Marine Corps (USMC) to provide prepositioning and logistics support services for the USMC Blount Island Command. This modification is the ninth year of the contract, which was originally awarded in 2009.

www.oceannews.com/news/defense/kbr-to-provide-combat-ready-equipment-to-marines-worldwide



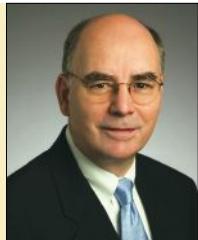
The Freedom variant littoral combat ship USS Milwaukee (LCS 5) fires an AGM-114L Longbow Hellfire missile during a live-fire missile exercise off the coast of Virginia, May 11, 2018. Milwaukee fired four Longbow Hellfire missiles that successfully struck fast inshore attack craft targets during a complex warfighting environment utilizing radar and other systems to track the targets. Photo credit: U.S. Navy.

USS Milwaukee Kicks Off LCS Missile Module Developmental Testing

The Freedom variant littoral combat ship USS Milwaukee (LCS 5) conducted a live-fire missile exercise off the coast of Virginia on May 11, 2018. The Milwaukee fired four longbow hellfire missiles that successfully struck fast inshore attack craft targets. During the evolution, the ship's crew executed a scenario simulating a complex warfighting environment, utilized radar and other systems to track small surface targets, simulated engagements and then fired missiles against the surface targets. www.oceannews.com/news/defense/uss-milwaukee-kicks-off-lcs-missile-module-developmental-testing

White Paper on Vessel's Critical Equipment Obsolescence

An ECA Group study on how to manage obsolescence for electronic equipment by introducing a virtual JAVA machine into ECA Group OPSYS architectures is available for download at www.ecagroup.com/sites/default/files/uploads/white-paper-eca-group-how-to-manage-the-life-cycle-of-vessel-critical-equipment.pdf.



SPRING BRINGS A FRESH PERSPECTIVE FOR COMMODITY MARKETS

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

Spring has brought better weather across the country, and a better tone to commodity markets. Higher oil prices have been driven by growing geopolitical tensions around the world, coupled with deterioration of output from one of OPEC's major oil suppliers. Following a winter in which natural gas storage was drained to near record lows, gas prices failed to rise in response. In the past few days, gas prices have shown some life offering hope for better economics for gas producers.

Spring is the time of the year when we move from the dark and cold days of winter to the sunny and warmer days of summer. During this shift in seasons, due to days of moderate temperatures, energy demand ebbs. This is referred to as the 'shoulder' months for energy demand, when markets and companies adjust their activities to prepare for the next surge in demand that comes with the summer heat and the nation's vacation season. According to the latest prediction from the National Weather Service's Climate Prediction Center, "The June-August (JJA) 2018 temperature outlook favors above normal temperatures over much of the contiguous United States." That outlook will be particularly welcomed by natural gas producers, who are much more sensitive to summer temperatures than oil producers. A potentially warmer summer will put pressure on the gas industry to rebuild storage for next winter, which may help lift prices as an incentive.

If we look at crude oil prices since the start of 2017, an interesting pattern is seen. Crude oil prices began 2017 higher than they had been for most of 2016, but they could not sustain that level the first half the year. Why? It was because the announcement in November 2016 of OPEC and Russia's agreement to

cut global output in an effort to shrink worldwide inventories back to their 5-year average during 2017 had boosted prices. The market optimism was dampened during the early months of 2017, as Russia's compliance with the output cut lagged, and the surge in exporting countries' output during the final months of 2016 in anticipation of higher prices weighed on prices. Producers had positioned themselves to sell more into a strengthening market, which failed to happen. The disappointment in the market's performance led to prices to actually decline.

By July 2017, the market sensed that the global synchronized economic recovery, coupled with the strict adherence by OPEC members and Russia to the lower output levels, was working to rapidly shrink the global oil inventory glut. Crude oil prices, both for North America (WTI) and globally (Brent), moved up steadily in lockstep until the end of 2017. Brent reached \$70 a barrel, while WTI approached \$65. The spread between the two oil price markers had widened slightly during the price rise from mid-year 2017, reflecting shifts in the value of the U.S. dollar and emerging geopolitical concerns over Iran, Libya and West Africa, this was not disconcerting for the market.

During the first five and half months of 2018, crude oil prices have continued to rise, but the advance has not been in a straight line. In fact, oil prices retreated at the start of 2018 as the price momentum of late 2017 ran out of steam. Moreover, the explosive growth in U.S. shale oil output began to weigh on the market's view of future prices. Traders began to believe that if oil demand did not start growing more rapidly, the growth in shale oil output would overwhelm the market, leaving too much oil in the world and putting downward pressure on prices.

That all changed as tensions in the Middle East, driven by the nerve gas attack in Syria, the U.S. military response to the attack, and the growing realization that the U.S. was destined to exit from the Iranian nuclear agreement, increased. Growing geopolitical tensions have become the primary driver behind the recent rise in oil prices, which has sent WTI above \$70 a barrel and Brent to \$80.

In the natural gas market, as the calendar turned from April to May, supply also turned a page. For the first time in years, April saw a decline in gas storage volumes. Now, however, the past three weeks have experienced meaningful injections of natural gas. That has propelled a sharp recovery in gas storage volumes from their near record recent low. Surprising, during those weeks of positive storage growth, there was no material increase in natural gas prices, despite the industry having substantially drained storage caverns last winter. The lack of a price response is likely due to the continued growth of associated natural gas produced from shale oil wells. This has contributed to national gas supply continuing to grow, even though the industry has stopped drilling for new dry natural gas supplies.

To gain an appreciation of how dramatically the natural gas market has changed, we created a chart showing how each week's gas storage volume compared with its immediate 5-year average. By plotting the percentages from 1999 to now, we can see how gas supply has ebbed and flowed in relation to the past. The current percentage is approaching that of the three previous record lows. That is not surprising given how low gas storage reached at the end of last winter. However, when we look at weekly average natural gas spot prices corresponding with those supply lows, they ranged between \$4.38 and

\$5.27 per thousand cubic feet of gas. The current depleted gas storage is matched with a spot gas price of \$2.73 per thousand cubic feet. In other words, the sharp fall in gas storage, from which we are currently recovering, has failed to stimulate gas prices, which confirms the market's assessment that we have plenty

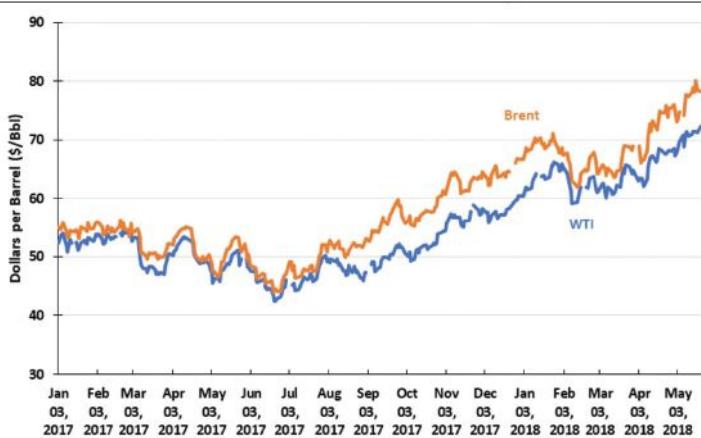
of supply because of our oil shale drilling boom.

While commodity markets are reflecting a better tone, they still driven by long-standing considerations – oversupply of domestic natural gas and global geopolitical concerns for crude oil. It is

difficult to see these drivers changing anytime soon. Therefore, look for continued strength in the oil market, while natural gas prices will continue struggling to climb above \$3 per thousand cubic feet. Producers will continue to respond to the incentives these markets deliver.

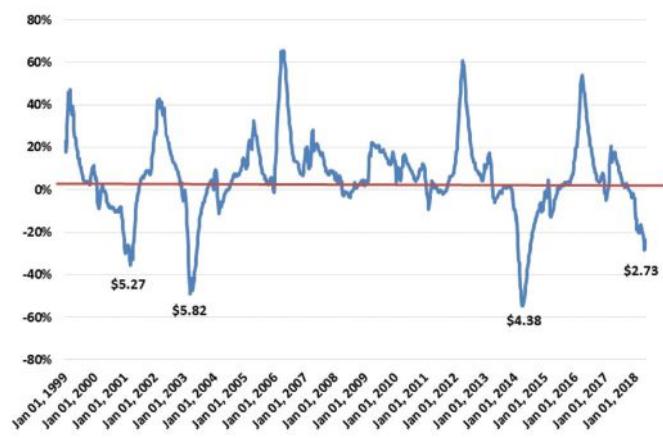
1.

HOW CRUDE OIL MARKETS HAVE CHANGED



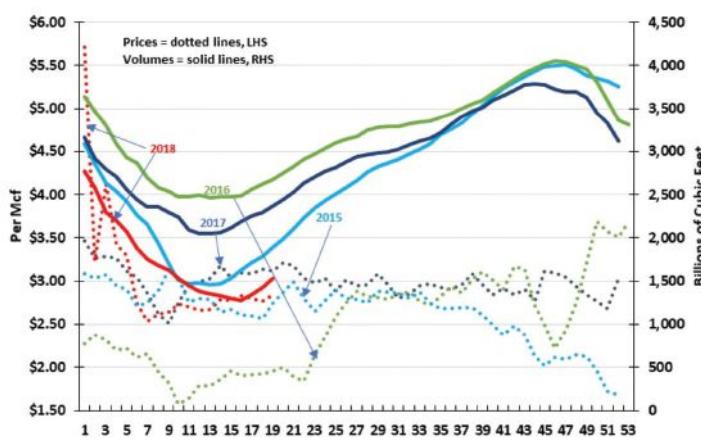
2.

CURRENT GAS STORAGE as PERCENT of 5-YEAR AVERAGE and CURRENT MONTH FUTURES PRICE (\$/Mcf)



3.

NATURAL GAS HH SPOT PRICES vs. STORAGE VOLUMES, WEEKLY



CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF MAY 11, 2018

Oil prices are up dramatically in May. WTI Spot prices passed the \$70/barrel mark by mid-May (the most recent data available at press time) and are expected to continue to rise. The International Energy Agency cited strong demand, efforts to reduce production under the Vienna Agreement, the possibility of sanctions on Iran following the U.S. withdrawal from the Iran Nuclear Agreement and political turmoil in Venezuela as factors driving the higher prices.

Henry Hub natural gas spot prices have not experienced the spike in prices that has been seen in oil. Prices have remained stable around the \$2.75 mark, which is where they were in early February.



WEEKLY WTI
CRUDE &
NATURAL GAS
SPOT PRICES
Last 52 Weeks

\$70.56

\$64.97 previous month



TRENDING UP



Cushing, OK
WTI Spot Price

\$2.76

\$2.67 previous month



Henry Hub
Spot Price

KEY EQUITY Indexes

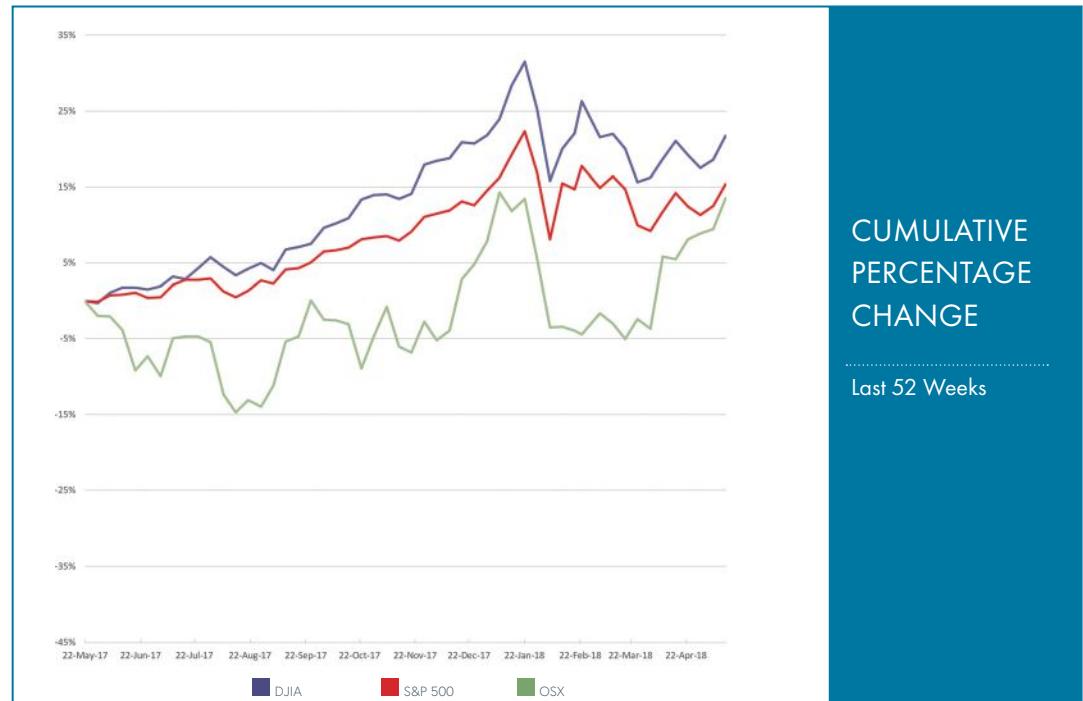
PRICES IN US DOLLARS AS OF MAY 14, 2018

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

The **Dow** has remained within the 24,000-25,000 range throughout the last six weeks following significant volatility earlier in the year.

Similarly, the **S&P 500** has been roughly within the 2,650-2,750 range for the same period. Perhaps reflecting the higher oil prices, the **OSX** has been trending upward and passed the \$160 mark in mid-May for the first time since January.

SELECTED EQUITY INDEXES



24,899.41

Up **112.78** from previous month



TRENDING UP

DJIA

2,730.13

Up **148.25** from previous month



TRENDING UP

S&P 500

163.08

Up **12.56** from previous month



TRENDING UP

OSX

ICCE

Baltimore, MD
July 30-August 3
icce2018.com

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

UDT

Glasgow, UK
June 26-28
www.udt-global.com/welcome-to-udt-2018

CORE

Glasgow, UK
August 26-28
www.offshore-renewables.co.uk

Ocean Energy Europe

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

ENGenius

Aerdeen, UK
September 4-6
engeniousglobal.com

Offshore Energy

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

ITST

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

WindTech Summit

Porto, Portugal
October 28-29
windtech.global/

Tug, Salvage & OSV

Marseille, France
June 25-29
www.tugandosv.com/its2018-home

Teledyne Marine Technology Workshop

Cannes, France
October 9-11
www.teledynemarine.com/events/TMTW2018

Clean Pacific

Portland, OR
June 19-21, 2018
2018.cleanpacific.org

Ocean Renewable Energy

Portland, OR
September 18-19
oregonwave.org/2018-conference

Pacific Marine Expo

Seattle, WA
November 18-20
www.pacificmarineexpo.com

OilComm & FleetCom

Houston, TX
October 3-4
2018.oilcomm.com

MTS Dynamic Positioning

Houston, TX
October 9-10
dynamic-positioning.com

SPE Subsea Well Intervention Symposium

Galveston, TX
August 7-9
www.spe.org/events/en/2018/symposium/18ssi/subsea-well-intervention-galveston

Arctic Technology Conference

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

Clean Gulf

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

International Workboat

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

OCEANS'18

Charleston, SC
October 22-25
charleston18.oceansconference.org

Offshore Northern Seas

Stavanger, Norway
August 27-30
www.ons.no/2018

Baltic Clean Technology

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

Offshore Wind Operations & Maintenance Forum

Prague, Czech Republic
June 28-29
www.offshore-wind-operations-maintenance.com

SMM

Hamburg, Germany
September 4-7
www.smm-hamburg.com/en

WindEnergy Hamburg

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

WindEurope

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

Oi China

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

AWTEC

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

Submarine Networks World

Singapore
September 24-26
www.terrapinn.com/conference/submarine-networks-world/index.stm

Power Week Asia

Singapore
November 12-16
www.power-week.com/Asia/index.html

Power Week Africa

Johannesburg, South Africa
September 10-14
www.power-week.com/Africa/index.html

2018 EDITORIAL CALENDAR

CALENDAR

JANUARY

EDITORIAL: Underwater Navigation; Manned Submersibles; Deepwater Pipeline/Repair/Maintenance
FOCUS: Multibeam and Side Scan Sonar; Oil Spill Prevention and Clean-Up Services

FEBRUARY

EDITORIAL: Oceanology; Maritime Security
FOCUS: Buoys and Monitoring Instrumentation; Diver Detection Systems; Training & Safety

MARCH

EDITORIAL: Offshore Technology; Subsea Fiber Optic Networks
FOCUS: Connectors, Cables & Umbilicals; Environmental Monitoring/Testing Services

APRIL

EDITORIAL: Meteorology; Ocean Mapping & Survey; Decommissioning & Abandonment
FOCUS: Subsea Tools & Manipulators; Data Acquisition Products; Seismic Imaging

MAY

EDITORIAL: Ocean and Coastal Engineering, Infrastructure, and Construction; Bathymetric Mapping
FOCUS: Cranes, Winches & Control Systems; Water Dredges and Airlifts

JUNE

EDITORIAL: UW Imaging and Processing; UW Archaeology
FOCUS: UW Imaging and Processing; Tracking and Positioning Systems; Magnetometers

JULY

BUYER'S GUIDE

AUGUST

EDITORIAL: ROV and AUV Technology
FOCUS: Cameras, 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

JANUARY

GoM Oil Spill & Ecosystem - February 5-8
Underwater Intervention - February 6-8
Subsea Expo - February 7-9
Decomm & Abandonment Summit - February 20-21

FEBRUARY

Oceanology International - March 13-15
Asia Pacific Maritime - March 14-16 *
CUC-E - March 25-27 *

MARCH

Int'l Offshore Wind Forum - April 3-6
OTC - April 30 - May 3

APRIL

TBD

MAY

Clean Pacific - June 19-21

JUNE

UDT - June 26-28

JULY

TBD

AUGUST

SMM - September 4-7 ^*
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 ^
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



George Morrison

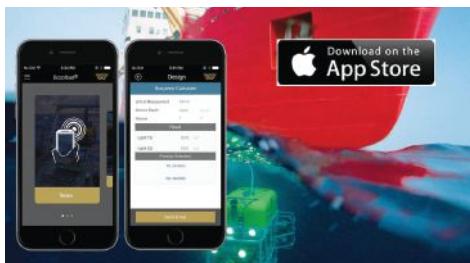


James Larnder

Aquaterra Energy Promotes Leadership Team to Drive Growth Strategy

Aquaterra Energy has announced two pivotal senior management promotions to spearhead its continued growth strategy. George Morrison becomes Group CEO of parent company Aquaterra Energy Group, while James Larnder fills Morrison's previous role as the new Managing Director of the Aquaterra Energy business.

The news follows last year's multi-million-dollar investment from EV Private Equity, which initiated a period of rapid growth. In his new position, Morrison will focus on expansion within the oilfield market through strategic acquisitions while Larnder will drive further business growth and product innovation within Aquaterra Energy.



Trelleborg Launches Mobile Eccofloat® App

Trelleborg's applied technologies operation has launched an app to allow for long-term traceability through automatic identification of Eccofloat® parts or vehicles throughout their product lifetimes.

The new app uses Near Field Communication (NFC) as part of a passive RFID (Radio Frequency Identification) system that allows customers to easily reorder products, look up product information and design new buoyancy, all from their smart phone. For more information, visit www.trelleborg.com/en/applied-technologies/products/rov-auv-hov--buoyancy/eccofloat



Damen Strengthens Female Presence in the Maritime Industry

Damen's Head of Communications, Sylvia Boer, has recently been appointed President of the Netherlands chapter of WISTA – the Women's International Shipping and Trading Association. WISTA the Netherlands was founded in 2000 and currently has 140 members from across the maritime industry. For more information, visit www.damen.com.



Craig McLean (l) of NOAA presents Fugro's Edward Saade (r) with a commemorative plaque in formal commendation of the company's leadership in advancing global ocean mapping.

NOAA Recognizes Fugro for its Contribution to Global Ocean Mapping

Fugro's leadership in advancing global ocean mapping has earned it a formal commendation from NOAA. The recognition came during a recent industry briefing with Fugro and NOAA about The Nippon Foundation-GEBCO Seabed 2030 Project, a global initiative to map the world's oceans by the year 2030.



DNV GL Appoints Klas Bendrik as Chief Digital Transformation Officer

Klas Bendrik will join DNV GL as Chief Digital Transformation Officer to support DNV GL's digitalization and IT strategy. Starting on 1 September 2018, Bendrik will be based at the DNV GL headquarters in Høvik, Norway and will be a member of DNV GL Group's Executive Committee and report to Group President and CEO Remi Eriksen.

At the beginning of the year, DNV GL established a dedicated Digital Solutions organization by consolidating its digital business across the Group. Digital Solutions is now one of five business areas within DNV GL. For more information, visit www.dnvg.com.

Over the past year, the company has contributed more than 65,000 square kilometers of high-resolution crowd sourced bathymetry data to NOAA in support of the project. Fugro is collecting the seabed data while transiting between offshore survey projects.

During this year's Ocean Technology Conference in Houston, McLean presented Fugro's USA President, Edward Saade, with a commemorative plaque on behalf of NOAA stating, "We asked for nothing and you're delivering a lot. We are very much appreciative of this and we wanted to commend and celebrate the work of Fugro in getting us to a better place, and in demonstrating the capabilities within the private sector for a larger public good."

For more information, visit www.fugro.com.

DeepOcean Appoints Øyvind Mikaelsen as New CEO

Mr. Mikaelsen was most recently Executive Vice President at Subsea7, and has 30 years of experience in the global subsea business holding various senior executive roles. Current DeepOcean interim CEO Ottar K. Mæland returns to his responsibilities as COO.

NSRI Strengthens Board to Meet Demands of Diverse Energy Mix

The National Subsea Research Initiative (NSRI) has elected two new board members as it looks to expand its capabilities in the growing renewables, mining, defense and aquaculture sectors.

Following a strategic review, NSRI identified the need to restructure in order to reflect the global energy transition. Although still heavily focused on the oil and gas market, the organization will be looking to enhance its offerings to better support other offshore sectors.

Simon Cheeseman, of the ORE Catapult and Claus Hjørringgaard of Wood Clean Energy have joined the board of NSRI to support the organization's plans to support UK companies break into multiple energy markets.

A former marine engineer, Mr. Cheeseman joined the ORE Catapult in February 2014. He is responsible for managing the organization's marine renewables strategy, identifying the wave and tidal technology innovation needs. Previously, he worked with the Energy Technologies Institute, where he was marine program manager for a range of high profile wave and tidal development projects. For more information, visit www.nsri.co.uk.

Europe's Ocean Energy Industry Will Meet in Edinburgh for OEE2018

Scotland will host the Ocean Energy Europe 2018 Conference & Exhibition (OEE2018) in Edinburgh on 30-31 October. Scotland has led the charge on ocean energy technologies by building some of the industry's flagship projects, and is a key hub for developments globally. Scottish Minister for Business, Innovation and Energy, Paul Wheelhouse will be present to welcome the ocean energy sector to Edinburgh. The event will be sponsored by Highlands & Islands Enterprise, Wave Energy Scotland, and Crown Estate Scotland.

The first Ocean Energy Europe Conference & Exhibition was held in Edinburgh in 2013. Since then it has grown to be the leading European event on ocean energy. Each year, it features the industry's leading CEOs, alongside key ministers and decision-makers. With a lively commercial exhibition, the latest business intelligence, and several networking and side events, OEE2018 will be the place to do ocean energy business this year.

www.oceanenergy-europe.eu/event/oee-2018/



Product Spotlight

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- Acoustic Monitoring: EASDA14, Embedded Multichannel Passive Acoustic Recorders
- WiFi remote Buoy: BASDA14, Multi-sensor & Rechargeable Acoustic Buoy accessible in Real-time
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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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 Contact: Richard Fryburg

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Contact: Gary Brown, Sales Manager



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

CONNECTORS

BIRNS, INC.

1720 Fiske Place
Oxnard CA 93033-1863 USA
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Fax: +1 805 487 0427
USA: +1 888 BIRNS 88 (+1 888 247 6788)
E-mail: service@birns.com
Website: www.birns.com
Contact: Eric Birns



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.

BIRNS AQUAMATE LLC

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Tel: +1 (401) 723 4242
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Website: www.birnsaquamate.com
Contact: Eli Bar-Hai



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

SEACON

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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.

TELEDYNE MARINE INTERCONNECT SOLUTIONS

1026 N. Williamson Blvd.
Daytona Beach, FL 32114
Tel: 386-236-0880
E-mail: TeledyneMIS@teledyne.com
Website: www.teledynemarine.com



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

DESIGN & ENGINEERING

HYDRO LEDUC NA, INC.

19416 Park Row, Ste. 170
Houston, TX 77084
Tel: 281-679-9654
E-mail: bogden@hydroleduc.com
Website: www.hydroleduc.com



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

EQUIPMENT RENTAL

OKEANUS SCIENCE & TECHNOLOGY, LLC

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Tel: 985-346-4666
Fax: 985-346-8444
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Website: www.oceanus.com
Contact: Benton LeBlanc



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



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Website: www.oceanspecialists.com



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

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



KONGSBERG

Kongsberg Seatec 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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E-mail: atl@atlinc.com
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Contact: David Dack



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

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 Website: www.evologics.de



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

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

NKE INSTRUMENTATION

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- Provor and Arvor profiling subsurface floats (ARGO project): CTD, dissolved oxygen, BGC, deep; Argos and Iridium transmission.
- Drifting surface buoys with temperature and GPS receiver for Surface velocity project.

RBR

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 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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 E-mail: info@sea-birdscientific.com
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 Contact: Calvin Lwin, Sales



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 Contact: Baldur Sigurgeirsson

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



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

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

EDGETECH
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 Website: www.edgetech.com
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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.

MARINE SONIC TECHNOLOGY
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 Website: www.marinesonic.com



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

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

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 Website: www.saivas.no
 Contact: Gunnar Sagstad



- STD/CTD, Sound Velocity probes/recorder with optional multi-parameter facilities; Turbidity, Fluorescence, Oxygen etc. The new CTD/STD model SD208 with wireless communication and high accuracy: 0.002 mS/cm, 0.002 °C.
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SUBSEA FABRICATION

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

SUBSEA TECHNOLOGY

**KONGSBERG MARITIME AS – SUBSEA DIVISION
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KONGSBERG

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

UNMANNED MARITIME VEHICLES

DEEP OCEAN ENGINEERING INC.

2403 Qume Dr, San Jose, CA 95131 USA
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Deep Ocean Engineering, Inc. provides remotely operated and unmanned surface vehicle (ROV / USV) solutions which are used by a broad range of industry applications - security, military, nuclear and hydroelectric power plants, inshore dams and lakes, oil and gas, scientific research, fisheries, salvage, search / recovery, and pipeline inspections.

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 Website: gdmissionsystems.com/
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 Contact: Adam Mara



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

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**HYDROID, INC.
A SUBSIDIARY OF KONGSBERG MARITIME**

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 Fax: +1 508 563 3445
 E-mail: sales@hydroid.com
 Website: www.hydroid.com
 Contact: Hydroid Sales Department



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.

**INTERNATIONAL SUBMARINE
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 Port Coquitlam, BC, V3C 2M8
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 E-mail: info@ise.bc.ca
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International Submarine Engineering Ltd. (ISE) is a world leader in the design and integration of autonomous and remotely operated robotic vehicles and terrestrial robotics. Over our 40+ years in business, we have accumulated a great deal of expertise in the design, manufacture, and maintenance of:

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

L3 OCEANSERVER, INC.

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 Tel: +1 508 678 0550
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L3 OceanServer, Inc. is one of the leading manufacturers of Unmanned Underwater Vehicles (UUVs) with over 300 units delivered to customers around the world.

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 Contact: Shannon Searing



Teledyne Oceanscience supplies the oceanographic community with deployment platforms for echosounders and environmental monitoring instrumentation. Our major products are remotely-controlled Q-Boats and tethered instrumentation deployment Riverboats for echo sounders and ADCPs, remotely controlled Z-boats for hydrographic surveys in shallow or hard to access areas, the UnderwayCTD that provides affordable and compact profiling from a moving vessel, and the popular Sea Spider and Barnacle seafloor platforms.

TELEDYNE SEABOTIX

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

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

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MECHANICAL HANDLING UNDERWATER

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