

A large, complex industrial structure, likely an offshore oil or gas platform, is shown from an aerial perspective. The structure is composed of numerous vertical and horizontal steel legs and beams, creating a intricate geometric pattern against the dark ocean water. The platform appears to be situated in relatively calm waters, with some white foam visible at the base.

April 2018

ON&T

Ocean News & Technology

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FEATURE STORY

**What's the Ocean Industry
Outlook for the Next Decade?
Our Experts Respond.**

PAGE 10



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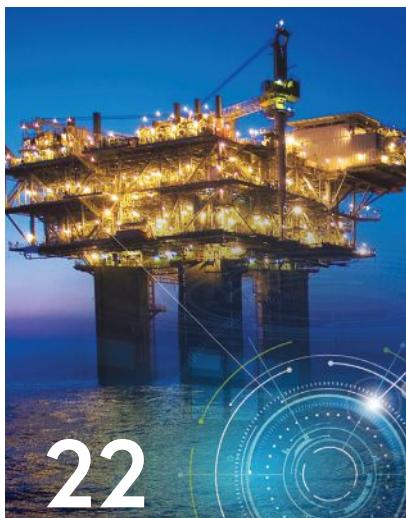


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10



22

DEPARTMENTS

- 15** Ocean Science & Technology
- 26** Offshore Energy
- 34** Subsea Intervention & Survey
- 40** Communication & Subsea Cables
- 46** Defense

FEATURES

- 10** A Seat At The Round Table
- 22** EDGSonline
The Environmental Geospatial Platform for Today's Offshore Digital Oilfield
- 32** Electric Tooling for Subsea Operations
- 48** Contested Seas:
Maritime Domain Awareness

IN EVERY ISSUE

- 8** Editorial
- 50** Stats & Data
- 54** Events
- 57** Milestones
- 59** Ocean Industry Directory



ON THE COVER:

Multibeam sonar image of the SMS Cormoran II (WWI) and Tokai Maru (WWII), Apra Harbor, Guam. Courtesy of U.S. Naval Base Guam and HDR, Inc. Survey conducted by CSA Ocean Sciences, Inc.



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EDITORIAL

GREG LEATHERMAN
Editor in Chief, Ocean News & Technology



An Unmanned Maritime Systems Legislative Update

The Commercial Engagement Through Ocean Technology (CENOTE) Act of 2018

A bill recently introduced in the U.S. Senate by Sen. Wicker, Roger F. [R-MS] would result in substantial changes in how NOAA coordinates its unmanned maritime systems activities. We though you should know what's in it.

If signed into law, the CENOTE Act of 2018 would give the Under Secretary of Commerce for Oceans and Atmosphere authority over NOAA's unmanned maritime system research, assessment, and acquisition activities, including the public distribution of collected data. To this end, a joint program within the Office of Oceanic and Atmospheric Research (OAR) and the Office of Marine and Aviation Operations (OMAO) would be established. The Under Secretary would also establish a committee consisting of representatives from the Office of Ocean Exploration (OER), the Integrated Ocean Observing System (IOOS), and other NOAA offices actively engaged with unmanned maritime systems.

One of the stated goals of the bill is to foster cooperation between NOAA and the U.S. Navy. This includes directives to align strategic and operational priorities, including during the acquisition and the testing of unmanned systems. For example, the CENOTE Act instructs the Under Secretary to utilize Naval unmanned systems test or training ranges, such as the Gulf of Mexico Unmanned Systems Test and Training Range.

The CENOTE Act of 2018 instructs the Navy and NOAA to jointly coordinate with other federal agencies, as well as the academic and private sectors. This includes maximizing research opportunities, providing training in unmanned maritime systems as part of an accredited certificate or degree program, and facilitating the commercialization of unmanned maritime systems. Among the existing efforts potentially impacted are partnerships between NOAA and the Sea Grant Colleges, National Estuarine

Research Reserves, the National Oceanographic Partnership Program, and regional associations of IOOS. It would also impact 16 Cooperative Institutes (consisting of 42 universities) that currently partner with NOAA.

The committee would produce a report, every four years, that includes an inventory of unmanned maritime systems used by NOAA, a summary of the data returned, and the benefits realized. It would also include a prioritized list of data requirements that could be met with unmanned maritime systems, and the estimated cost of acquiring such systems and data. For the public distribution of unclassified data, the bill specifies the use of existing secure infrastructure such as IOOS.

Lastly, the bill authorizes joint projects with private industry for:

- Improving ocean observing capabilities to monitor the physical, chemical, and biological conditions of the ocean;
- Increasing cost effectiveness of developing technologies relating to unmanned maritime systems;
- Seeking efficiencies in data collection and management;
- Expanding global capabilities of ocean technology; and
- Capitalizing on emerging technological advances.

The bill promises to define how NOAA works with unmanned maritime systems going forward, and that could have real impacts on many of our readers. I encourage stakeholders in the unmanned maritime system industry to contact their congressional representatives to provide your informed assessment of the CENOTE Act of 2018. Read the full bill at www.congress.gov by searching S.2511.

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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A Seat at the Round Table

Our Advisory Board Provides Insights on the State of Ocean Industry, Technical Innovation, and Emerging Opportunities

Over nearly four decades of publishing, *Ocean News & Technology* has benefitted from guidance provided by the thought leaders that make up our Advisory Board. They recommend relevant topics, introduce us to top innovators, and provide perspectives on industry developments and emerging opportunities. Recently, we sat down with our current Advisory Board to share some insight with our readers.

ON&T ADVISORY BOARD MEMBERS:

Drew Michel: With 50 years of experience in technical and executive positions in the offshore diving and ROV industry, Drew is one of the true pioneers in the technology of undersea Remotely Operated Vehicles (ROVs). Today, he is the Principal Consultant for ROV Technologies, Inc.

Phi Hart: Phil has worked internationally in the Marine Sector for more than 25 years, including an extensive history in Engineering and Management, with core skills in technology development, strategy, business analysis, people and company leadership, and international partnering. He is the Vice President of both Fleetway Inc. and Oceanic Consulting Corp.

Tobias Stapleton: Tobias helps technology-driven companies build ideas. He serves as the Assistant Vice Chancellor and Director of the UMass Dartmouth Center for Innovation and Entrepreneurship (CIE) and Vice President of the Marine and Oceanographic Technology Network (MOTN).

WHAT'S THE OCEAN INDUSTRY OUTLOOK FOR THE NEXT DECADE?

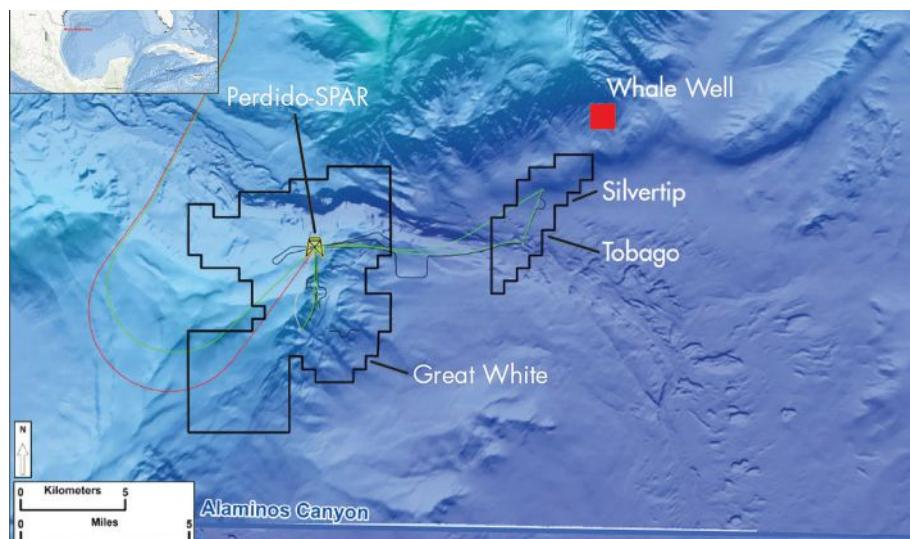
Drew Michel: Offshore oil has always had cycles. Right now, we're in a very down cycle, but there will always be another boom, and there will always be another bust. That's our motto. So, I guess if you look a decade out, it looks good.

Now, if oil prices were higher, the offshore industry would be evolving in the southern Gulf of Mexico in both Mexican and U.S. waters. The conventional thinking is that there's just a tremendous amount of oil down there, but it's all in seven to ten thousand feet of water, so oil has to be at least seventy-five dollars a barrel before anybody will invest money to do that. For Shell's Perdido project, for example, the main facility

was anchored at 7000 feet, while the deepest wells were at 9500 feet; and that system cost four and a half billion dollars to put in, but it also had twenty-five wells. And these aren't twenty-five little pumper wells, these are twenty-five high pressure wells. I don't know how many came in really hot, but you can bet a lot of them did or they wouldn't have spent the money.

However, because things are down right now people are investigating ways to do things more cost effectively. For example, there's definitely a trend toward electric vehicles from hydraulic. Some technical challenges still exist, but I think it is going that way. There are probably a lot of ROVs right now that are being scrapped, and they'll be replaced by electric vehicles in the future.

Phil Hart: Naval shipbuilding is booming in Canada. The government has made a decision to fund orders for the next twenty-five years, which will keep the major shipbuilding yards in Canada busy (<http://www.tpscgc-pwgsc.gc.ca/app-acq/amd-dp/mer-sea/sncn-nss/index-eng.html>). As a result, the area that I specifically work in currently, which is the support of and design of those ships, is also on an upward cycle and seeing very consistent and aggressive growth. There are no signs of that slowing down.



In January 2018, Shell Offshore Inc. announced one of its largest U.S. Gulf of Mexico exploration finds in the past decade from the Whale deep-water well. The well encountered more than 1,400 net feet (427 meters) of oil bearing pay. Drew Michel says this area of the Gulf of Mexico is a key development region in the coming decade.

In terms of offshore marine renewables, they are still on the whole waiting for the breakthrough phase. Certainly, if you look at wave energy, I don't think that's going to contribute effectively until someone makes a step change in capability. It's very easy to extract power from waves, but incredibly difficult to do it economically. We are still waiting on that a-ha moment.

The tidal side of renewables is starting to gain traction. It's doing very well in Scotland and not so well in the U.S. or Canada (Bay of Fundy). A lot of the needed technology / system developments could be around installation technologies and trying to reduce the cost deploying the equipment. If there was a bit more focus on the operational (installation and O&M) aspects, as well as the core technology, that could make a big impact on overall lifetime costs. Within the next ten years I think you'll see it start to mature and be more widespread.

Meanwhile, I think Europe will continue to lead in offshore renewables. The expansion of offshore wind will continue in Europe and wind will continue to be the dominant offshore renewable energy source for a long time. In the U.S.A., offshore wind is only just starting to make its mark (see Block Island), but the signs of an industry reaching a tipping point are all around. The U.S. has the resources and now the political will to install a huge amount of capacity over coming years; definitely something to keep a close eye on.

Tobias Stapleton: Right now, there's a lot of excitement about marine technology. At CIE, we incubate technology companies and the sector that we've focused on recently is marine technology. The amount of startup activity in the marine technology world is robust. In southern New England, we're seeing more activity over the last two years than we've seen in the ten years prior combined. I'm also seeing companies think more holistically about how they build out what they're doing as a system, because it's getting tougher to sell a single component to somebody. The end user wants a system.



Canada's National Shipbuilding Strategy is a long-term project to renew Canada's federal fleet of combat and non-combat vessels. The project formed partnerships with two Canadian shipyards to deliver vessels to the Royal Canadian Navy and the Canadian Coast Guard.

L3 OceanServer's Iver was the first commercially developed low-cost AUV. Iver is ideal for coastal applications such as sensor development, general survey work, subsurface security, research and environmental monitoring. Photo courtesy of Business Wire.



In southern New England, we have the University of Massachusetts Dartmouth, the Woods Hole Oceanographic Institute, and the University of Rhode Island; and within each of those ecosystems there are startups looking for the kind of support that we provide, in terms of building the physical product and helping them to connect to other entrepreneurs who are at the same phase of growth, which is start up, or having a prototype for proof of concept. Getting assets together from each of those technology ecosystems enables companies to innovate and create new startups.

If you look at the marine technology space in general, you've got the ROV manufacturers, the AUV manufacturers, sensor companies . . . but you also have ancillary industries that are

supported. For example, cyber security is now becoming critically important especially to those who are selling to the Department of Defense. Internet of Things (IoT) is another—connecting the devices—and this includes a number of companies that want the ability to communicate what's happening on the platform or the device back to somebody so that they can track what's going on out there, see if there are problems . . . Even in aquaculture. Rhode Island and southeastern Massachusetts is a hotbed for aquaculture and industry. Lots of those are small family farms producing mussels, clams, oysters . . . but they need the ability to monitor the oyster beds, for example, and they can't afford a seventy thousand dollar sensor. Globally speaking, large commercial farms can afford to have large pods with sensor systems, but family farms, especially in

poorer countries, aren't able to afford really expensive sensors. That demand will drive the availability of smaller, cheaper, and easier to use sensor kits.

The other challenge with some sensor companies is that you need training in order to operate the sensor and to understand what the sensor is telling you. One of our spinouts, OceanServer (www.ocean-server.com) started with the premise that they could make a less-expensive, easier-to-use autonomous vehicle that didn't require a team of Ph.D.'s to operate. They were successful and were acquired by L3 (www.l3t.com) last year.

And you're seeing companies like Riptide (riptideas.com), which makes a small autonomous vehicle that can run on multiple types of batteries, including alkaline, lithium, or aluminum seawater

batteries. Their price point is around ten thousand dollars, as compared to one hundred thousand or more for any of the larger systems out there.

WHAT HAPPENS TO THE WORKFORCE IN THESE KINDS OF CYCLES?

PH: In shipbuilding, what used to happen is that construction would employ hundreds or possibly thousands of people, but once the ship was completed, all those people would be laid off. The Canadian government's investment gives shipbuilding a more stable long-term view. As a result, the opportunities for the skilled and semi-skilled workforce to solidify a long-term future is the source of some real optimism. Normally, when there is an economic downturn, you lose experienced workers—people with thirty years on the job who are really difficult to replace; this is a very similar problem in the wildly cyclical Oil and Gas industry. With the long-term strategy in play, that level of productivity and experience will become a stable resource.

DM: In the eighties when people were laid off, they literally scattered. Then, when oil came back strong, companies had to develop a whole generation of young people. So, a downturn does create an opportunity for young people because senior people take a retirement package and go fishing, and the mid-career people go to another industry. That leaves you with brilliant engineers fresh out of school—drilling engineers, structural engineers, ocean engineers—and they've learned a lot in college, but they haven't learned what's really going to happen offshore.

For example, one thing that has improved over the last couple of decades is the safety and environmental culture. Fifty-years ago, we worked on an offshore oil rig in short pants, flip flops, no shirt, and no hard hat. Now, the safety culture is established, but an inexperienced engineer can still make some serious mistakes. You have to have an old gray-haired guy who can explain how we did something wrong the first three times, and what lessons we learned, so the new guys don't do it wrong today.

PH: In the companies I run, our co-op and internship programs intentionally get students straight out there doing "real" stuff, some of them for instance are on ship doing technical surveys within days of their arrival with us. The experiences are amazing. They leave us as different people and

when they go back to school to carry on with their education, they can connect their studies directly to what they learned when they were onboard a ship.

TS: In New England, we lose a lot of our students who go off to college and never come back, or they come back later in life to take care of aging parents or something like that. I think the same thing is true in Canada. They don't realize that there are opportunities in their backyard to be an engineer. So, the aim is that before they leave university or the vocational school, that they get some understanding of what the opportunities are, what the companies are.

WHEN OIL PRICES DO RECOVER, WILL OFFSHORE ENERGY GROWTH LAG?

DM: I don't think so. When things start recovering, they ramp up pretty fast. An oil company will invest billions if their reservoir engineers and their geologists have convinced the board that there is enough there.

PH: Some of the oil and gas majors are starting to move into renewables. They are making serious investments, such as Statoil investing in floating wind farms. If we were at \$100 oil, they would probably be making more traditional field investments; renewables still represent a long play and perhaps somewhat of a niche at the moment. It's very expensive to develop an offshore oil field, many billions of dollars, but the payback is still orders of magnitude greater than for a renewable energy site. And the only way for oil companies to keep their level of inventory steady is to bring on new offshore fields as older ones deplete. While you can fill some of the gap with land-based oil wells, the big barrel finds are always offshore. So, we might see a bit of a lag, but at some point, they have to go back to drill big offshore fields.

For the wind energy market, a lot of the drive has come from Europe. And they've put such a large volume of wind in now that, in terms of levelized cost of energy, production from a wind farm is actually quite good compared to traditional means. There are still subsidies in place and so forth, but they're not so necessary for a large enough wind farm to become profitable with the turbines just emerging in the industry. Once you get the volume that it is in Europe, once the technology has been around for thirty years or so, then you start to hone in on reliable, low-maintenance, high-power



A 1,000 nautical mile UUV may sound like fiction, but Riptide is making this a reality through their partnership with Open Water Power, producer of an extremely high-energy density and safe aluminum seawater battery. Riptide's Micro UUV could already run 48 hours running at 2-3 knots in a standard configuration, but with the addition of Open Water Power's aluminum seawater battery endurance is increased 10x.



output, especially when you go offshore. And all of that has driven the costs down to where offshore wind should be able to survive without significant subsidies and compete with traditional power sources.

If there's a risk to the renewables industry, it's related to permitting. I worked for a company, for instance, that wanted to put a prototype wave energy device out in the water. It took us five years and multi-millions of dollars to get the permit that said we could deploy the device for three months. Because you're breaking new ground, people don't know how to deal with it. And you have multiple agencies and multiple levels of government that sometimes fight against each other with competing priorities. Of course, you've got to have regulation, but whenever you're trying to do something new—driving innovation, driving industry, driving new investments—there is a challenge for smart regulation. So, if there is a key barrier to the deployment of renewable energy technology, it's when regulations are applied that don't apply well. Speed permitting up and reduce permitting costs, and uptake in the technology/industry will accelerate.

TS: Compared to other renewables, the argument for offshore wind is easier to make with government officials because they understand a traditional wind turbine. In Massachusetts, offshore wind platforms are going to get the buy in from the legislature as well as the

governor's office in Rhode Island and Massachusetts. They understand what this could mean terms of the energy grid, because we're importing hydropower from Quebec and there's controversy around that. There's also controversy in that Massachusetts doesn't want to import any kind of power from Rhode Island and vice versa.

If the oil companies, which do have the ability to fund renewables in a big way, get serious beyond something just to report to shareholders or to keep regulators at bay, those entities are politically savvy, and would be able to get the regulators to see marine renewables as not only as a logical next step, but something that has to be put in place in terms of energy diversity. From a sheer security standpoint, we have to think about the diversity of our energy portfolio and marine renewables plays into that.

The whole idea behind our technology incubator is to de-risk the technology side of the business model, but if we're speaking just about marine renewables, it's going to take a quantum leap in technology. It's going to take somebody developing that product—whether it's a wave power device, a turbine, or a buoy system or something else—somebody is going to have to prove the technology.

Investment in the marine technology sector in general is challenging for a number of reasons. The Massachusetts

Clean Energy Center and the Department of Energy through ARPA-E provide some funding, but it's tough to get an investor to invest in the space. There is private investment, but it tends to be someone with a passion or interest in the industry. For one thing, there are a lot of people throwing things against the wall in terms of technology to see what works. There's a lot of R&D that taking place right now and nobody's found "the thing" that's going to take marine renewables technology to the next level.

Vehicle manufacturers are going to make a dozen vehicles a year and they're going to sell each vehicle for fifty or sixty thousand dollars apiece. Now go take that to a venture capitalist and try to explain that you're only going to make ten or twelve of these things a year and it is going to take a few years to develop the technology, but you'll be profitable in year five or year six . . . and maybe longer. And tell them the exit strategy is unclear, whether you're going to get acquired or go public or some other exit event that allows the investor to cash out. So, getting investment in marine tech in general is difficult, but with marine renewables, it's even more difficult.

WHAT NEW TECHNOLOGY SHOULD EXCITE ON&T READERS

DM: The step change is going to be battery technology. And the best example of that it is: You can use low power for putting AUVs in the water with sensors on them and go out and do surveying and things like that, but if you want to go down and close a valve on a subsea tree, you need a lot of power. And to get an AUV with an impact wrench on it, that's run by batteries, to go down and open and close that valve, you're going to have to have a lot of power. If there's a silver bullet, that's it.

TS: One company we incubated, Open Water Power (<http://openwaterpower.com>), has developed an aluminum-water platform for undersea power generation. They still have some work to do, but the technology promises a big improvement in the endurance of AUVs and sensors.

PH: Yes, the problem is that you just

can't pack enough power into an AUV without making it unfeasibly large. So, battery technologies are key, because until you have a really compact high-power source, AUVs are necessarily going to be limited. And it's not just AUVs. Every single technology relies on having the right amount of power with the right characteristics. Fire up a gas-fired power plant and out comes a certain amount of power. But with renewables, power production is uneven, and you have to throttle them back (produce less energy) or smooth that out with large power storage systems (which is obviously the better solution). That requires a massive battery. The guy who builds a better battery is going to be crazy rich.



New Control Methods Can Help Protect Coral Reefs From Invasive Species

Control efforts such as the removal of shipwrecks and application of chlorine may help mitigate the damaging effects of *corallimorph*, which is a type of invasive anemone, on valuable coral reefs in the Central Pacific Ocean, according to a new U.S. Geological Survey study.

"Coral reefs are home to a significant diversity of marine life, provide valuable economic and environmental services to millions of people, buffer shorelines from erosion and waves, and can serve as a resource for the development of new medicines," said Thierry Work, a USGS scientist and the lead author of the study.



Corallimorphs are a type of invasive anemone that typically thrive in coral reefs that have been degraded by environmental or man-made disturbances.
Photo credit: Thierry Work, USGS.

Corallimorphs, or CM, can rapidly spread in coral reefs that have been degraded by environmental or man-made disturbances. At the Palmyra Atoll National Wildlife Refuge in the Central Pacific, researchers found CM expanding and smothering otherwise pristine coral reefs in an area near a shipwreck. Starting in 2007, USGS scientists and partners surveyed the CM-infested coral reef before and after removal of the shipwreck. They found that wreckage removal helped reduce the proportion of highly CM-infested areas from 21% to 14%, marking the first time that shipwreck removal was shown to have beneficial effects for reef recovery from CM.

By exposing CM to chlorine, the scientists found that they could nearly eradicate the organism from small plots of about 100 square feet after several days. These plots remained mostly CM-free for at least 15 months, allowing native organisms to regrow.

"Scaling up the control methods tested in our study might provide hope that the Palmyra *corallimorph* could be contained or possibly eradicated," Work said. "Coupling these methods with shipwreck removal could potentially help control infestations at other sites."

For the original paper, visit <https://link.springer.com/article/10.1007/s10530-018-1696-1>.

This Soft Robotic Fish Swims Alongside Real Ones

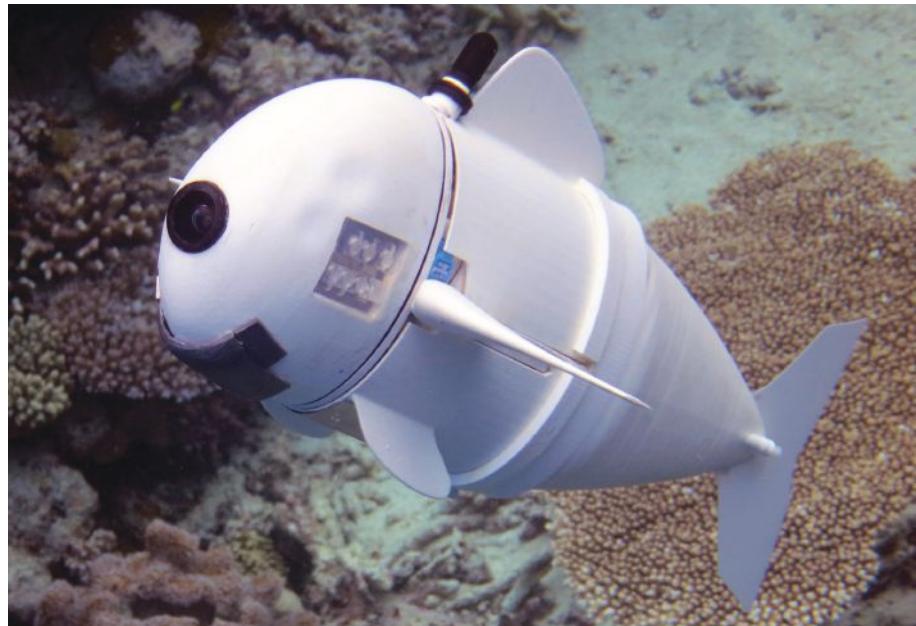
In a paper out 21 March 2018, a team from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) unveiled "SoFi," a soft robotic fish that can independently swim alongside real fish in the ocean. During test dives in the Rainbow Reef in Fiji, SoFi swam at depths of more than 50 feet for up to 40 minutes at once, nimbly handling currents and taking high-resolution photos and videos using (what else?) a fisheye lens.

Using its undulating tail and a unique ability to control its own buoyancy, SoFi can swim in a straight line, turn, or dive up or down. The team also used a waterproofed Super Nintendo controller and developed a custom acoustic communications system that enabled them to change SoFi's speed and have it make specific moves and turns.

"To our knowledge, this is the first robotic fish that can swim untethered in three dimensions for extended periods of time," says CSAIL PhD candidate Robert Katzschmann, lead author of the new journal article published in *Science Robotics*.

Katzschmann worked on the project and wrote the paper with CSAIL director Daniela Rus, graduate student Joseph DelPreto and former postdoc Robert MacCurdy, who is now an assistant professor at the University of Colorado at Boulder.

Existing autonomous underwater vehicles (AUVs) have traditionally been tethered to boats or powered by bulky and expensive propellers. In contrast, SoFi has a much simpler and more lightweight setup, with a single camera, a motor, and the same lithium polymer battery that's found in consumer smartphones. To make the robot swim, the motor pumps water into two balloon-like chambers in the fish's tail that operate like a set of pistons in an engine. As one chamber expands, it bends and flexes to one side; when the actuators push water to the other channel, that one bends and flexes in the other direction.



Using its undulating tail and a unique ability to control its own buoyancy, SoFi can swim in a straight line, turn, or dive up or down. Photo courtesy of MIT CSAIL.

These alternating actions create a side-to-side motion that mimics the movement of a real fish. By changing its flow patterns, the hydraulic system enables different tail maneuvers that result in a range of swimming speeds, with an average speed of about half a body length per second.

"The authors show a number of technical achievements in fabrication, powering, and water resistance that allow the robot to move underwater without a tether," says Cecilia Laschi, a professor of biorobotics at the Sant'Anna School of Advanced Studies in Pisa, Italy. "A robot like this can help explore the reef more closely than current robots, both because it can get closer more safely for the reef and because it can be better accepted by the marine species."

The entire back half of the fish is made of silicone rubber and flexible plastic, and several components are 3-D-printed, including the head, which holds all of the electronics. To reduce the chance of water leaking into the machinery, the team filled the head with a small amount of baby oil, since it's a fluid that will not compress from pressure changes during dives.

Indeed, one of the team's biggest challenges was to get SoFi to swim at different depths. The robot has two fins on its side that adjust the pitch of the fish for up and down diving. To adjust its position vertically, the robot has an adjustable weight compartment and a "buoyancy control unit" that can change its density by compressing and decompressing air.

Katzschmann says that the team developed SoFi with the goal of being as nondisruptive as possible in its environment, from the minimal noise of the motor to the ultrasonic emissions of the team's communications system, which sends commands using wavelengths of 30 to 36 kilohertz.

"The robot is capable of close observations and interactions with marine life and appears to not be disturbing to real fish," says Rus.

For more information, visit
WWW.CSAIL.MIT.EDU

Marine-i Announces £1 Million Fund for Robotics and Autonomous Vessels

Marine-i, the EU-funded programme set up to boost the marine technology sector in Cornwall and the Isles of Scilly, is inviting applications to a £1 million innovation fund.

The fund has been created to support research, development, and innovation in marine robotics and autonomous vessels. This is an area of marine technology that has been growing rapidly over recent years and offers major commercial opportunities for those businesses that can develop the technologies of the future.

Some of the key drivers for innovation are expected to be improving the reliability of autonomous systems, using robots to replace people in hazardous environments, increasing mission capabilities, and improving offshore monitoring.

Marine-i has released a Call for Applications at www.marine-i.co.uk/assets/uploads/pdf/Marine-i_Funding_for_Autonomous_Robotics_Document.pdf.

Applications for funding support must be submitted by midnight on 27 April 2018.

Professor Lars Johanning, Marine-i lead, says, "This is a fantastic opportunity for Cornwall-based businesses who are working in this area to bring their ideas to market more quickly. As well as funding support, the selected businesses will be able to benefit from comprehensive help from the Marine-i partners, including access to some of the leading researchers in marine technology, technology assessments, and subsidised graduate staff. We have a dedicated business engagement team who will be able to assist companies with their applications. So, I would urge interested parties to make contact with us as soon as possible."

Part funded by the European Regional Development Fund, Marine-i is a £9.3 million collaboration between the University of Exeter, Plymouth University, The Cornwall College Group, Cornwall Marine Network, Cornwall Development Company, and the Offshore Renewable Energy Catapult.

Full details can be found at
MARINE-I.CO.UK



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Researchers aboard the RV Roger Revelle prepare a bottle to collect water from the deep ocean. Credit: Rebecca Fowler

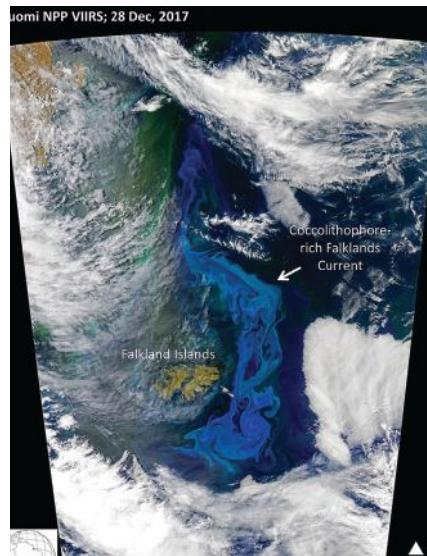
New Satellite Method Enables Undersea Estimates from Space

Bigelow Laboratory for Ocean Sciences researchers have developed a statistical method to quantify important ocean measurements from satellite data, publishing their findings in the journal *Global Biogeochemical Cycles*. Their research remedies a problem that has plagued scientists for decades: ocean-observing satellites are incredibly powerful tools, but they can only "see" the surface layer of the ocean, leaving most of its depths out of reach.

The new method makes it possible to quantify six types of particles that are key to understanding ocean dynamics and ocean-atmosphere interactions. Scientists have long used ocean color remote sensing to measure these particles in surface waters, and now, they will be able to reliably calculate concentrations of these particles through the water column. These calculations will provide data about the first 100 meters of ocean water, or to the depth where light levels dim to about 1 percent of the brightness at the surface.

One important algae quantified by this new technique are the coccolithophores, ocean plants that surround themselves with reflective chalk plates that, en masse, can cause entire ocean basins to reflect more light when they "bloom."

The effects of these microscopic coccolithophores are far-reaching: they influence biogeochemistry, global carbon cycling, and global microbial ecology. The carbon they produce when building their chalk plates even helps buffer the



increasing acidity in the ocean caused by excess carbon dioxide in the atmosphere.

"It hit me that we've been calculating chlorophyll profiles from surface measurements for more than thirty years, but we don't know what the depth profiles of other biogeochemically-

important materials look like," said Barney Balch, a senior research scientist at Bigelow Laboratory and lead author on the paper.

The researchers also studied variables related to other ocean plant groups, like diatoms, which build glass shells that carry carbon to the deep sea, sequestering it from the atmosphere. Understanding carbon cycling is essential to understanding present and future changes to global climate. Balch and his co-authors used data from 19 cruises, gathered from more than 1,300 locations in all of the world's oceans. From this vast dataset, they calculated the concentrations of six biogeochemically-relevant particles in the sunlit portion of the ocean.

"It's just a simple question, but it required a large global dataset to answer," Balch said. "The results provide new oceanographic insights into the ecology and biogeochemistry of these important algae and particles, and they make satellites an even more powerful tool for describing the entire illuminated depths of the ocean."

For more information, visit
WWW.BIGELOW.ORG

Nautilus Minerals' Begins a New Era in Deep Sea Mining Production

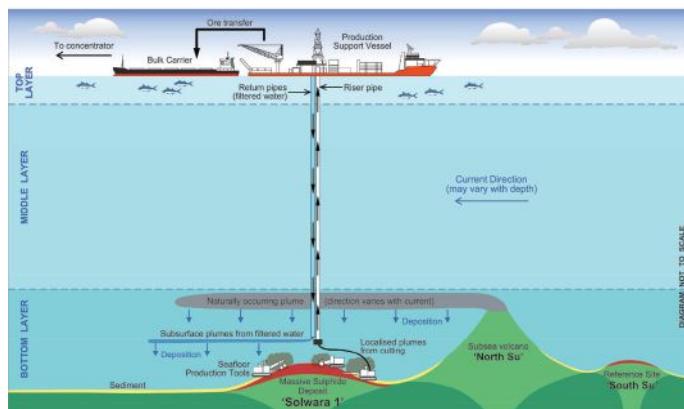


On 29 March 2018, Toronto-based Nautilus Minerals Inc. launched the world's first deep sea mining production support vessel—Nautilus New Era—at the Mawei shipyard in China. The vessel will be used by Nautilus and its partner, Eda Kopa (Solwara) Limited at the Solwara 1 Project site, in the Bismarck Sea of Papua New Guinea. Nautilus has contracted to charter, but not own, the vessel, which is a hybrid of a mobile offshore drilling unit, a cargo ship, and various special purpose ships.

Mike Johnston, Nautilus' CEO, commented at the launch: "Today's launch is a significant milestone for the company and the deep-water seafloor mining industry."

The vessel will generate power, house the mining crew, provide a platform for the launch, recovery, and servicing of the seafloor production tools, and provide a place for dewatering and temporary storage of mineralized material before shipment to offtakers for further processing, smelting, and precious metals recovery.

Broken mineralized material will be pumped to the surface via the riser and lifting system directly to a dewatering plant, which is located on Nautilus New Era. The dewatering plant is the only mineral processing function that will occur at Solwara 1. From an environmental management perspective, this means that no surfactants, filter aids, or other processing chemicals will be used in operation of the dewatering plant, which will reduce water content of the mineralized material to approximately 10%.



The dewatered mineralized material will be loaded directly onto Handymax-sized vessels that come alongside Nautilus New Era to carry the material away for further processing. Other than dewatering, no minerals processing activities will occur at sea. Nautilus has agreed to sell the mineralized material to the Tongling Nonferrous Metals Group Company, Ltd.

Johnston added, "We believe that mining the seafloor for much needed minerals will be a more cost effective and environmentally friendly source of obtaining high grade copper, gold, and silver. Nautilus further differentiates itself from others by having a "first-mover advantage," which is protected by intellectual property and 20 patents. Once our new vessel is delivered, and subject to final funding, mining operations at 1,600 m water depth is anticipated to commence in late 2019."

For more information, visit
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Researchers Capture Underwater Volcano Eruption in the Caribbean

by Hayley Dunning, Communications and Public Affairs, Imperial College London

Researchers got a rare opportunity to study an underwater volcano in the Caribbean when it erupted while they were surveying the area. The research, published in the journal *Geochemistry, Geophysics, Geosystems*, provides new insight into the little-studied world of underwater volcanoes. It investigated a volcano named Kick-'em-Jenny (KeJ), one of the Caribbean's most active volcanoes, which sits eight kilometres off the northern coast of the island of Grenada.

The team from Imperial College London, Southampton and Liverpool universities, in collaboration with The University of the West Indies Seismic Research Centre (SRC), were collecting ocean-bottom seismometers aboard the NERC research ship R.R.S. James Cook as part of a larger experiment when they were alerted to the volcano erupting.

Direct observation of submarine eruptions is very rare, but having the ship nearby allowed them to get to the volcano in time to record the immediate aftermath of the eruption. Using ship-based imaging technology, the team was able to survey the volcano, observing gas coming from the central cone. The data was then combined with previous surveys going back more than 30 years to reveal the long-term pattern of activity.

UNIQUE VIEW

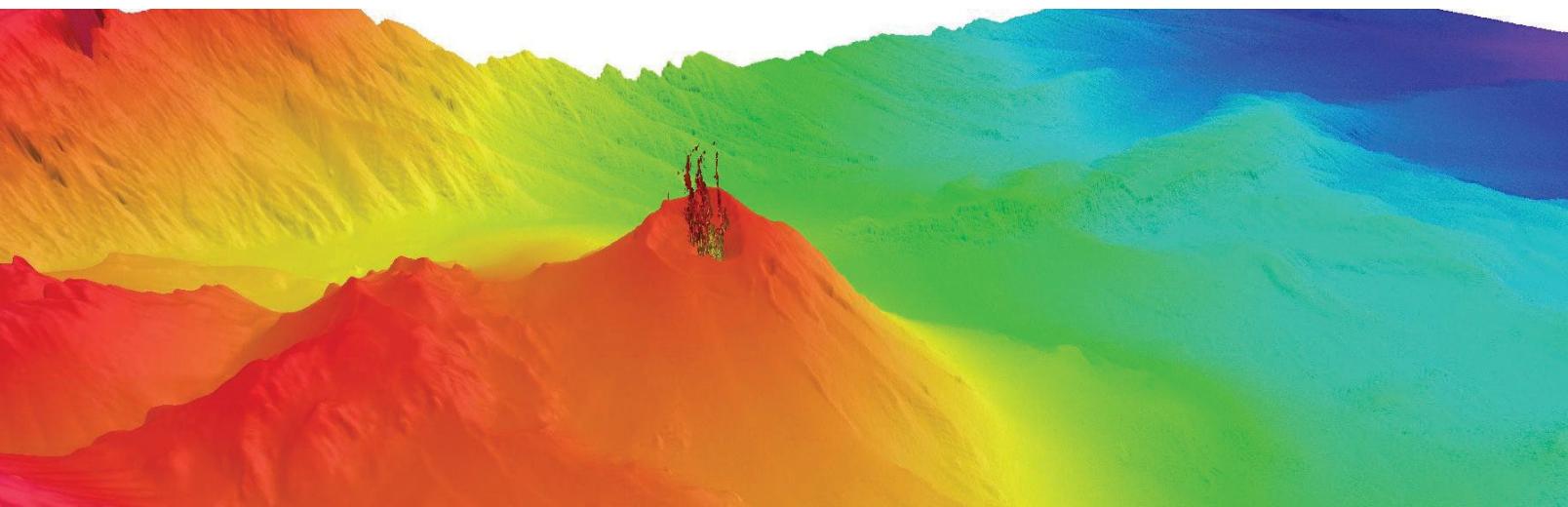
Lead author Robert Allen, a PhD student from the Department of Earth Science & Engineering at Imperial, said: 'There are surveys of the Kick-'em-Jenny area going back 30 years, but our survey in April 2017 is unique in that it immediately followed

an eruption. This gave us unprecedented data on what this volcanic activity actually looks like, rather than relying on interpreting seismic signals.'

The team found that the volcano has frequent cycles of lava 'dome' growth followed by collapse through landslides. Similar cycles have been recently witnessed on the nearby volcanic island of Montserrat. Co-author Dr. Jenny Collier, from the Department of Earth Science & Engineering at Imperial, said: "Kick-'em-Jenny is a very active volcano but because it is submarine is less well studied than other volcanoes in the Caribbean. Our research shows that whilst it has quite regular cycles, it is on a relatively small scale, which will help inform future monitoring strategies."

Any volcano on land which was as lively as KeJ would be constantly monitored by satellites and an array of local instruments looking for the slightest change in behavior that could precede a major volcanic eruption. Under the ocean this job is much more difficult, as the electromagnetic energy emitted by satellites cannot penetrate the sea surface and instruments are much more difficult to set up on the volcano itself. Scientists therefore know comparatively little about the growth and long-term behavior of a fully submerged volcanic cone like KeJ.

*Reference: '30 Years in the Life of an Active Submarine Volcano: A Time-Lapse Bathymetry Study of the Kick-'em-Jenny Volcano, Lesser Antilles' by R. W. Allen, C. Berry, T. J. Henstock, J. S. Collier, F. J-Y. Dondin, A. Rietbroek, J. L. Latchman, and R. E. A. Robertson, is published in *Geochemistry, Geophysics, Geosystems*.*



Underwater survey of Kick-'em-Jenny showing gas venting after the eruption in April 2017

Real-time Data Help Miami Seaport Safely Bring in Ships

PORTS® provides critical environmental data to help pilots make quick navigation decisions

Every day off the Florida coast, pilots steer mega-ships down a watery highway into the Miami seaport. Each ship must stay on a narrow, carefully planned course



A container ship enters the shipping channel at PortMiami, where vessel pilots now have access to real-time current information to help guide them safely into port. PORTS® is deployed in many busy waterways throughout the U.S. to provide key environmental parameters, including water levels, currents, waves, salinity, bridge clearance (air gap), winds, air and water temperature, and visibility. Sensors are tailored to meet specific needs at each seaport.

to protect not only the lives of those on board, but also the sensitive ecosystem in which the vessel operates, as well as the thousands of containers loaded up with furniture, machines, clothes, food, beverages, and other commodities bound for the United States.

As ships approach the port in Miami, they face a particular challenge: strong currents from the Gulf Stream run perpendicular to the shipping channel. This makes navigation especially difficult. Pilots need information on these currents to make immediate and rapid navigation decisions. Miami ship pilots now have access to real-time information that will help them get into seaport more safely, thanks to a NOAA system called Physical Oceanographic Real-Time System (PORTS®).

The system, established in a public-private partnership between NOAA and PortMiami, consists of three current meters located on U.S. Coast Guard buoys that measure current speed and direction. Sophisticated sensors collect data every six minutes and send it to NOAA via Iridium satellite, where it is published online at tidesandcurrents.noaa.gov.

PORTS® around the United States provide vessel operators with real-time status of key environmental parameters—including water levels, currents, waves, salinity, bridge clearance (air gap), winds, air and water temperature, and visibility. At each location, the local partner identifies the sensors they need to enable the best safety of life and property decisions for the seaport.

The trend towards bigger vessels and greater port traffic means increased potential for accidents. An investment in PORTS® provides data and decision-support tools that can help mariners and port operators avoid maritime accidents. Studies show vessel accidents are reduced by more than 50% at seaports where PORTS® is in place.

Some PORTS® can even help ship operators maximize cargo and plan more efficient routes based on how high-water levels will be along the way. Just one additional inch of usable draft can translate into millions of dollars of additional cargo per vessel transit. Now that Miami PORTS® is completed, 31 systems provide safer and more efficient navigation to seaports across the U.S., supporting seaports handling around 85% of the nation's cargo by tonnage.

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The Environmental Geospatial Platform for Today's Offshore Digital Oilfield

THE NEED TO DO MORE WITH LESS

While worldwide oil demand and production are increasing, oil prices have dropped over 50% since mid-2014. Additionally, offshore operators have seen increased regulatory regimes while also proactively developing enhanced Safety and Environmental Management Systems. This has significantly reduced operating margins. As a result, companies look for innovative ways to become more efficient and productive. Digital oilfield technologies offer a valuable means to this end.

The digital oilfield can be broadly characterized as the adaptation of software and data analysis tools and techniques to improve key business drivers. These business drivers include more efficient production, better safety, reduced risk, and improved environmental protection. The digital oilfield is about integrating data and workflows across the life of a field to provide access and insight to information that facilitates informed data driven decisions.

As offshore operators adapt to a lower-for-longer oil price outlook, the implementation of information management solutions and the digital oilfield will allow for better data capture and process optimization across all upstream activities. While the majority of optimization may focus on reservoir, well, and facility performance, opportunities exist to increase the efficiencies in the acquisition, interpretation, analysis, and distribution of environmental data.

REGULATORY PERMIT APPROVAL REQUIREMENTS

As a precursor to regulatory permit approval, offshore operators are required to develop an Environmental Impact Assessment (EIA). Impact assessments come in many forms depending on the project location and regulatory requirements.

For U.S. domestic needs at the federal level, the most frequently encountered assessments in the marine environment are in response to the National Environmental Policy Act (NEPA 42 USC

4321 et seq.). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and evaluating reasonable alternatives.

Internationally, offshore operators often require an EIA, Environmental and Social Impact Assessment (ESIA), or Environmental, Social and Health Impact Assessment (ESHIA). The type of assessment, the process, and the document contents can vary depending on the country and its regulatory framework.

The development of these environmental impact documents often specifies initial baseline studies as well as potential ongoing environmental monitoring programs. Baseline conditions can be supported by historical data and/or supplemental field collected data.

For offshore drilling programs, typical environmental data collected include:

- Benthic samples;
- Water chemistry;
- Sediment characteristics;
- Visual assessment of sea floor;
- Discharge plume modeling;
- Metals analysis of drilling fluids;
- Sea bottom surveys; and
- Bird and mammal observations.

The centralization and management of these environmental data sets is key for sharing information about a project, region, or event. In almost every instance, this environmental data will have a spatial component, for which the scale may be local or global. The data may exist in many forms, including physical documents, laboratory data, asset locations, and video or modelling results. The information may be highly dynamic, as with real-time data feeds, or relatively static, such as historical information. The data may

be intended for foundational planning, required for guiding procedures and work flows, assisting with decisions, or displaying results.

The adaptation of digital oil field technologies to support environmental activities in the offshore oil and gas industry enhances collaboration across business units, geographic locations, and stakeholders. The availability of high definition video, along with the ability to spatially orient video, provides new methods of collaboration, analysis, and communication.

A STRUCTURED FRAMEWORK FOR OFFSHORE ENVIRONMENTAL DATA

Recognizing the transformational nature of applying digital oil field technologies to offshore environmental science, preparedness, and response activities, CSA Ocean Sciences Inc. (CSA) designed and developed a custom web-based Geographical Information System (GIS) platform to enable the secure integration and visualization of geospatial data, tabular data, documents, and online data services. The platform—EDGSonline—provides a structured framework for acquiring, managing, analyzing and distributing offshore environmental data.

EDGSonline is both a secure authoritative data repository as well as a platform

for organizing layers of environmental spatial information with the ability to provide access and insight into data relationships and patterns. Whether in the feasibility stage of an offshore project, the development of an EIA or a response to an incident, EDGSonline allows users to leverage the significant investment in data acquisition, storage, access, security and maintenance to make informed data driven decisions.

SHARE COMMON DATA

The key to maximizing digital oil field technologies is having integrated, high-quality data. Additionally, by leveraging the EDGSonline platform, the environmental data is accessible and clients, regulators and other concerned stakeholders can connect and collaborate.

For offshore oil and gas activities, environmental data is used, shared, and leveraged in multiple phases of the life of a field. For example, shoreline Environmental Sensitivity Indexes (ESIs) will be referenced in the Feasibility stage to develop Environmental Risk Assessments. That same data is used to develop EIAs, Oil Spill Response Plans (OSRPs), and is referenced in oil spill trajectory modeling. Figure 1 shows the integration of multiple data sets across

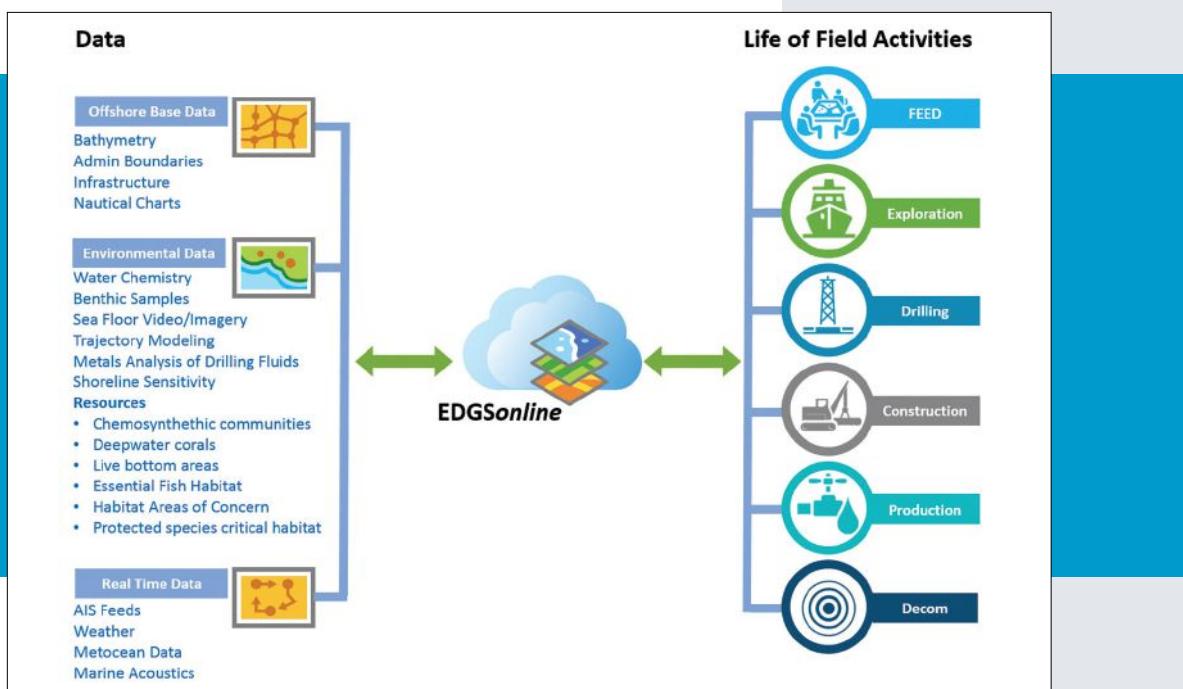
the Life of Field.

With secure log-in based user access, the EDGSonline platform provides spatial views of key environmental data layers. Using an intuitive interface, users can navigate the maps, query for data, and define saved views. Key capabilities include:

- Rapid, secure communication of field data and observations from multiple scientific and operational teams;
- Secure, centralized access to sampling plans and project documentation;
- Advanced search capabilities to unlock the data behind the view; and
- Customized tools for leveraging spatially-referenced still images and video.

The example screen capture above illustrates how baseline data for the Gulf of Mexico are integrated with project-specific data layers, documents, and imagery. EDGSonline has unique, custom videospatial tools for displaying and managing spatially-referenced imagery.

The EDGSonline platform leverages key digital oilfield technologies and is the system of record for offshore oil and gas



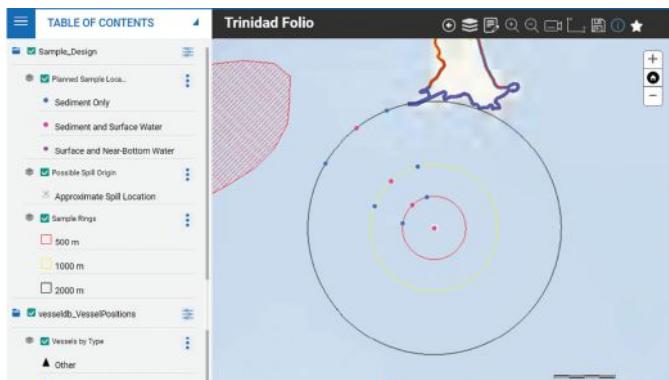


Figure 2. Oil sampling plan developed in response to a product release on an offshore platform. The plan provides critical information for the field data collection and is a secure repository for sampling results.

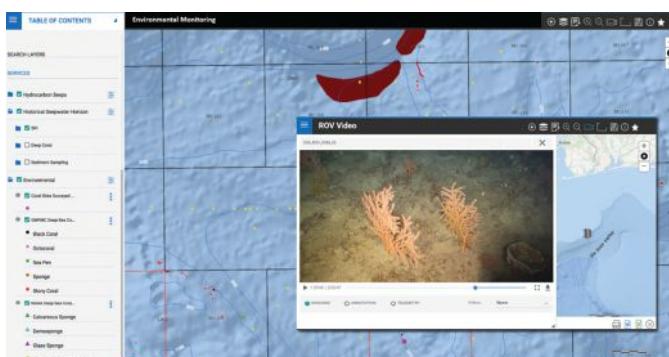


Figure 3. Integrated Spatial Video.

companies' environmental activities. The same technologies and platform used to analyze environmental risk are used to store and analyze collected data during the project and to securely house post decommissioning studies data. EDGSonline is an important component to an offshore oil and gas companies' overall digital transformation and is the core component of leveraging the investment in environmental data.

CONCLUSION

Offshore operators are faced with continuing challenges, including changing energy policies, environmental concerns, and uncertain oil prices. As energy demand rises and oil prices remain low, offshore oil and gas operators will seek greater efficiencies in overall operations. The adaptation of digital

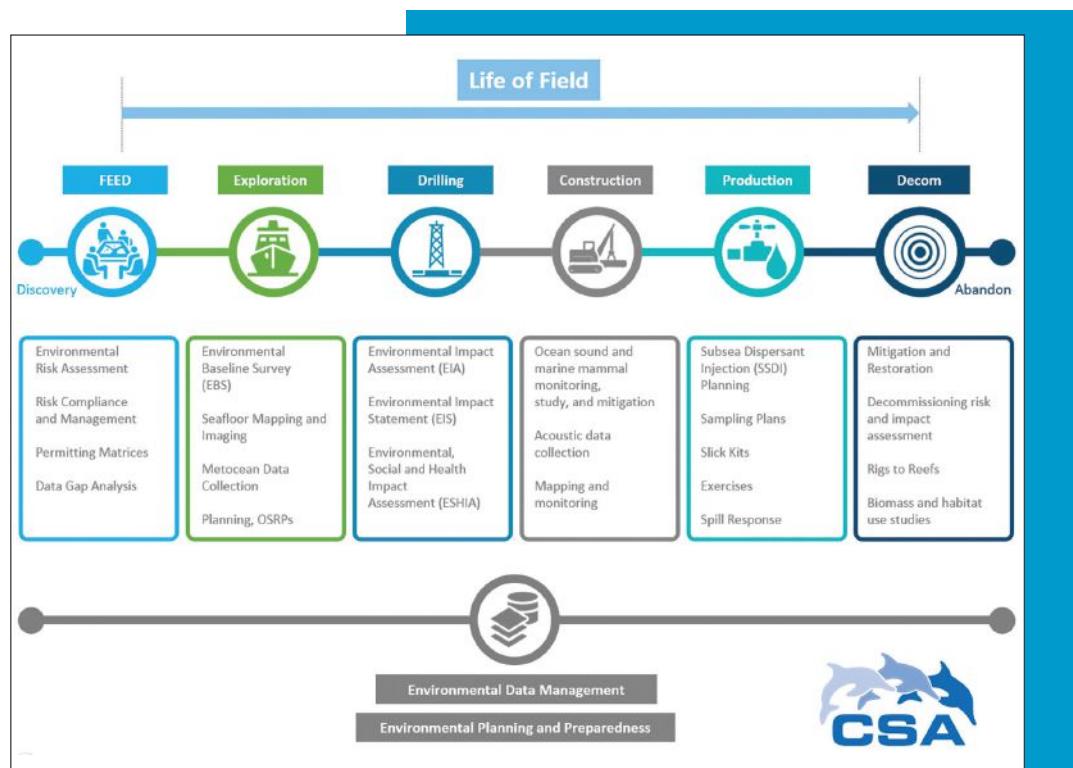
oilfield technologies will facilitate these efficiency gains. As a premier provider of environmental preparedness and response services, CSA recognizes the significant investment companies make in the acquisition, analysis, and management of environmental data in support of offshore operations.

With the implementation of EDGSonline, companies have the core platform for digitally transforming the acquisition, distribution, management, and analysis of environmental data. Companies adapting the EDGSonline platform as a key component in the digital oilfield transition will improve business performance and efficiency. Additionally, the simultaneous access to historical data, field acquired data, and real-time data, in the context of spatial relationships, will facilitate more informed data-driven decision making.

CSA OCEAN SCIENCES, INC.

CSA specializes in multidisciplinary projects concerning potential environmental impacts of activities throughout the world. Additionally, CSA provides environmental preparedness and response services to assist the energy industry with preparing for and responding to oil spills and damage assessments in the offshore environment. CSA's decades of experience in marine science, operations and data management are applied to these unique challenges in the U.S. and internationally. CSA provides this range of marine environmental services throughout the life of a field from feasibility to abandonment.

Figure 4. CSA services provided for each life of field activity.



THIS MIGHTY BLUE HAMMER

Drives Piles into the Seabed—Quietly

The Carbon Trust has launched a large-scale demonstration project aimed at reducing costs and underwater noise during construction of offshore wind farms as part of the Offshore Wind Accelerator (OWA).

The BLUE PILOT project will deploy The BLUE Hammer, a new type of pile driver developed by Fistuca BV, a Dutch technology company spun-off from Eindhoven University of Technology. It is anticipated that the project can enable potential lifetime savings of up to €33 to 40 million for a 720-MW offshore wind farm, which is equal to a levelised cost of energy (LCOE) reduction of €0.9-1.2/MWh.

The BLUE Hammer is predicted to reduce underwater noise levels by up to 20 dB (SEL), and potentially reduce the fatigue damage during installation on the pile by up to 90%.

This could not only remove the need for underwater noise mitigation, but also enable secondary steel to be pre-welded to the monopile before installation, potentially unlocking "transition piece free" designs. By reducing the amount of time and number of operations carried out offshore, the innovative piling method could improve health and safety and result in a significantly lower installation cost.

The BLUE PILOT project aims to verify these predictions through the installation of a full-size monopile offshore, using measurement equipment and sensors to validate the predicted noise levels and fatigue damage. The tests will take place during summer 2018 and high-level findings will be made publically available later in the year.

The BLUE Hammer will be tested offshore in Dutch waters. Sif will provide the monopile, and Van Oord will support the installation logistics. Other industry partners will provide funding and strategic advice.

The BLUE Hammer consists of a large water tank that contains an open combustion chamber. Energy for driving the pile is created with gas combustion that accelerates a large column of water.

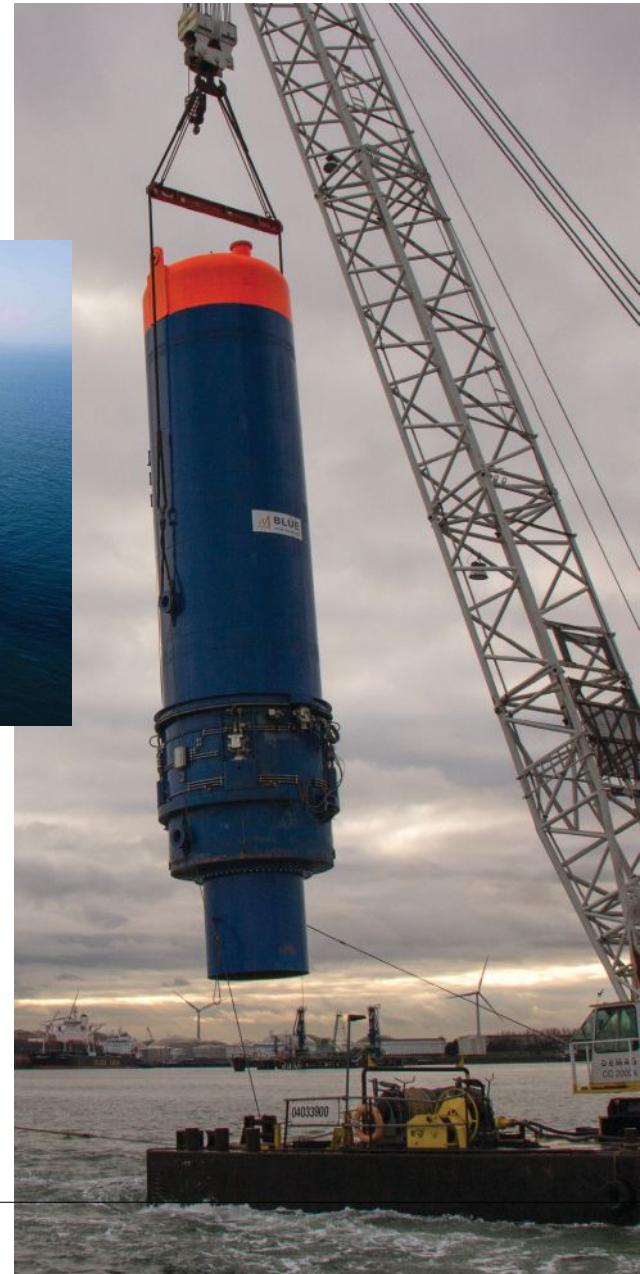
As the column of water falls back to the bottom of the water tank, it decelerates transferring the energy into the pile. Due to the properties of water, this deceleration occurs over a longer time period than a conventional hydraulic hammer, providing a quieter and gentler—but more energetic—blow.

OWA partners E.ON, EnBW, Ørsted, Statoil, and Vattenfall, alongside industry partners Fistuca, Van Oord, Shell, and Sif are contributing €3.2 million funding to the project. The Netherlands Enterprise Agency has granted public subsidies of over €2.5 million.

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The BLUE Hammer deployed on the crane ship Svanen. The hammer uses a large water column to drive a pile in the soil.



Offshore Energy Insurance Prospects Improving, says IUMI

Against the backdrop of encouraging global economic growth and an improved outlook for the shipping industry, the International Union of Marine Insurance (IUMI) provided its expert opinion on the current state of offshore energy insurance market at its Spring Conference in Hamburg 18-19 March 2018. The content below has been edited for length.

A 25% increase in the oil price has encouraged an upturn in offshore exploration activity which is starting to impact positively on the offshore energy insurance sector. Similarly, the oil price rally has increased the value of "loss of production" insurance purchased.

However, Chair of IUMI's Offshore Energy Committee, James McDonald, remains cautious: "Capex growth is mainly confined to the US shale market where insured values are considerably



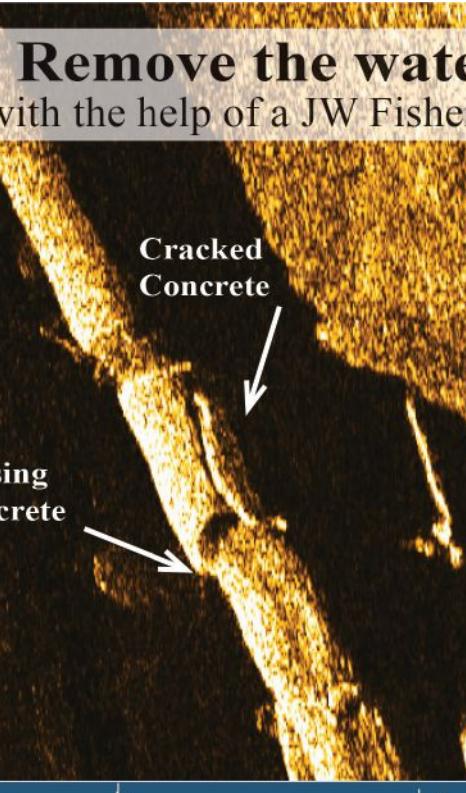
less than those achieved offshore. That said, we expect to see an increase in premiums associated with mobile offshore drilling rigs as they come out of lay-up. But day rates for floaters and jack-ups remain well below their earlier peaks due to continued over-supply."

Loss activity offshore remains low. Hurricane Harvey bypassed the heavily populated Gulf of Mexico and large losses, in general, were minimal. A

worrying trend for construction sector losses involving buoyancy devices seems to be developing, however. Attritional losses continued to track at a low rate due to reduced activity and improved health and safety practices. But this might reverse as rigs are reactivated.

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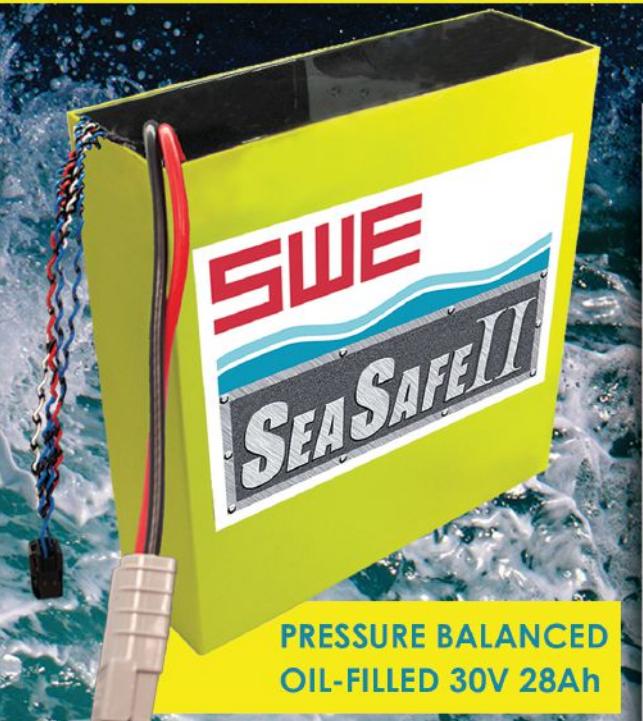
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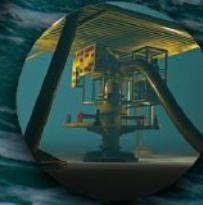
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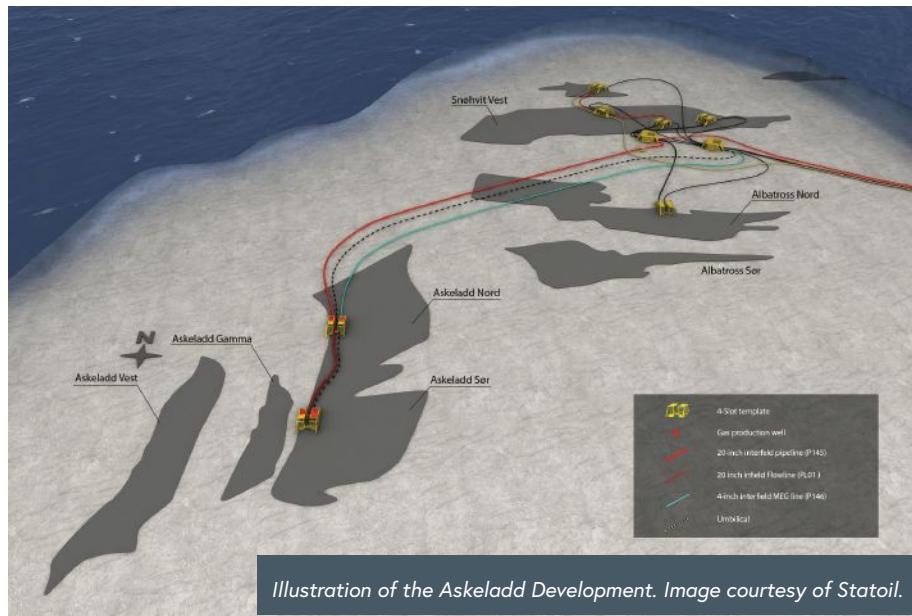


Illustration of the Askeladd Development. Image courtesy of Statoil.

STATOIL AND PARTNERS INVEST in Askeladd Development

Statoil and its partners have decided to invest just over NOK 5 billion in the further development of the Snohvit field in the Barents Sea, which will provide feedstock for the LNG plant at Melkøya in Hammerfest. As part two of the multi-phased Snohvit development, the Askeladd development will supply 21 billion cubic meters of gas and two million cubic meters of condensate to Hammerfest LNG. Production is expected towards the end of 2020.

"This is the next step in the development of Snohvit. Askeladd will help maintain a plateau production rate at the Hammerfest LNG plant until 2023 and is a profitable investment that will help secure jobs and ripple effects in the region," says Torger Rød, Statoil's senior vice president for project development.

But the perspective for Snohvit and Hammerfest LNG is much longer: "The Snohvit license contains enough gas to maintain production beyond 2050, and Hammerfest LNG will provide jobs for many years to come," says Per Henry Gonsholt, acting production director at Hammerfest LNG. More than 400 people currently work at the plant.

Askeladd will be developed with three wells via two new subsea templates with space for additional future wells. In addition, infrastructure will be installed to tie-in the Askeladd development to existing Snohvit field infrastructure. The multi-phased development of Snohvit was covered in the plan for development and operation (PDO) of Snohvit, approved by authorities in 2002 and the partnership is already working on next steps.

The Askeladd development will contribute to increased activity at the Polar Base in the project period, and Aker Solutions has been awarded the contract for the two subsea templates. Additional contracts will be awarded in the following months.

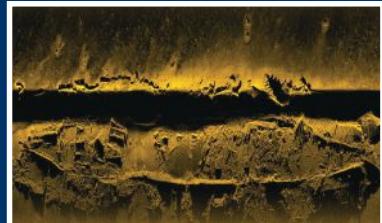
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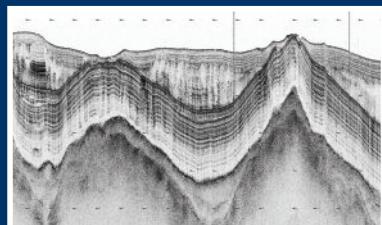
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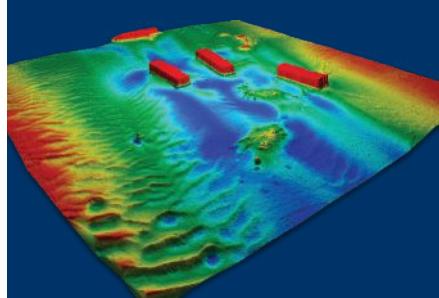
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SIEMENS GAMESA to Expand Taiwan's Formosa 1 Offshore Wind Power Plant



One year after the commissioning of Taiwan's Formosa 1 Phase 1 offshore wind power plant, Siemens Gamesa Renewable Energy (SGRE) has been contracted to supply an additional 120 MW of capacity for Phase 2. The contracts signed are subject to the joint venture's final investment decision and financial close, which are expected later in 2018. In addition to the turbine supply agreement, a signed 15-year full service agreement includes the provision

of spare parts and tools to help ensure the reliability and optimal performance. The installation of the 20 SWT-6.0-154 wind turbines will start in 2019 and will expand the total capacity of Formosa 1 to 128 megawatts (MW).

SGRE signed the contract together with the owner's consortium partners, including Macquarie Capital, Ørsted, and lead developer Swancor Renewable Energy Co. When completed, Formosa 1 will be the first project successfully built as part of the official Taiwanese Grant Scheme. The program defined by the government in 2012 supports an offshore turbine fleet of up to 520 MW to be in operation by 2020.

The project is located around six km off the west coast of the Miaoli district in the Taiwan Strait with water depths between 15 to 30 m. The Siemens Gamesa wind turbines will be installed on monopile foundations. This foundation has already proven its suitability in the local sea bed conditions when the first two SWT-4.0-130 turbines were installed for Phase 1.

The Taiwanese government announced a tender for which the results of the first round are due April 2018. A new SGRE Taipei office opened in 2017 and agreements have been signed with Taiwan International Ports Corporation, Yeong Guan Energy Technology Group and Swancor Holdings Co. on the development of the supply chain.

ABB Delivers Virtual Flow Meters Powered by Arundo Analytics

Arundo Analytics and ABB have collaborated to create the first cloud-based virtual multiphase flow meters for the offshore oil and gas industry. Typically, intermingled fluids in a single stream are measured with multiphase flow meters (MPFMs), which can take up a significant amount of a facility's capital expense. The cloud-to-cloud solution connects ABB Ability™ and Arundo's Composer and Fabric software, helping facilities gain real-time data to understand the constituent properties of any given stream of produced fluids.

www.arundo.com

Gardline Close Metocean Department

As part of the ongoing review of the Gardline Group's strategic direction, the Metocean Department within Gardline will be closed. No new assignments will be accepted and all long-term clients have been informed of the closure. Gardline thank their clients, partners, and collaborators with whom they have worked over the years.

[http://www.gardline.com/
newsandmedia/110](http://www.gardline.com/newsandmedia/110)

Interior Announces Offshore Leases for Commercial Wind Off Massachusetts

U.S. Secretary of the Interior Ryan Zinke has announced the proposed lease sale for two additional areas offshore Massachusetts for commercial wind energy leasing, totaling nearly 390,000 acres. A Proposed Sale Notice (PSN) for Commercial Leasing for Wind Power on the Outer Continental Shelf Offshore Massachusetts was published in the Federal Register on 11 April will include a 60-day public comment period.

www.boem.gov/Massachusetts

BOEM to Conduct Environmental Review Offshore Massachusetts

BOEM has announced a Notice of Intent to prepare an Environmental Impact Statement (EIS) for the Construction and Operations Plan submitted by Vineyard Wind LLC that would allow it to construct and operate an 800-MW wind energy facility approximately 14 miles from the Martha's Vineyard, Massachusetts and a similar distance from Nantucket. Water depths where the turbines would be located range from approximately 37 to 49 meters.

<https://ont.news/2Hbc6nMdd>

Offshore Oil & Gas Lease Sale Announced for Gulf of Mexico

The Department of Interior has announced that it will offer 77.3 million acres offshore Texas, Louisiana, Mississippi, Alabama, and Florida for oil and gas exploration and development. The region-wide lease sale, scheduled for 15 August 2018, would include all available unleased areas in federal waters of the Gulf of Mexico.

Lease Sale 251, scheduled to be livestreamed from New Orleans, will be the third offshore sale under the National Outer Continental Shelf (OCS) Oil and Gas Leasing Program for 2017-2022. Under this program, ten region-wide lease sales are scheduled for the Gulf, where resource potential and industry interest are high, and oil and gas infrastructure is well established. Two Gulf lease sales will be held each



year and include all available blocks in the combined Western, Central, and Eastern Gulf of Mexico Planning Areas.

The sale will include approximately 14,474 unleased blocks, located from 3 to 231 miles offshore, in the Gulf's Western, Central, and Eastern planning areas in water depths ranging from 9 to more than 11,115 feet. Excluded from the lease sale are blocks subject to the congressional moratorium established by the Gulf of Mexico Energy Security

Act of 2006; blocks that are adjacent to or beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and whole blocks and partial blocks within the current boundary of the Flower Garden Banks National Marine Sanctuary.

For more information, visit
WWW.BOEM.GOV/SALE-251

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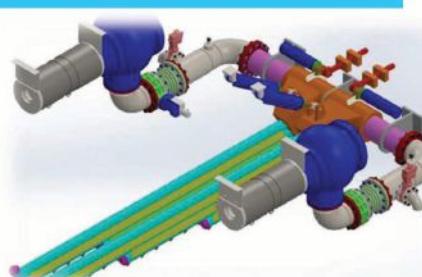


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NEW TOOLS BRING ADVANTAGES OF ELECTRIC POWER TO SUBSEA OPERATIONS

BY CHARLES BIRGER HANSEN AND DAN SCOVILLE, OCEANEERING INTERNATIONAL, INC.

Since the first remotely operated vehicles (ROVs) were introduced to the oil and gas industry in the 1980s, they have relied on hydraulically powered tooling to perform tasks required for subsea operations, such as tightening bolts, opening and closing valves, attaching flying leads, and cleaning wellheads and other equipment. As oil companies develop reserves beneath environmentally sensitive Arctic waters and regulators increasingly require "no spill" operations in the North Sea and other areas, subsea equipment suppliers are taking steps to replace systems powered by hydraulic oil with tooling driven by electric motors.

Benefits and Drawbacks of Hydraulic Power

The first several generations of ROVs relied on hydraulics to power mechanical tools needed for subsea construction and maintenance. Hydraulic tooling uses mature technology and straightforward design to provide torque to turn valves, clean components, cut tubulars, tighten bolts, and perform other tasks. The advantages of hydraulic motors include the ability to incorporate them into appropriately sized tooling packages without extensive research and development (R&D) and their capacity to deliver enough power to perform even the most demanding tasks, such as attaching flying leads, in the subsea environment.

Hydraulically powered ROV tooling also has drawbacks. While hydraulic tools provide substantial power output, it is difficult to control them with precision. For example, on low-torque valves that open or close with one or two turns at 100 to 200 Newton of force, a hydraulic tool can over-tighten the valve and potentially cause damage. In addition, hydraulic tools typically have a narrow operating range. Traditional hydraulic torque



tools in the Gulf of Mexico usually require three different sizes of motors to operate all classes of subsea valves, so ROVs must return to the surface frequently to change tooling. Hydraulic tooling always presents the risk of leaking hydraulic fluid into the environment or into the tool's internal components, which requires frequent inspection and continual maintenance. New electrically powered systems have the potential to address most of the shortcomings of hydraulically powered tools.

Advantages of Electric Motors

Traditionally, ROV designers have opted for hydraulic motors because they have offered the only practical means to power subsea tooling. Until recently, electrically powered components were too large and too expensive to replace standard hydraulic tooling. However, in the past several years, the size and cost of available electrical motors and controllers have been reduced

considerably, so electrically powered tooling is now available at the same cost and in the same sizes as standard hydraulic equipment. In addition to eliminating the risk of hydraulic oil leaks, electrically powered ROV tooling has fewer parts and can be controlled more precisely than hydraulic tools that perform the same tasks.

While hydraulic torque tools can be controlled to within one-quarter of a turn, electric tools can be controlled precisely to within 0.005 of a revolution. This precision takes the guesswork out of operations and improves equipment reliability by limiting potential valve damage.

Hydraulic tooling will continue to find widespread use, particularly for tasks that require high torque levels. To maintain compatibility with existing ROVs and subsea equipment, tooling suppliers have developed ways to replace hydraulic motors with electric motors in common tools while keeping mechanical operation and outside dimensions the same.

New Electric ROV Tooling

For example, Oceaneering International has developed a range of electric motors that can replace hydraulic motors in many of its ROV tools. New electric motors can power a multipurpose cleaning tool, such as an 18 ¾-inch wellhead cleaning tool, a suction kit, and a tool elevator—all of which previously used hydraulic motors.

In addition, Oceaneering has introduced a newly designed electric torque tool that is simpler than previous torque tools and can be controlled more precisely. The new electric torque tool also features a universal end effector that, unlike hydraulic torque tools, can actuate Class I through Class IV valves without

being retrieved to the surface to change tooling.

Before its commercial introduction, this electric torque tool was tested in an Oceaneering facility in Norway, where prototypes underwent more than 80,000 operating cycles without failures. Such extensive testing is unusual for subsea equipment, which typically performs just a few dozen operations between maintenance cycles. The new electric torque tool was deployed and successfully operated in deepwater fields in Norway, the Gulf of Mexico, and the Asia Pacific region.

Important Step for Subsea Systems

This new electric tooling represents an important step toward the widespread use of electrically powered subsea systems. The electric tools are compatible with new electric ROVs, like the Oceaneering® eNovus ROV system, and can also be used with smaller ROVs that do not have the capacity to drive hydraulic tools. In addition, the new tools can be modified easily to fit different housings and can become semi-permanent components of a subsea installation and controlled from surface production facilities.

Another potential application for electric motors will be on light

well riserless intervention systems that provide access to live deepwater wells. Accumulators used to actuate valves and shear tools on current intervention systems could be replaced with electrical motors and battery-powered failsafe systems. The electric alternative would not be affected by water depth and would reduce the overall system's weight, so intervention could be performed with a smaller crane and service vessel.

Electric tools will also be important components on future electric "resident" ROVs, which will be docked on floating production units or parked long term on the seafloor to inspect and service nearby subsea production equipment and infrastructure. These ROVs will be controlled remotely from shore to perform subsea operations independent from service vessels.

For more information, visit
WWW.OCEANEERING.COM



Above and left: This electric torque tool replaces legacy hydraulic ROV tooling for opening and closing subsea valves, eliminating the risk of hydraulic fluid leaks. It can be precisely controlled and features a universal end effector compatible with Class I through Class IV valves.

Aquabotix Releases Revolutionary SWARMDIVER™ MICRO USV / UUV



AQUABOTIX

SwarmDivers™ in a swarm of approximately 30 units encircling a vessel.

UUU Aquabotix Ltd (ASX:UUU) (Aquabotix), an underwater robotics company with operations in Australia and the United States, announces the release of SwarmDiver, a micro unmanned surface vehicle (USV) and unmanned underwater vehicle (UUV) that operates in a swarm. Multiple SwarmDivers can function simultaneously as a single coordinated entity, be easily controlled via one operator on the surface, and perform dives on command to collect valuable intelligence.

Whitney Million, Aquabotix's Chief Executive Officer, commented, "This vehicle is a game-changer for both the industry and Aquabotix. Until today, there were simply no micro hybrid USV/UUV vehicles and no swarming unmanned vehicles with diving capabilities commercially available in the industry. Aquabotix has changed that."

Maritime swarming is rapidly becoming an area of focus for naval forces globally, and SwarmDiver leads a revolution in underwater technologies.

SwarmDiver advances amphibious warfare tactics as it is engineered to handle dynamic operational situations, including Intelligence, Surveillance, and Reconnaissance (ISR) missions and sophisticated, coordinated assaults through tracking, trailing, and overwhelming targets.

In addition to defense and security applications, SwarmDivers can be deployed in research, harbour management, and oceanography.

The key details of SwarmDiver are set out below:

- Miniaturized: weighing just 1.7 kg at a length of 75 cm
- Vertical dive capability
- Ability to operate as both a UUV (diving underwater) and a USV (on the surface)
- 50 meter dive depth
- Easily deployable and recoverable

- Wireless data feedback upon surfacing
- High accuracy temperature (+/-0.1° C) and pressure sensor (+/- 2 cm depth)
- Additional sensor payloads available
- Multi-constellation GPS for +/- 1 m location accuracy
- Deployable in groups for synoptic data gathering
- Sustained surf zone operation
- Low cost

For more information, visit
WWW.AQUABOTIX.COM

JFSE LAUNCHES THE 'EXCAVATION PLUS' INTEGRATED SERVICE PACKAGE

Global subsea excavation specialist James Fisher Subsea Excavation (JFSE), a part of James Fisher and Sons plc, has launched an integrated services package to deliver improved time and cost efficiencies to its clients worldwide.

The world's leading provider of controlled flow excavation (CFE) services recently completed its largest integrated services project in the Middle East. Its Twin R2000 with ancillary jetting spread was contracted for shallow water post-lay trenching and backfilling. Additionally, JFSE chartered the vessel, project personnel, and crew as well as the positional and bathymetric survey services.

As part of the Excavation Plus offering, JFSE is the single point of contact for a range of areas, including project management, geotechnical services and naval architects as part of a full-vessel mobilisation package. JFSE also draws upon the wider expertise of its sister companies in the James Fisher group to provide services such as diving, IRM works and cable repairs.

Kenneth Mackie, managing director of the world's most trusted, experienced and innovative provider of CFE services, said: "We are delighted to now officially offer our clients a truly integrated solution to their subsea excavation requirements. The industry is evolving and we are working to be true partners to our clients, streamlining the entire process."

"Multiple services from a single supplier is incredibly efficient and means our clients don't have to interface with numerous vendors. As part of the James Fisher group of companies, we have unrivalled access to a wealth of expertise."

"We are proud to be the only CFE provider offering this level of service to our clients and further proves our commitment to responding to, and anticipating, the needs of the global oil & gas, decommissioning and renewables industries."

JFSE is currently preparing for integrated projects in the Middle East, Eastern Asia, and Gulf of Mexico and is planning to roll out the Excavation Plus service worldwide. Clients will be able to tailor the package to suit their particular project requirements—providing a flexible approach.

FOR MORE INFO, VISIT
www.jfsubseaexcavation.com



NOC'S ALR BOATY McBOATFACE Completes First Under-Ice Antarctic Mission

The National Oceanography Centre's autonomous underwater vehicle Autosub Long Range (ALR), known affectionately around the world as Boaty McBoatface, was successfully recovered in early March following its first under-ice mission beneath the Filchner Ice Shelf in West Antarctica. This success marks a significant milestone in proving the vehicle's capability.

From January to February 2018, the autonomous underwater vehicle (AUV) was deployed in the southern Weddell Sea during Research Vessel (RV) Polarstern cruise PS111 as part of the Filchner Ice Shelf System (FISS) project—a collaboration involving leading UK research institutions including the British Antarctic Survey (BAS), National Oceanography Centre (NOC), Met Office Hadley Centre, University College London, University of Exeter, and Oxford University, and international partners including Alfred Wegener Institute, Germany, and University of Bergen, Norway.

The AUV plays a critical role in the project that aims to investigate and describe the current state of the complex atmosphere-ice-ocean system. Boaty spent a total of 51 hours under the Antarctic ice, travelling 108 km over the duration of the deployment.

The vehicle reached water depths of 944 m and spent 20 hours exploring beneath a section of the ice shelf that was 550 m thick.

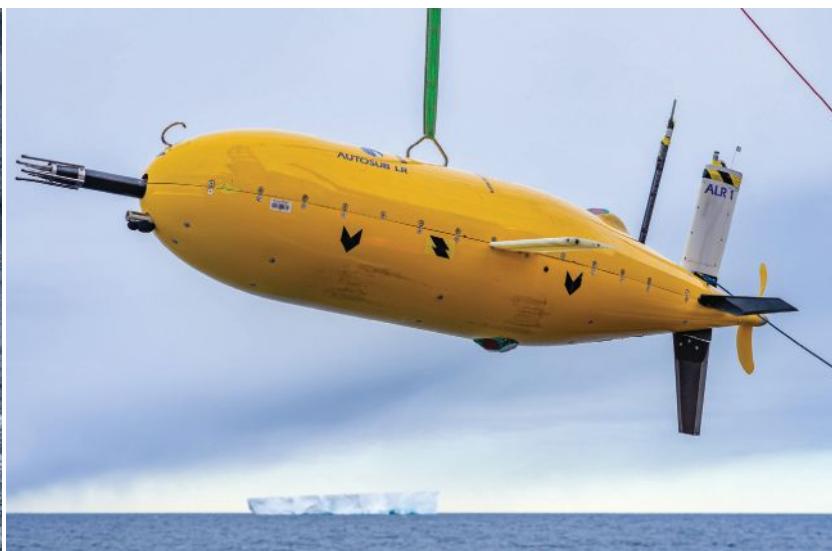
Steve McPhail, Head of AUV Development at NOC, said, "For the engineers involved, this was a very challenging deployment that was not without risk. We knew that the environment was harsh, with -20°C air temperatures and sea temperatures very close to the freezing point of seawater. Under the ice shelves there are significant tidal currents and the high southerly latitudes pose difficulties for the AUV's underwater navigation. Once in the ice shelf cavity we had neither detailed information on the thickness of the ice nor the depth of the water. We had no communication with the AUV for 90% of its time in the water."

"Waiting for the AUV to return after a 48-hour mission into a largely unknown environment is—to say the least—exciting, and as a result I was very relieved each time the AUV turned up, on time and in the right place, circling 900 m below the ship. Even then, our problems were not over. With the surface of the sea frozen, we needed RV Polarstern's help to create an ice hole through which we carefully navigated the AUV."

The AUV carried two sets of conductivity, temperature and depth sensors, measuring the salinity and temperature of the water. It was also equipped with a micro-structure probe to measure ocean turbulence, a sensor to measure the amount of phytoplankton in the water (by measuring the fluorescence of their chlorophyll), and a sensor to detect the turbidity of the water. Acoustic instruments also measured the water current up to 80 meters above and below the AUV's position and accurately measured the depth of the seabed and the draft of the ice along the vehicle's track

The Filchner-Ronne Ice Shelf is the second largest of its kind in the world. Covering an area of around 450,000 km², it holds a greater volume of ice than any other floating glacier tongue. Climate researchers are particularly interested in whether more glacial ice is currently being transported into the ocean, since this process is related to rising sea levels. In addition, so-called 'deep water' forms near the ice shelf, which is a key driver of global ocean circulation and, therefore, impacts upon the climate system everywhere on the planet.

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



EDGETECH SONAR Utilized in the Search and Discovery of the USS Lexington

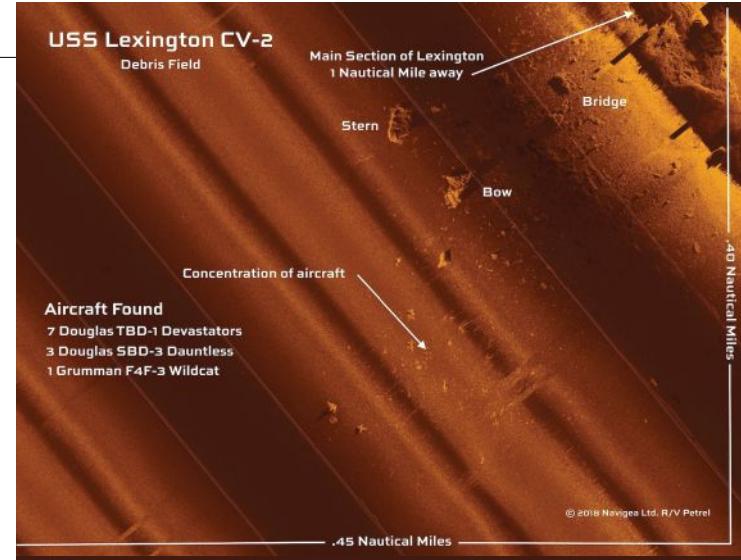
EdgeTech's side scan sonar technology was used by the Research Vessel Petrel and Paul Allen's talented team in the discovery of the USS Lexington.

The USS Lexington, one of the first aircraft carriers built and commissioned by the United States, was sunk during the Battle of the Coral Sea in 1942 off the coast of Australia.

The wreckage was discovered in approximately 3,000 m of water. EdgeTech side scan sonar systems provide operators the ability to image large areas of the seafloor during important deepwater searches when the whereabouts of sunken objects are largely unknown. EdgeTech's unique

side scan sonar frequency pairings such as 75/230kHz provide the ability to image over a 2,000 m swath as researchers conduct search patterns in deep waters.

The discovery of the USS Lexington comes less than one year after the discovery of the USS *Indianapolis*. EdgeTech takes great pride in knowing its high-quality, reliable underwater acoustic imaging systems continue to assist in these historical endeavors.



Above: Side scan sonar image of USS Lexington wreckage and its aircraft on the seafloor. Photo courtesy of Paul Allen and the R/V Petrel team.

Read more about finding the
[WWII Aircraft Carrier](#)
[USS Lexington](#)
on page 48.

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The Barracuda is a new breed of ROV, designed to work in high current. Small, Streamlined, Extremely Powerful and loaded with Advanced Capabilities.

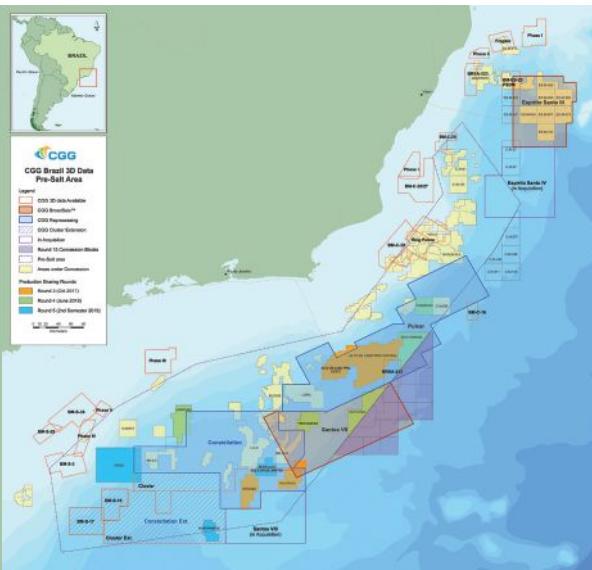
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CGG ADDS NEW SANTOS VIII Multi-Client Survey Offshore Brazil

For more information, visit
WWW.CGG.COM



CGG has commenced acquisition of a large broadband 3D multi-client survey in the pre-salt area of the deepwater Santos Basin. *Santos VIII* is the most recent survey in CGG's vast on-going pre-salt program that delivers

ultramodern seismic data, enabling exploration companies to better evaluate pre-salt opportunities in advance of Brazil's pre-salt licensing rounds.

Santos VIII covers an area of over 8,000km² adjacent to the Peroba, Pau Brasil, and Boumerangue fields. The resulting BroadSeis™ data will be imaged with CGG's advanced full-waveform inversion (FWI) technology in its Rio de Janeiro Subsurface Imaging Center and merged with the *Constellation* reprocessing project to provide a regional broadband image of this prolific basin. Fast-track products will be available in the fourth quarter of 2018 and final

products will be available in the second quarter of 2019.

Constellation is a 44,000 km² project that upgrades CGG's existing *Cluster* and *Cluster Extension* surveys with its

latest subsurface imaging technology, including 3D deghosting with bandwidth extension and TTI FWI velocity model building, to provide detailed broadband pre-salt images.

Jean-Georges Malcor, CEO, CGG, said: "The addition of *Santos VIII* will extend our world-class broadband data coverage in the highly prospective deepwater Santos Basin. It is the latest installment of our contiguous volume of over 94,000 km² of seismic data and integrated geologic studies that bridge the Santos and Campos Basins to cover the entire pre-salt area. These multi-client data sets are an essential resource for oil and gas companies to complete a detailed picture of the complex Santos Basin in advance of Brazil's future licensing rounds."

Left: Map showing CGG's 3D data coverage in the pre-salt area offshore Brazil.

Riptide Displays New Deep-Rated UUV at Sea-Air-Space

Riptide Autonomous Solutions displayed a new variant of their unmanned undersea vehicle (UUV) during the Sea-Air-Space exposition in National Harbor, MD (9-11 April). To support acoustic telemetry research programs, the UUV is rated for 1,500 meters, but still measures only 7.5 inches in diameter. Its payloads include CTD, acoustic modem, and a custom towed acoustic receiver array. With a low power hotel load, this system stills deliver over 48 hours of endurance for field testing.

C-Innovation Announces Contract with BP

C-Innovation, LLC (C-I), an affiliate of Edison Chouest Offshore (ECO) and its family of companies, has secured a three-year contract with BP Exploration & Production, Inc. The contract encompasses subsea construction, inspection, maintenance, and repair (IMR) and logistics services in the Gulf of Mexico.

<https://ont.news/2qjPF64>

IKM Subsea Awarded Drilling Contract

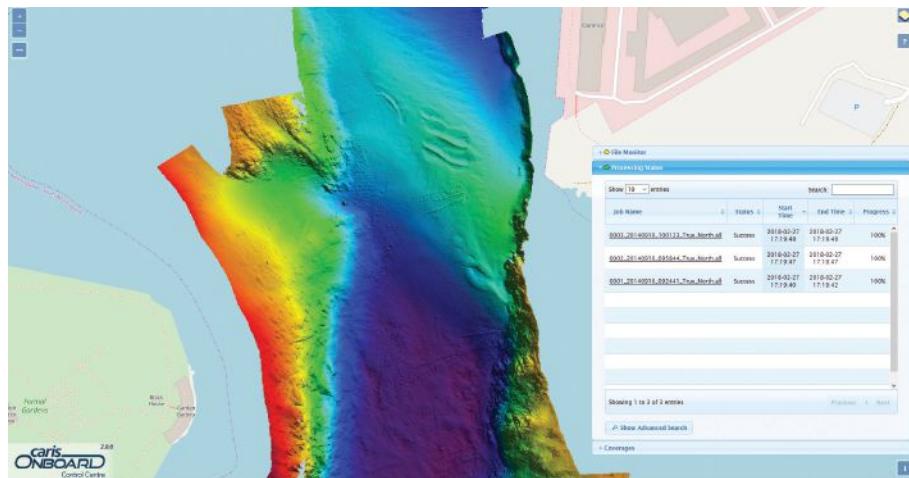
IKM Subsea Singapore signed a contract with PTTEPI for their appraisal campaign offshore Myanmar. The company will provide a Merlin WR200 electrical propulsion system together with a BOP intervention tool and an IKM Technology designed and built diamond wire cutter for this project on board the rig. This marks as IKM's second deepest dive in South East Asia as the water depth ranges from 200 to 2,000 meters.

<https://ont.news/2H6daJB>

Successful ROV Inspection with Novacavi Tether Cable

Novacavi reports use and satisfaction of its hybrid electro-optical neutrally buoyant cable for the latest inspection and control of the Apulian Aqueduct. The ROV was equipped with high-resolution colour rotating video camera and sonar system connected through Novacavi's tether cable.

<http://ont.news/2GOOxl0>



Real-time Mapping and Visualization in CARIS ONBOARD 2.0

Teledyne CARIS™ has released CARIS Onboard™ 2.0. CARIS Onboard enables users to apply processes automatically to their data in near real-time, resulting in minimized data conversion and processing times.

By making the processed products available at the office or on a survey vessel during survey operations, CARIS Onboard helps improve survey efficiency by valuably reducing the turn-around time and helping to ensure that data quality and coverage requirements are met before leaving an area.

Focused around the latest web map technology, the redesigned control center dynamically controls and monitors the automated system. Products generated (including surfaces, backscatter mosaics, and the survey track lines) are live-streamed during acquisition and accessed through a web browser. By providing access to processed products in a web application, the new Control Centre allows review of a survey dataset from any device with a network connection to the vessel. This increased access allows information about survey operations to be accessible when and where needed.

Other updates in this version include a simplified installation process for CARIS Onboard and process improvements to help increase ease of use. Vessel parameters will now be automatically

read from the raw data files and applied during processing, further streamlining the workflow.

CARIS Onboard 2.0 also introduces several improvements to the File Monitor, with support for multiple sensors and advance filters to provide more control over which files are processed. By creating up to four File Monitors, each with a unique filter and unique Process Model, a single installation of CARIS Onboard can process data from all sensors on a given survey platform.

For more info, visit
CARIS.COM/PRODUCTS/ONBOARD

Above: CARIS Onboard Control Centre (lower right) showing background connection to Open Street Maps, with a dynamically updated Digital Terrain Model (DTM) being rendered in near-real time).



UNDERWATER ACOUSTICS & DRONES

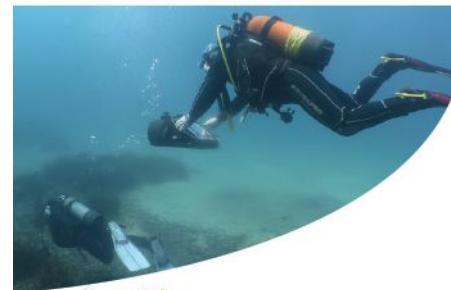
Underwater Acoustic Equipment



Underwater Drones



Sonar Systems



Powered by SDA



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Huawei Marine, CTR to Deploy System in Southern Chile

Huawei Marine announced that it will partner with CTR (Comunicación y Telefonía Rural S.A.) to deploy the Fiber Optic Austral (FOA), the southernmost submarine cable in the world, to connect three regions in southern Chile. This project is dedicated to improving the connectivity of residents, businesses and regional governments; to improve education, health care, agriculture, and the tourism industry; and stimulate e-commerce initiatives in Chile.

Chile has the highest Internet penetration in South America. While its national backbone network covers much of the country, complex topography south of Puerto Montt leave that region short on well-established network infrastructure and unable to meet ever-increasing connectivity demand of surrounding areas.

Subtel, as a Vice Ministry of Telecommunication and Transportation

Ministry of Chile, will invest in the new FOA to connect the Las Lagos, Aysén, and Magallanes regions.

CTR was awarded the contract to deploy and operate the network, while Huawei Marine will provide the end-to-end submarine cable solution. Huawei Marine's advanced 100G universal platform will provide a seamless optical network architecture between submarine and terrestrial networks. The system has a design capacity of 16 Tb/s and a length of 2,800 kilometers. It is expected to be completed by the end of 2019.

Pamela Gidi, vice minister of Telecommunications, stated that "Huawei has been working with the public and private sectors to innovate with a wide range of High-Tec solutions, and this is reflected in the FOA project that will bring multiple benefits to Chile's southern region."

Patricio Morales, CEO of CTR has indicated: "The work of gathering technical information through the marine survey and its use for the development of detailed engineering by Huawei Marine for the Southern Submarine Trunk is of high technological standard and detail, which makes it suitable for the complicated circumstances and challenges that the area represents for its deployment. The systems of optical transmission of capacities of up to 100Gbps per channel will provide high capacity to the area, which can be interconnected in a simple way to the networks of existing operators to improve their services with superior quality in terms of bandwidth and delay—in addition to more convenient prices, which will guarantee an adequate return on the capital expenditures made."

Mike Constable, chief executive of Huawei Marine, said, "Huawei Marine's technology and service capabilities are again recognized by customers in South America. The FOA cable will provide state-of-the-art connectivity to enhance the digital economy of the southern Chile region. Huawei Marine is proud to be selected as the system supplier and partner with CTR to successfully deliver the social and economic benefits that this network investment will facilitate."

For more information, visit
WWW.HUAWEIMARINE.COM



Beatrice Offshore Windfarm: Final Section of Nexans Power Export Cable Sails to Scotland

Nexans has reached two key milestones in its major contract to create the high voltage power export connection for Scotland's Beatrice 588-MW offshore windfarm. The first of the two 400-kV onshore cable links and the high voltage accessories have been installed successfully and tested on site. At the same time, the Nexans factory in Norway has completed the manufacturing of the 220 kV offshore cable and loaded the final section onto the Group's Skagerrak cable laying vessel for the journey across the North Sea to the Moray Firth, where it will be installed and later trenched into the seabed by Nexans' unique Capjet system.

The Beatrice Offshore Windfarm project, scheduled to be fully operational by 2019, is a joint venture between SSE, Copenhagen Infrastructure Partners and Red Rock Power Limited - the UK subsidiary of China's SDIC Power Holding Co. Located in the Moray Firth, it will be Scotland's largest windfarm, with the combined output of 84 turbines capable of generating enough electricity to power approximately 450,000 homes.

To export the energy from the windfarm to the grid, the two offshore cables take a route of 70 km along the seabed to a landfall point to the west of Portgordon on the Moray coast. A transition joint bay then connects them to the onshore cable system, which takes a 20 km route to Blackhillock substation. From there, the 400 kV onshore cables will transmit the electricity to the grid.

Nexans was awarded the turnkey contract to design, manufacture, test, deliver, and install both circuits of the complete power transmission cable system. This included the delivery of a total of 265 km of cables, including 145 km of 220 kV offshore cables, 115 km of 220 kV and 5 km of 400 kV onshore cables and the associated high voltage accessories.

Nexans completed the laying and burial of the first offshore cable route in 2017 and connected it to the offshore platform in February 2018. In March 2018, Nexans installed the 400 kV onshore circuits and their outdoor sealing ends using its expertise of carrying out the termination works horizontally prior to connecting them vertically at Blackhillock substation.



The offshore cables for the Beatrice Offshore Windfarm were produced in Halden, Norway and installed by Nexans Norway. The onshore cables were manufactured at Nexans Benelux facility in Charleroi, Belgium and installed by Nexans France. The associated high-voltage accessories were delivered by Nexans Switzerland.

For over 15 years Nexans has been a key driver in the development of windfarm technology. It was the first company to manufacture three-core 245 kV submarine cables as well as the first to manufacture 420 kV submarine cables. To date, Nexans cables have enabled in excess of 3,500 MW of offshore windfarm energy to be integrated into power grids across the world.





Globalstar Satellite Technology Tracks North Sea Drift Movement

SPOT Trace™ and Globalstar satellite communications are helping a research team from the University of Oldenburg study the movement of floating plastic pollution to get a clear picture of the drift patterns in the North Sea. PhD student Jens Meyerjürgens explains: "We embed low-cost satellite trackers into floating buoys which provide a wealth of information on the movement of plastics on the sea's surface. This helps us understand how plastic debris moves and how it is affected by the complex interaction of wind, current and tides."

Buoys are fitted with a 7x5 cm SPOT Trace device which includes an integrated GPS receiver, simplex transponder and motion sensor. This solution allows researchers to accurately track drift movement using the Globalstar LEO (Low-Earth Orbit) satellite constellation. Using modelling tools to analyze complex ocean currents at the surface, the team can study the movement of waste on

the ocean. The University's 3D computer simulation programs use data from the SPOT Trace devices, including depth and wave height, to understand and predict surface drift behavior as well as how debris travels in the water column and on the sea floor.

One of the most revealing discoveries so far has been the huge effect of wind, with some buoys beaching in as little as one month having travelled up to 700 miles: "It is clear that the influence of the power of the wind on the movement of floating particles in the North Sea is greater than we anticipated," says Meyerjürgens.

"75 percent of the debris that washes ashore on our islands is plastic, mostly from fishing activity," says Mathias Heckroth, Managing Director of Mellumrat e.V., an NGO dedicated to conservation and scientific research of the uninhabited island of Mellum, one of the 32 Frisian Islands in the North

Sea expanse being studied by the team. Mellum is situated in the intertidal Wadden Sea, a UNESCO World Heritage Site protecting more than 10,000 species of plants and animals, and where up to 12 million migrating birds spend time each year.

Other partners in the project are analyzing the composition of the pollutants, while other organizations are handling removal. Researchers hope to help authorities establish regulatory frameworks and legislation that encourages organizations and the general public to pollute less. Additionally, the ability to predict the movement of pollutants can help clean-up operations to be more targeted and efficient.

Globalstar
Be Heard.

Construction Begins on Cable System to Connect Japan, Guam, and Australia

A consortium including RTI Connectivity Pte. Ltd. (RTI-C), AARNet Pty Ltd. (AARNet) and Google, together with Alcatel Submarine Networks (ASN), part of Nokia, and NEC Corporation (NEC: 6701) announced that the construction of the Japan-Guam-Australia Cable System (JGA) has officially commenced. The 9,500-km undersea fiber optic cable system will deliver a design capacity of more than 36 terabits per second and is expected to be completed in the fourth quarter of 2019.

JGA will further enhance and contribute to the much-needed expansion of communications networks from Japan and Australia, to Asia and the United States, thereby improving network redundancy, ensuring highly reliable communications, and expanding onward connectivity options in Guam.



JGA interconnects with SEA-US and HK-G cables.

RTI-C's investment in JGA will be built utilizing capital from the Fund Corporation for the Overseas Development of Japan's ICT and Postal Services Inc. (Japan ICT Fund), along with syndicated loans from Japanese financial institutions, including NEC Capital Solutions Limited.

Russ Matulich, RTI-C's President and CEO, acknowledged this important milestone

For more info, visit
WWW.NEC.COM/EN/PRESS

stating, "Hyperscale cloud providers and enterprise companies are fueling exponential data-growth between Asia, Australia, and the United States. These customers require alternative paths, enhanced quality of service, and cost-effective bandwidth solutions. By adding JGA to our existing cable investments, RTI is well-positioned to serve these massive data-growth needs. JGA's unique design will also improve latency between Tokyo-Sydney, while greatly reducing provisioning timeframes. Finally, RTI is grateful for NEC and ASN's collaborative and innovative approach, making commercial service likely in late 2019."



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SubCableWorld



Analyzing the cable industry.

PRYSMIAN Investing €170 million in New Cable Laying Vessel



Prysmian Group has announced an investment in excess of €170 million in a new cutting-edge cable laying vessel. The new vessel is intended to be the most capable cable layer in the market and to offer enhanced project versatility thanks to advanced features such as deep water installation capabilities for depths of more than 2,000 m; increased cable loading capacity thanks to large cable rotating platforms; capability to perform complex installation operations supporting a variety of burial systems, including heavy duty ploughs; state-of-the-art positioning and seakeeping systems and a reduced environmental footprint. The cable laying vessel is expected to be delivered by Q2 2020.

With three of the world's most advanced cable laying vessels in its existing fleet—*Giulio Verne*, *Cable Enterprise* and *Ulisse*—and the widest range of high-tech installation and burial equipment, such as the Hydroplow, the PLB machines Sea Mole and Otter, and HD3 ploughing technology, this new strategic asset will consolidate the Group's leadership in the submarine cables and systems business and will boost the capability of its submarine cable operations by insourcing installation activities while achieving on-time delivery and execution.

The Group's submarine business secured several important contracts in 2017 with a robust order intake of approximately €1 billion developing a solid order book in excess of €2,400 million as at 31 December 2017. Recent main interconnection projects secured include IFA2 for a submarine link between Britain and France and an NGCP interconnection in the Philippines. In the offshore wind connections market, Prysmian has been awarded projects by RTE to link three offshore wind farms to the French electricity grid.

FOR MORE INFORMATION, VISIT
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MONTH IN REVIEW

CSA Key to Acquiring Permits for South Atlantic Cable System

CSA Ocean Sciences Inc. (CSA) teamed with their affiliate Brazil office CSA Ciências Oceânicas (CSACO) to successfully acquire all marine and coastal environmental permits for Angola Cable's South Atlantic Cable System (SACS) within a challenging timeframe. Through Ocean Specialists, Inc. (OSI), CSA and CSACO carefully negotiated and managed the complicated permit application requirements of regulatory authorities and received crossing approvals with all associated seabed users across the Atlantic Ocean.

<https://ont.news/2v1ODjK>

Huawei Marine Kicks Off Phase II of Philippines' Grid Project

Huawei Marine has kicked-off Phase II of its Sorsogon-Samar Submarine Fiber Optical Interconnection Project (SSFOIP) for the National Grid Corporation of the Philippines (NGCP). The SSFOIP system is located in the San Bernardino Strait, linking Sorsogon, the southernmost province on Luzon to the island of Samar.

www.huaweimarine.com/en/

MakaiLay Commissioned by Prysmian Group on Cable Laying Vessel

Cable deployment control software MakaiLay was commissioned on the DP2cable laying vessel *Giulio Verne* by the Prysmian Group. It is expected that MakaiLay, with its power-cable-specific module, will be used by *Giulio Verne* when it starts working on the North Sea Link installation: a subsea power cable interconnector between Norway and UK, which will be the longest subsea interconnector in the world upon completion in 2021.

<https://ont.news/2GRhtop>

TE SubCom Constructs Key Cable Landing Infrastructure

TE SubCom has announced that easements, permitting and agreements are complete and that groundbreaking and construction have begun on a beach landing project that will serve multiple subsea cables and users in Southern California. The project will use horizontal directional drilling to install bore pipes for the shore-end landing due to the minimal impact this type of operation has on the environment of the beach and tidal area.

<https://ont.news/2HskUTU>



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What Lies Beneath: Bridging the Gap between Ocean Science, Technology and the Naval Community

BY YOUSUF MALIK | PRINCIPAL CONSULTANT AT DEFENCE IQ

Amid excited talk of stealthy fighter aircraft proliferating around the world, submarines remain the ultimate stealth force. It is no surprise then that submarines are experiencing a buoyant market this decade, led by multiple acquisitions in Asia.

'Old navies' that have operated submarines for decades have long known that you cannot have an effective submarine fighting force without an intimate knowledge of your surroundings, or the undersea 'lay of the land,' if you will.

Submarine survival depends on a detailed knowledge of every reef, undersea hill, mountain and rock formation, in order to know the best hiding places and best avenues of attack and safe retreat—and to deny use of them to your adversaries. This requirement has led new submarine operators to acquire their own survey assets to accurately map the sea floor and gather scientific knowledge of their own coasts and seas in their area of operations.

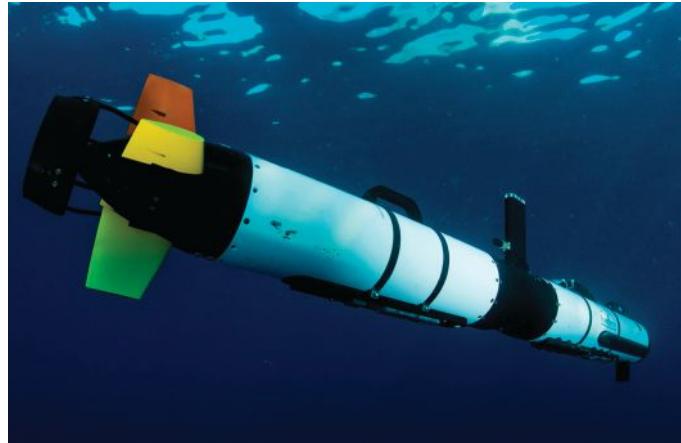
And it is not just the topographical features of the undersea landscape that these surveys capture: Water temperature, density and salinity significantly affect the propagation of sonar waves underwater—a thorough and timely knowledge of which enables you to detect and track your adversary while remaining safely undetected yourself.

Gaining the Tactical Edge

Acquiring hydrographic and oceanographic survey vessels and Autonomous Underwater Systems (AUVs) are just the beginning. In an article appearing in Asia's current affairs and geopolitics magazine, *The Diplomat* (20 February 2018), Steven Stashwick, a reserve US Navy officer who works as an analyst in New York argues that the military balance between China and the United States will rest largely on which is best able to exploit the ocean depths. And while the widely-reported jostling above water and in the air between China, its neighbours and the United States continues unabated, "one of the most important arenas of intensifying competition between China and the United States is also the least obvious—in marine laboratories and on oceanographic research and hydrographic survey vessels," asserts Stashwick.

It is a fact that without mastery of oceanography, neither side can claim dominance over the undersea domain thereby "granting freedom of action to its submarines, and denying it to adversaries" he added.

Creating an effective understanding of the maritime environment requires persistent long endurance systems with sensors and open mission systems integrated architectures that operate from below the sea right into space. Imagine the possibilities afforded by hundreds of self-powered



An Iver Autonomous Underwater Vehicle (AUV) being used as part of Exercise Eager Lion with the Royal Jordanian Navy in 2015 in a mine countermeasures role. U.S. Navy photo by Mass Communication Specialist 2nd Class Arthurgwain L. Marquez.

underwater drones like the *Wave Glider* developed by Boeing-owned firm Liquid Robotics that can operate unattended for months transmitting data via satellite. Or the *Submaran*, a wind and solar powered surface and subsurface drone developed by innovative US start-up, Ocean Aero. These undersea drones may supplement data gathered from other new concepts at the US Defense Advanced Research Projects Agency or DARPA, that the agency is calling the "Ocean of Things."

The Big Data Challenge

One thing is clear: all these sensors are going to be generating terabytes of data and it is the analysis of this data which is the time-consuming bit. As illustrated in the ongoing search for the missing Malaysian Airlines aircraft, that analysis requires trained humans to patiently watch hours of incredibly detailed ocean floor imagery generated by the synthetic aperture sonars mounted to a fleet AUVs busily searching for debris that might or might not be a piece of the missing aircraft.

The future lies in advanced artificial intelligence or AI, trained to speedily consume mountains of subsea data in order to spot anomalies that might represent a submarine, a snooping enemy AUV, or a sunken shipwreck. But the real prize in understanding what lies beneath is fusing data from multiple sensors; shipborne, undersea, in the air and in space and a clever AI to rapidly process it in order to create a near real-time picture of the undersea environment like we have only recently been able to successfully do above the waves and on land.

The Naval Survey and Ocean Intelligence Conference

Defence IQ will feature these topics at the Naval Survey and Ocean Intelligence conference to be held 19-21 June 2018 at the Copthorne Tara Hotel in London.



Wreckage of WWII Aircraft Carrier USS Lexington found off Australia

Wreckage from the USS Lexington, a U.S. aircraft carrier which sank during World War II, has been discovered in the Coral Sea, a search team led by Microsoft co-founder Paul Allen.

The wreckage was found a day earlier by the team's research vessel, the R/V Petrel, some 3,000m (two miles) below the surface more than 500 miles (800km) off the eastern coast of Australia. The search team released pictures and video of the Lexington, one of the first ever US aircraft carriers, and some of the planes which went down with the ship. Remarkably preserved aircraft could be seen on the seabed bearing the five-pointed star insignia of the US Navy on their wings and fuselage. On one aircraft, an emblem of the cartoon character Felix the Cat can be seen along with four miniature Japanese flags presumably depicting "kills."

The search team also released pictures and video of parts of the ship, including a name-plate, and anti-aircraft guns covered in decades of slime. The USS Lexington and another US aircraft carrier, the USS Yorktown, fought against three Japanese aircraft carriers from May 4-8, 1942 in the Battle of the Coral Sea, the first ever between carriers. The badly damaged Lexington, nicknamed "Lady Lex," was deliberately sunk by another US warship at the conclusion of the battle.

More than 200 members of the crew died in the battle, but most were rescued by other US vessels before the Lexington sank. Admiral Harry Harris, who heads up the US military's Pacific Command (PACOM)—and whose father was one of the sailors evacuated—paid tribute to the successful research effort.

"As the son of a survivor of the USS Lexington, I offer my congratulations to Paul Allen and the expedition crew of Research Vessel (R/V) Petrel for locating the 'Lady Lex,' sunk nearly 76 years ago at the Battle of Coral Sea," Harris said in a statement.

"We honor the valor and sacrifice of the 'Lady Lex's' Sailors—and all those Americans who fought in World War II—by continuing to secure the freedoms they won for all of us," he said.

The USS Lexington was carrying 35 aircraft when it went down. The search team said that 11 planes had been found including Douglas TBD-1 Devastators, Douglas SBD-3 Dauntlesses and Grumman F4F-3 Wildcats.

"Lexington was on our priority list because she was one of the capital ships that was lost during WWII," said Robert Kraft, director of subsea operations for Allen.

"Based on geography, time of year and other factors, I work with Paul Allen to determine what missions to pursue. We've been planning to locate the Lexington for about six months and it came together nicely," Kraft said in a statement.

Search teams led by Allen have discovered the wreckage of a number of historic warships including the USS Indianapolis, a US heavy cruiser which sank in the Philippine Sea in July 1945 after being torpedoed by a Japanese submarine.



All photos: Handout photo obtained 5 March 2018 courtesy of Microsoft co-founder Paul G. Allen showing wreckage from the USS Lexington aircraft carrier, which sank during World War II and has been found in the Coral Sea.

CONTESTED SEAS

Maritime Domain Awareness in Northern Europe

SUMMARY WRITTEN BY KATHLEEN H. HICKS, SENIOR VICE PRESIDENT; AND ANDREW METRICK, ASSOCIATE FELLOW, INTERNATIONAL SECURITY PROGRAM, CSIS

Responding to Russian challenges in NATO protected waters requires a deep understanding of the Northern European maritime environment, says a new report from the Center for Strategic & International Studies (CSIS).

Northern Europe, and specifically the Baltic and Norwegian Seas, has been the site of increasingly provocative and destabilizing Russian actions. The country's use of a range of military, diplomatic, and economic tools to undermine NATO and its allies highlights the need to monitor and understand Russian activity. The region is characterized by complex factors like unique geographic features, considerable civilian maritime traffic, the presence of advanced Russian and Western military capabilities, and strategic proximity to Russia and the Kola peninsula, home to the Russian Northern Fleet. While the Norwegian and Baltic Seas do differ in key ways, they are linked by the emerging risk posed by Russia's long-range strike capabilities.

Responding to Russian challenges across the competitive space requires a deep understanding of the Northern European maritime environment. Maritime Domain Awareness (MDA) defined by the United States as the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of a nation or region, is an exceptionally broad concept. At its core, MDA has three functions: the collection of raw data, the analysis of that data, and the action of disseminating information to and coordinating among the different components of the framework. In order to provide security in Northern Europe, NATO and its allies must use MDA frameworks to understand and respond to the challenges above, on, and underneath the sea, as well as the surrounding land environment. They must also make changes to their current MDA capabilities to evolve alongside the Russian threat.

Russia presents three challenges of particular concern to the MDA efforts in Northern Europe: maritime hybrid warfare, electronic and cyber warfare capabilities, and long-range strike systems.

1. Maritime Hybrid Warfare—The Russian military is experienced and effective in its use of hybrid warfare, seen in Syria, Crimea, and Northern Europe. The ambiguity possible in the maritime domain lends itself well to this strategy. Russia uses three specific approaches in this realm: deception through different types of vessels including civilian ships, deniable forces like the amphibious and light infantry that easily navigate the complex Baltic and Norwegian Seas, and the country's well-developed and diverse force for seabed warfare.

2. Cyber and Electronic Warfare—Russia's advanced EW capabilities have the potential to hinder information gathering and dissemination methods, which are both vital functions of MDA. These capabilities are challenging for military personnel but potentially devastating in civilian contexts, especially as civilian networks and technology (like GPS) are far less secure.

3. Long-Range Strike Capabilities—New challenges for NATO and Northern European partners have emerged with Russia's development of a long-range precision strike complex. The weapons, now being mounted on new and existing Russian naval vessels, give these

vessels the option to stay in the Barents or White Seas and strike targets across Northern Europe. This, combined with air force capabilities based on the Kola Peninsula and in Kaliningrad, presents threats unlike any seen by NATO before. These capabilities require NATO and its partners to use MDA frameworks to monitor launch platforms across the domain.

The modern history of MDA begins in the U.S., with a Homeland Security Presidential Directive issued in 2004 by President George W. Bush. The document lays out core interests for the U.S. to enhance security in the maritime domain and creates a cooperative framework to support MDA operations across different spheres. At the same time, the European concept of maritime security awareness was built upon the U.S. definition of the challenge, placed within the context of rising illicit traffic in the Mediterranean.

A weakness of the original MDA and Maritime Situational Awareness (MSA) concepts is that many of the associated capabilities and frameworks are focused on civil maritime issues. Given the global proliferation of advanced military capabilities, like antiship cruise missiles, NATO and its partners require a holistic understanding of the maritime environment that focuses on everything from civil maritime actions to high-end military operations and even issues associated with the maritime environment.

A key implication of the heightened maritime threat environment is the need to improve the integration of and attention to undersea aspects of



MDA. Antisubmarine warfare (ASW), a traditional strength of Western naval intelligence and operations, has atrophied since the end of the Cold War. Today, Russian submarines with conventional long-range missiles pose a threat to NATO. ASW must be integrated with MDA to address these concerns. Comprehensive understanding of the undersea realm should extend beyond ASW. Russia's amphibious special forces and combat swimmers threaten more than just military targets, including civilian vessels and undersea cables, which are an integral part of MDA. ASW technology can be useful in countering these and other threats.

In the Norwegian Sea, the biggest challenge for NATO is detecting advanced ultra-quiet submarines. This issue is sharpened by dramatically depleted stockpiles of sonobuoys, a constant need for increasingly advanced sonobuoy technology, and an American unwillingness to share highly classified information about the undersea domain. NATO would benefit from an apparatus like the ASW Operations Centers (ASWOC), used prominently during the Cold War to streamline ASW operations. Integration of platforms is a challenge in the Baltic Sea as well, largely because Sweden and Finland are not NATO

states, making data sharing challenging.

Frameworks like Sea Surveillance Co-Operation Baltic Sea (SUCBAS) and the Maritime Surveillance (MARSUR) project facilitate the work of regional states to address these issues but more must be done. Additionally, NATO monitoring of the Baltic region is largely domain specific and suffers from not examining the maritime domain holistically. The alliance and its partners should also act to focus on resiliency to continue to operate in the face of jamming and nonkinetic attacks from Russia.

The key to enhancing MDA capabilities in Northern Europe is the integration of frameworks across the maritime domain. Cooperation between NATO states and allies is vital to understanding the complex environment. The CSIS study team has identified seven recommendations of particular importance:

- Create a Baltic Sea MDA analytic center at the Baltic Maritime Component Command (BMCC) at Rostock, Germany;
- Empower a small analytic team at the BMCC to focus on maritime hybrid issues;

- Develop a training course for military intelligence officers on best practices for Baltic Sea MDA analysis;
- Create a classified Baltic Sea data environment that can incorporate both NATO and partner states;
- Develop a multinational operational framework for the Baltic Sea;
- Integrate subsurface sensors and antisubmarine warfare into a comprehensive MDA framework;
- Acquire significant stockpiles of advanced sonobuoys and associated acoustic processing systems.

These priority recommendations are presented in detail in the report, along with others. Collectively, their implication would markedly enhance security in Northern Europe by closing identified gaps and ensuring capabilities for collection, analysis, and action in MDA.

FOR THE FULL REPORT, VISIT
[www.csis.org/analysis/
contested-seas](http://www.csis.org/analysis/contested-seas)



A TALE of Two Markets

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

"It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness..."

Thus, begins Charles Dickens "A Tale of Two Cities." Besides setting the scene in Paris and London at the time of the French Revolution, this description could easily be applied to the crude oil and natural gas markets of 2018. While "best" and "worst" may be relative terms, for analysts attempting to fathom the outlook for these markets, the contrasting views create problems for businesses dependent on oil and gas prices to sustain its cash flow lifeblood.

Crude oil prices have recently returned to the mid-\$60s a barrel range, after having fallen below \$60 in mid-February. While the current price rise has been largely driven by concerns over increased geopolitical tensions, the price rise has been helped by further declines in global oil inventories, chart 1. The inventory move is critical as the entire strategy of Saudi Arabia and its OPEC pals is to cut output to help soak up the surge in global inventories that occurred in 2013 and 2014 as producers maxed out their production at the same time the shale revolution had boosted America's oil production and turned it into an oil exporter. In 2015, in response to America's oil production resuming growth after decades of declines, Congress overturned the 40-year ban on crude oil exports it had put in place following the 1973 Arab Oil Embargo.

When we look at how crude oil prices have traded since 2014, it becomes clear that once the peak in domestic crude oil inventories was recognized as permanent in the spring of 2017, oil traders began pushing oil prices higher. With healthy demand, reflected in the IEA's recent higher global oil consumption forecast for 2018, pressure for higher oil prices

is building. Forecasters and traders are suggesting crude oil prices might even reach \$70 a barrel before demand is dampened. If that price is attained, even only briefly, the psychology of the oil market will improve significantly, which should result in higher capital spending and increased drilling and production. It will be the best of times!

On the other side of the ledger, the natural gas market is plagued by continuing production growth in the face of waning domestic demand. Several years ago, natural gas demand was growing rapidly. Cheap natural gas, at least relative to prices in prior years, undercut coal's price and prompted utilities to switch fuels. That switch was helped by the realization that cleaner-burning natural gas would aid utilities in achieving their carbon emissions targets.

At the same time natural gas was gaining market share from coal in the power generation sector, electricity consumption began falling. Although the decline was small, it came at a crucial time for the natural gas market. Gas output growth put downward pressure on gas prices, heightening the importance of greater exports. More domestic gas would also help cut imports from Canada. Both needs have been met. However, based on current natural gas prices, it appears today's gas market believes these trends will not prove sufficient to offset the projection for further gas output growth.

To examine this issue, we have produced two charts. Chart 2 shows natural gas inventories for each year from 2012 to the present, along with the 5-year average (2012-2017) storage volume. This chart

shows that after several spells of bitter cold weather in the early weeks of 2018, gas storage is now at about the same level as in 2015. As of the week ending March 16, 2018, gas storage volumes were 283 Bcf, or 16.3% lower than the 5-year average. As the chart further conveys, the remaining storage volume is equivalent with the amount in storage at the same point in 2015, but importantly, it is below the level of all other years since 2012, with the exception of 2014.

Potentially more depressing is chart 3. It shows gas storage volumes for each year of 2015-2018 (solid lines), along with the corresponding weekly natural gas prices (dotted lines). Not only is gas storage similar to that of 2015, natural gas prices were virtually the same. While gas prices have dropped from nearly \$6/Mcf at the start of 2018 to \$2.74, if we track prices for the balance of 2015, as gas storage volumes were rebuilt, prices fell. That does not signal an attractive prospect.

As gas consumption in the power generation sector wanes and the EIA reports manufacturing gas use continuing to fall, the natural gas industry's only growth outlet appears to be exports, either via pipelines to Canada and Mexico, or as LNG. The recent start-up of the Cove Point, Maryland LNG export terminal is boosting gas export shipments, especially from the oversupplied Marcellus region. Four additional LNG export facilities are under construction, so natural gas producers can expect increased volumes flowing abroad in the future. The problem is that none of these new terminals will be in operation this year, meaning that while the volume of gas exports will increase,

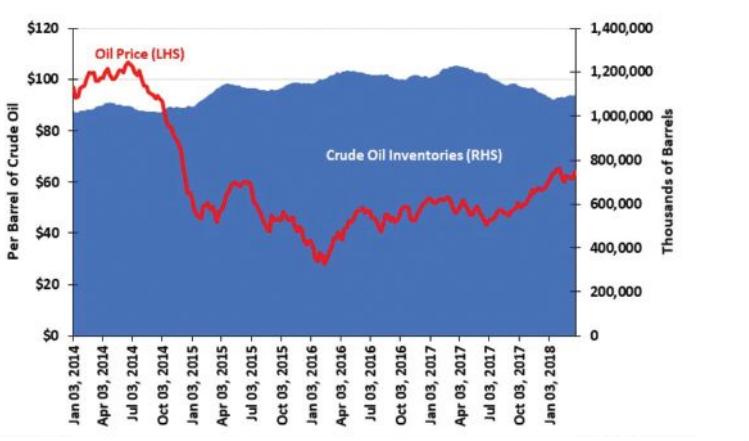
the amount exported will be only marginally higher than 2017 shipments. In other words, there is little likelihood of much relief for natural gas prices from increased exports. Sustaining gas prices will be the challenge. For natural gas, it is the worst of times!

The best of times for the crude oil market will help the petroleum industry, but the worst of times for the gas industry will sap overall cash flow growth projected by the industry optimists. This means drilling and completion activity in America's oil patch will likely not increase as much as

expected, so the oilfield service industry will remain subject to increased pricing pressure for its services and equipment, limiting company earnings growth and share price performance.

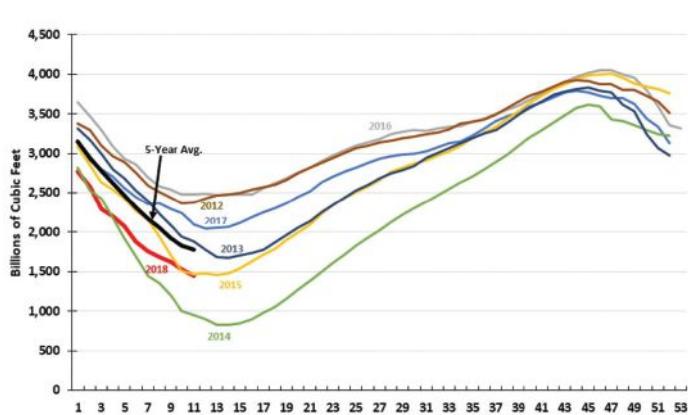
1.

OIL FUTURES PRICE vs. WEEKLY COMMERCIAL OIL INVENTORIES



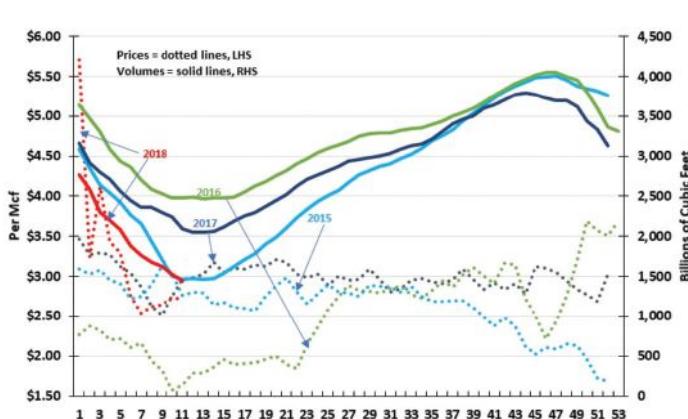
2.

WEEKLY GAS STORAGE VOLUMES vs. PAST YEARS and 5-YEAR AVERAGE



3.

NATURAL GAS HH SPOT PRICES vs. STORAGE VOLUMES, WEEKLY

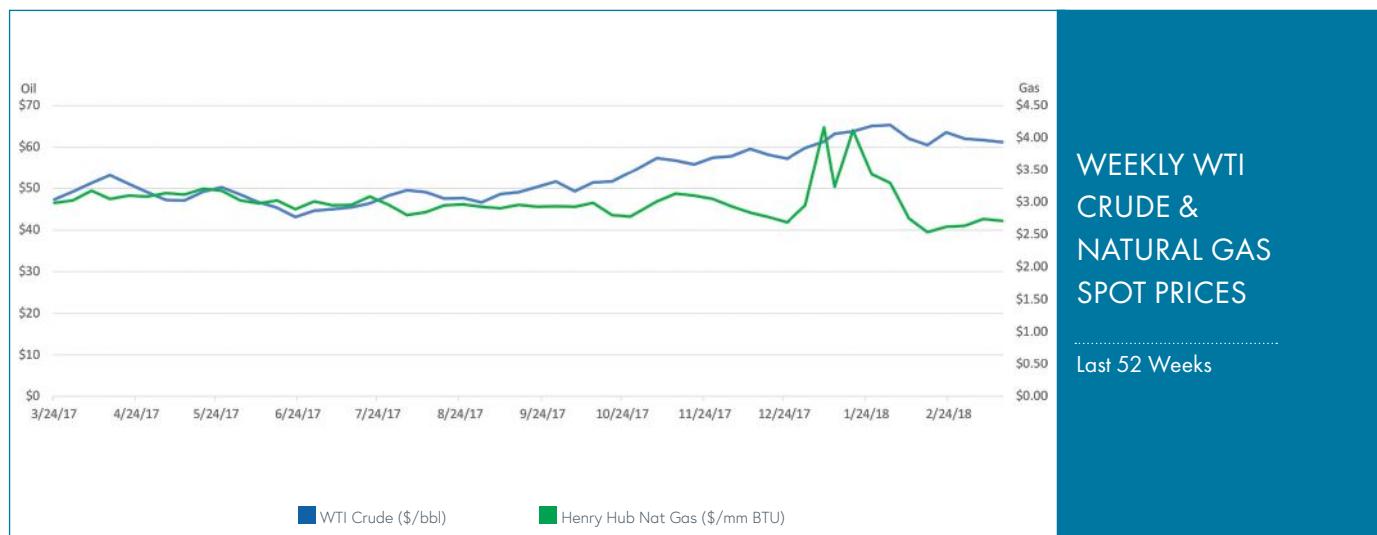


CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF MARCH 16, 2018

Oil and gas prices were basically flat for the past month. While March witnessed several snowstorms in the Northeastern United States, they lacked the extended period of bitter cold that drove up prices in January. WTI crude oil prices were at \$61.28 by the middle of March; down from around the \$65 peak high during the coldest of the winter but still trending upward over the past year, which had not past the \$60-mark until the beginning of 2018.

Henry Hub natural gas spot prices also were stable in March. As with oil, gas prices spiked in late January, but unlike oil prices have trended down over the past year.

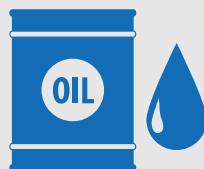


\$61.28

\$60.56 previous month



TRENDING UP



Cushing, OK
WTI Spot Price

\$2.71

\$2.54 previous month



Henry Hub
Spot Price

KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF MARCH 16, 2018

U.S. EQUITY MARKETS

continued to fluctuate wildly in 2018.

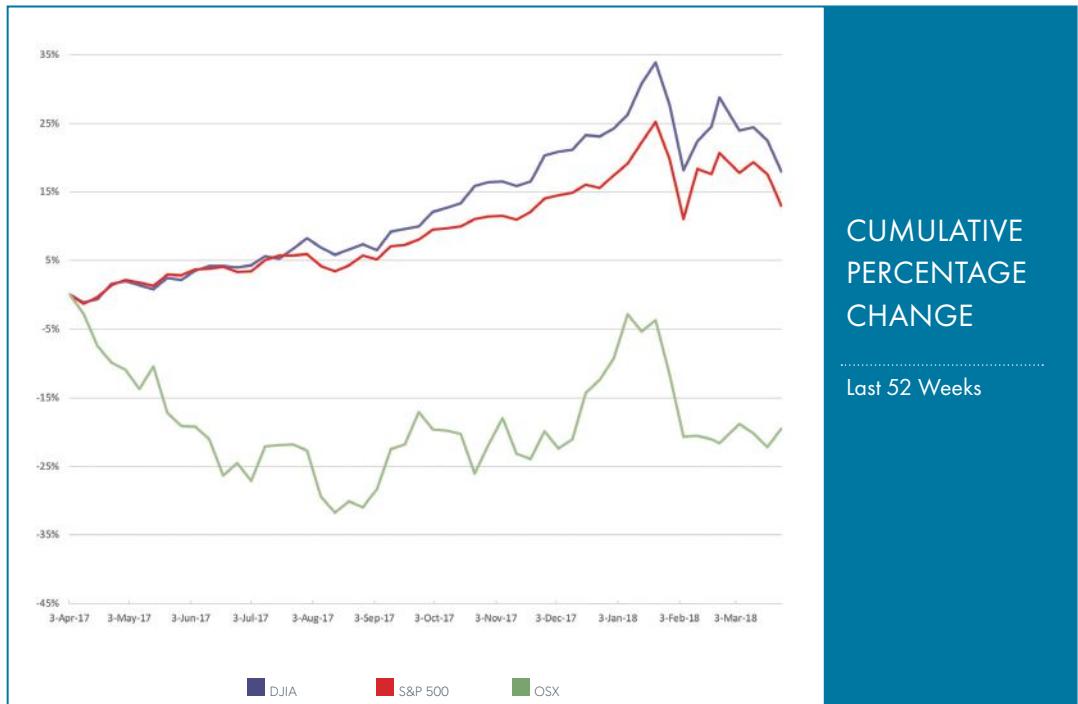
Since reaching a record high of over 26,000 in late January, the **Dow Jones** Industrial Average saw six weekly swings of over 700 points (three positive and three negative) over a period of nine weeks. The trend has

been down, however, as the DJIA closed at under 24,000 on March 26. An almost identical pattern took place in the **S&P 500** and **OSX**. The S&P 500

dropped by more than 250 points in the same period, while the OSX fell from a 2018 high of just over 164 points in January

to 138.46. Political turmoil in Washington and the threat of a trade war between the United States and China were among the causes of the March losses.

SELECTED EQUITY INDEXES



23,825.74

-1,139.01 from previous month



TRENDING DOWN

DJIA

2,619.35

-96.91 from previous month



TRENDING DOWN

S&P 500

138.46

-2.40 from previous month



TRENDING DOWN

OSX

AUVSI XPONENTIAL

Denver, CO
April 30-May 3
[www.xponential.org/
xponential2018/public/
Enter.aspx](http://www.xponential.org/xponential2018/public/Enter.aspx)

International Telecoms Week

Chicago, IL
May 6-9
www.internationaltelecomsweek.com

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=5011&navItemNumber=8237](http://www.awea.org/events/event.aspx?eventid=5011&navItemNumber=8237)

UDT

Glasgow, UK
June 26-28
[www.udt-global.com/
welcome-to-udt-2018](http://www.udt-global.com/welcome-to-udt-2018)

CORE

Glasgow, UK
August 26-28
[www.offshore-
renewables.co.uk](http://www.offshore-renewables.co.uk)

Ocean Energy Europe

Edinburgh, UK
October 30-31
[www.oceanenergy-europe.eu/
event/oee-2018/](http://www.oceanenergy-europe.eu/event/oee-2018/)

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/

ICOE

Normandy, France
June 12-14
www.icoe-conference.com

OMAE

Madrid, Spain
June 17-22
www.asme.org/events/omae

Tug, Salvage & OSV

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

Clean Pacific

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

Ocean Renewable Energy

Portland, Oregon
September 18-19
[oregonwave.org/
2018-conference](http://oregonwave.org/2018-conference)

OTC

Houston, TX
April 30-May 3
2018.otcnet.org

MTS Dynamic Positioning

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

OCEANS'18

Charleston, SC
October 22-25
[charleston18.
oceansconference.org](http://charleston18.oceansconference.org)





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

Int'l Conf on Ocean Energy - June 12-14 ^
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

Wind Energy Hamburg - September 25-28 ^
AWEA Offshore Wind - October 16-17 ^
Offshore Energy - October 22-24 ^
Pacific Marine Expo - TBD

OCTOBER

Clean Gulf - November 13-15 ^
Offshore Well Intervention - TBD

NOVEMBER/DECEMBER

TBD

* Digital Distribution

^ Pending

MILESTONES



The Lithuanian Delegation at Oceanology International in London, March 2018. Photo credit: ON&T.

INTERMARE South Baltic Bolsters Maritime Partnerships

Cooperation between maritime economies is nothing new to nations bordering the Baltic Sea. As far back as the thirteenth century, the Hanseatic League brought prosperity and political cohesion to 170 cities that shared a common interest: economic growth and stability across the Baltic region. That's why it is so surprising to learn that this same region has lagged behind other EU macro-regions when it comes to developing international cooperation and promoting the "blue economy."

Recently, however, INTERMARE's South Baltic project has sought to use cross-border coordination of efforts to promote the region's maritime sector. They say that while small nations like Lithuania have previously lacked the resources to compete with other European economies, the region as a whole can team in order to promote blue economy enterprises.

INTERMARE South Baltic supports the region's maritime economy through a network of companies and stakeholders joined under a common brand, which can be easily recognized in regional, European, and global markets. The goal is simple: improve cooperation within regional supply chains, share knowledge, and achieve greater recognition for small and medium-sized enterprises in the South Baltic region.

The Lithuanian Case

Recent trends show a conversion of large scale conventional maritime business models toward modular, sustainable, socially-aware, and innovation-driven industries, such as coastal and marine tourism, marine biotechnologies, aquaculture, and renewable offshore energy. This shift creates a challenge for traditional maritime businesses, but it can also bring increased opportunities for international partnerships, especially when it comes to educational and economic development.

In the EU, technology leaders like Germany, Denmark, Sweden have offered their expertise to effectively foster blue economy business and support facilities in partnering nations. Because of this, Lithuanian maritime expertise is growing. While, Lithuania is mainly the recipient of blue growth technologies and culture, there is a great deal of optimism about where they are headed.

ON&T spoke with Prof. Stasys Paulauskas, head of Lithuania's Strategic Self-Management Institute, about some of the opportunities that have emerged from his organization's partnerships as facilitated by INTERMARE South Baltic.

Prof. Paulauskas says that over a decade learning from the best practices and experience of partner countries empowered the Strategic Self-Management Institute (SSI), along with Klaipeda University (KU), to offer offshore wind energy educational coursework. He also noted that participation in projects that examined offshore wind energy opportunities in the marine territories of Poland, Lithuania and the Kaliningrad district (Russia) played a key role in developing the expertise needed for this effort.

The European Wind Energy Association (EWEA) predicts a tenfold increase in offshore wind energy capacities in the South Baltic in the coming years. Cross-border cooperation via INTERMARE South Baltic can help make that happen. Through their success, the region will have the chance to position itself among the top offshore wind energy regions.

For more information, visit these websites:

INTERMARE South Baltic: <http://www.intermare-southbaltic.eu>.
Interreg South Baltic Programme: <https://southbaltic.eu>.
European Regional Development Fund: ec.europa.eu.



K-Line Pleads Guilty to Criminal Cartel Conduct

On 5 April 2018, Kawasaki Kisen Kaisha (K-Line), a global shipping company based in Japan, entered a guilty plea in the Australian Federal Court to criminal cartel conduct. K-Line's plea follows an investigation concerning the international shipping of cars, trucks, and buses. This is the second guilty plea in Australia in relation to this cartel. In 2016, Nippon Yusen Kabushiki Kaisha (NYK) pleaded guilty to criminal cartel conduct and were fined \$25 million (AUD). K-Line is scheduled for sentencing in November. For more, visit www.accc.gov.au/media-release/second-shipping-company-pleads-guilty-to-criminal-cartel-conduct.

Teledyne Marine Recognized for 2018 OTC Spotlight Technology Award

Teledyne Marine was recently recognized by the Offshore Technology Conference (OTC), the largest global industry event for oil and gas, with a 2018 Spotlight on New Technology Award for the FlameGuard™ P5-200. OTC recognizes innovative technologies each year with the Spotlight on New Technology Award, which showcases advanced solutions that will lead the industry into the future.

The FlameGuard™ P5-200 is a flame-proof ceramic electrical penetrator for use as part of the fire-resistant envelope of an offshore surface wellhead and Christmas tree system. The penetrator is a key technology element in a 5-kV electrical feedthrough system that provides three-phase power to downhole electrical submersible pumps (ESPs) in offshore dry trees. The penetrator is rated as fire resistant in accordance with API 6FB, Part II.

The ceramic material was developed by the New Product Development team at the Teledyne Oil & Gas Technology Development Center, in partnership with the advanced materials scientists at Teledyne Scientific. For more information, visit: <http://www.teledynemarine.com/p5-200?ProductLineID=100>

IT'S WHAT'S ON THE INSIDE THAT COUNTS



BE A PART OF THE 2018 ON&T UV BUYERS' GUIDE

Our newly re-designed UV Buyers' Guide is a comprehensive resource of ROV vehicle manufacturers and operators, detailed product descriptions, vehicle specifications, and company contacts.

Contact us for more information about listing and advertising opportunities.

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 Contact: Glenn Pollock



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

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

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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
- Sediment Characterization: INSEA, Acoustic Velocimeter for Sediment Characterization

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

ADCP/DVL

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Nortek excels in the development and manufacture of acoustic Doppler instrumentation. Doppler Velocity Logs (DVLs) are used for subsea navigation. Acoustic Doppler Current Profilers (ADCPs) are used to understand physical processes in the ocean, rivers, lakes and laboratories. We pride ourselves on being innovative in product development and production processes. Nortek provides solutions to engineers and scientists by offering real-time data collection and support from our responsive technical team.

ROWE TECHNOLOGIES, INC.

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



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

BUOYS



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

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 Website: www.DeepWaterBuoyancy.com
 Contact: Dan Cote, Sales Manager

DeepWater Buoyancy creates subsea buoyancy products for leading companies in the oceanographic, seismic, survey, military and offshore oil & gas markets. Thousands of customers have relied on our products for over thirty-five years, from the ocean surface to depths exceeding six thousand meters.

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



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 Contact: Richard Fryburg

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CABLES

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Website: www.cortlandcompany.com
Contact: Marco Cano



Cortland has more than 30 years of manufacturing experience supplying custom-designed electro-optical-mechanical cables. We provide solutions that meet the challenges posed by harsh environments, hydrostatic pressures, and high mechanical stresses.

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

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Website: www.falmat.com
Contact: Shawn Amirehsani



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

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Website: www.southbaycable.com
Contact: Gary Brown, Sales Manager



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

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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.

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

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

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

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

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Website: www.atlinc.com
Contact: David Dack



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Website: www.csaocean.com
Contact: Gordon Stevens



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

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

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

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



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

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

UNMANNED MARITIME VEHICLES

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UNMANNED MARITIME VEHICLES (cont)

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ON&T ROV Photo Contest

A photograph showing an ROV control console on the left, illuminated with various buttons and screens, connected by cables to a green ROV submersible on the right. The submersible has a large, ribbed, semi-circular hatch and the word 'OCEANEERING' printed on its side. The background is dark, suggesting an underwater environment.

Ocean News & Technology has launched its first #ROVatWork photo competition. Three winning photographers will be announced and profiled alongside their images in the Nov/Dec issue of ON&T magazine, including information about the ROV technology they have captured.

For details, visit <https://ont.news/2EGiYE0>

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Oceaneering International7 www.oceaneering.com	VideoRay.....2 www.videoray.com
ON&T Buyers' Guide58 www.oceannews.com/uv-buyers-guide	
ON&T ROV Photo Contest.....65 https://ont.news/2EGiYEO	
PT. Marine Propulsion Solutions31 www.marinepropulsionsolutions.com	
Remote Ocean Systems (ROS)21 www.rosys.com	
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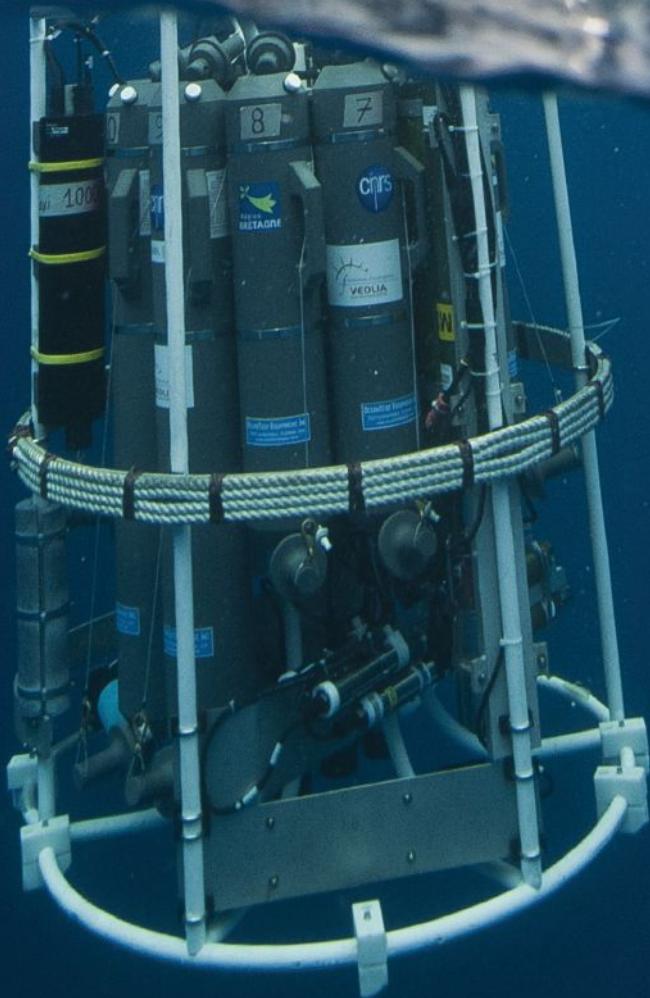
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