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April 2020

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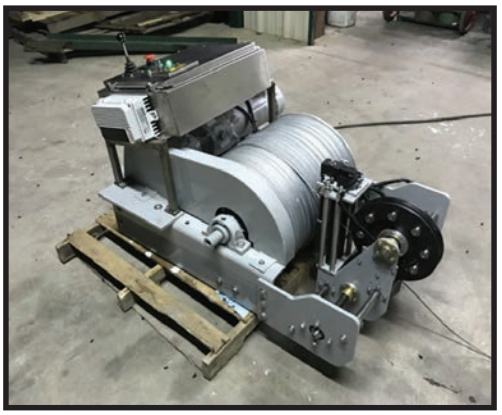

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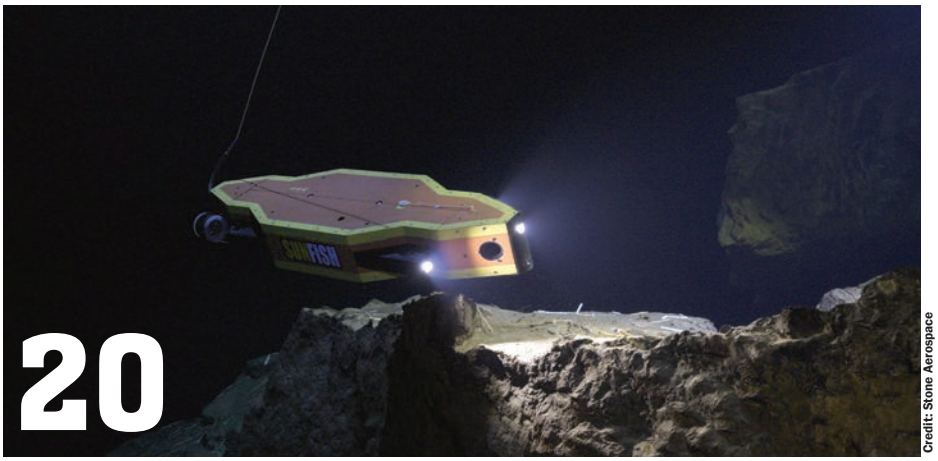

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On the Cover

SUNFISH in a Cave.
(Credit: Stone Aerospace)

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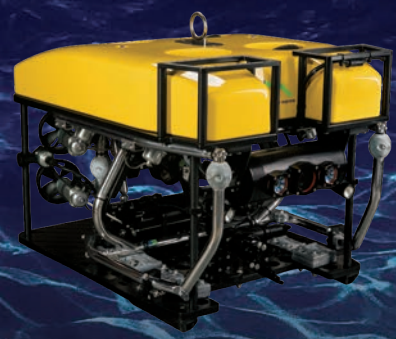

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The Mako has a large open-frame design & capability to carry various accessories up to 22 kg & can run them all at once.
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Editor's Note

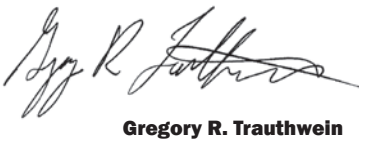
Last month COVID-19 prompted the world and its commerce to grind to a 'socially distanced' halt, a reality that hit the crew here at *Marine Technology Reporter* directly as our headquarters is in the middle of New York City, which has morphed into a surreal ghost town and a 'hot spot' for this pandemic. Personally, I consider myself and our staff very fortunate. Our business has always been 'global and mobile,' so when the decision was made in early March to stop the daily trek into Manhattan, the work-from-home model kicked in seamlessly thanks to our IT crew, and to date all are healthy, accounted for and operating at 120% capacity.

Simultaneous to the COVID-19 scare was a precipitous plunge in oil prices, again, fueled by lack of demand and a spat between Russia and Saudi Arabia which flooded the world with oil exactly when it was not needed. I think it safe to say that this is cumulatively the very definition of a 'Black Swan' event.

The good news? This crisis will end, and when we come out on the other side the work being conducted by many of the people reading these pages will be more important than ever to help facilitate the flow of commerce.

For now though, our daily lives and work routines have been flipped upside down, and it will be most interesting to see when we return to normal, and indeed more fascinating to see what that new normal looks like. From Oceanology International to OTC, there are dozens of postponed and cancelled events, events traditionally used to launch new products.

The discussion surrounding new products and systems is central to our mission, and in print and online we offer, by far, the largest global network to help you spread the word. Many of you already are in close communication with our staff, and we welcome your inquiries as to how we can leverage our media and social media network to your benefit.



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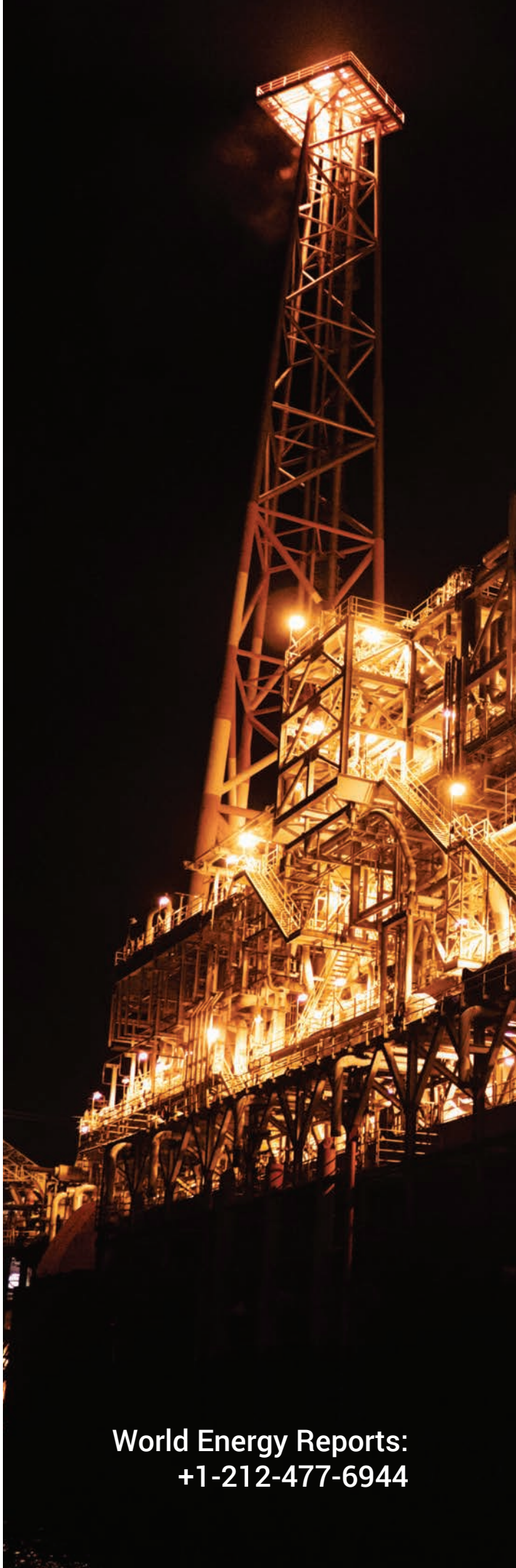

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SAAB

SAAB SEAEYE

New Drone Makes a Buzz and a Splash

By Capt. Marc Deglinnocenti

A new type of aerial drone was unveiled at Underwater Intervention 2020 in New Orleans earlier this year. It is a trifecta of new technologies: it flies through the air like an Unmanned Air System (UAS); it lands on water; and soon it will be able to propel itself as an Unmanned Surface Vehicle (USV).

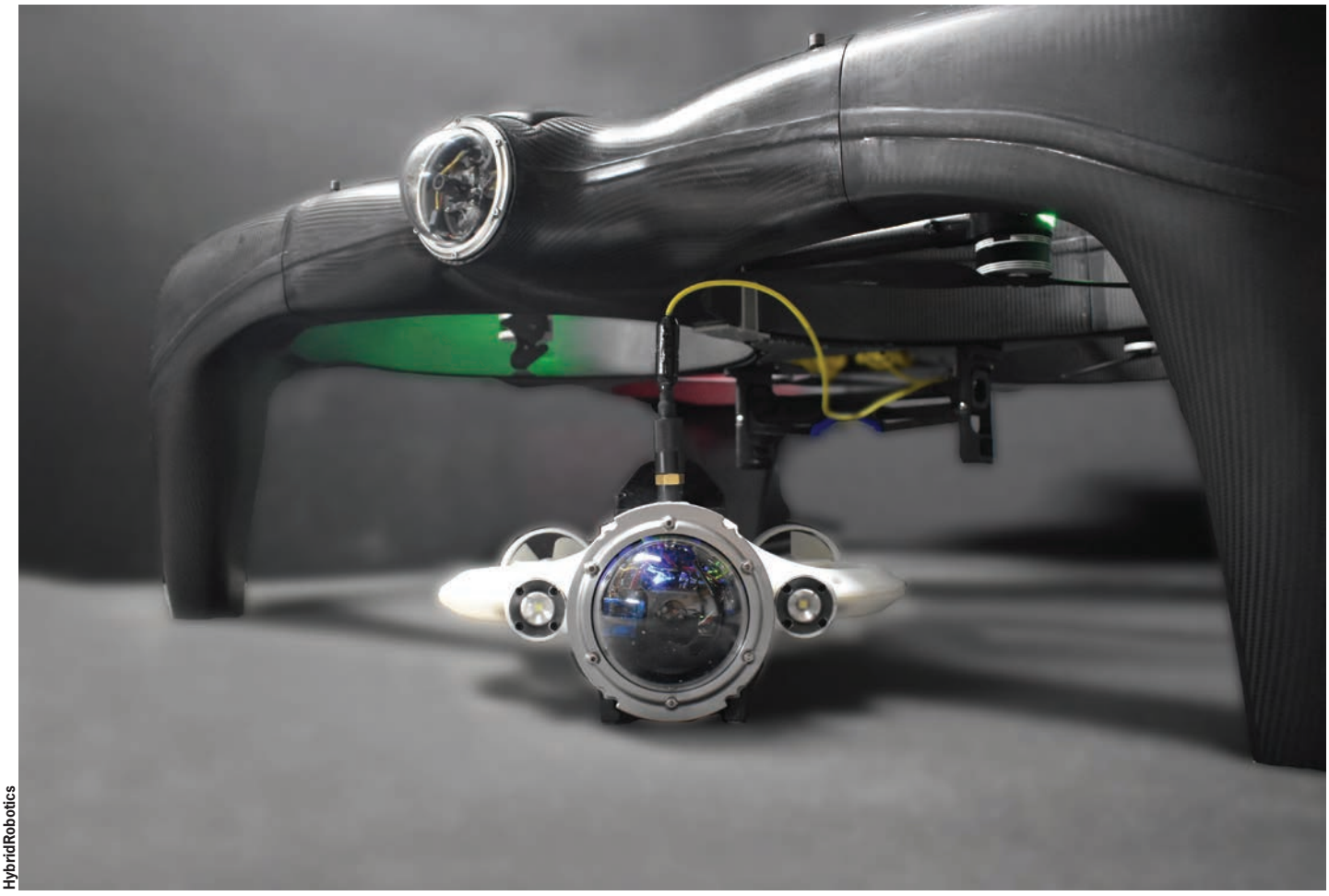
But it does even more than that.

By design it can send a Remotely Operated Vehicle (ROV) beneath the waves controlled and powered via a tether. This achievement will drastically reduce the time needed to place the new HybridRobotics model Catalina UAS on station. It flies at 48.28 kph (30 mph) which is a great deal faster than even the larger size USVs, and it can do quite a few things once it's deployed, too.

After the Catalina lands on waves up to 1.52 meters (5 ft.) high, it can deploy its custom made light weight 4.12 kg (9.1 lbs) ROV, the Cavalla, to a depth of 100.6 meters (330 ft.). It is designed to support other brands of ROVs too, but ROV weight becomes a concern.

This author recommends the small Sofar Ocean, Trident ROV which weighs 3.4 kg (7.5 lbs) if you really need to use an alternative ROV. It's also small, light, and surprisingly aerodynamic.

The ROV Cavalla can support a sonar, a gripper, and various water quality sensors. It has a built-in accelerometer, a gyroscope for enhanced stability, two LED lights at 1500 lumens each, magnetometer for compass bearings, and GPS along with a tilting camera. The Cavella battery life right now is rated at one hour, but I had a chat with their Co-Founder and Director of Research and Design Aaron Bottke about that. I recommended the installation of shape conforming solar panels to increase both the Catalina flight time and the Cavalla dive time. Bottke said that they already have a company working on such a solar panel bid. I then recommended the addition of navigation lights, and I was told that they are currently being manufactured. I then recommended underwater thrusters on the



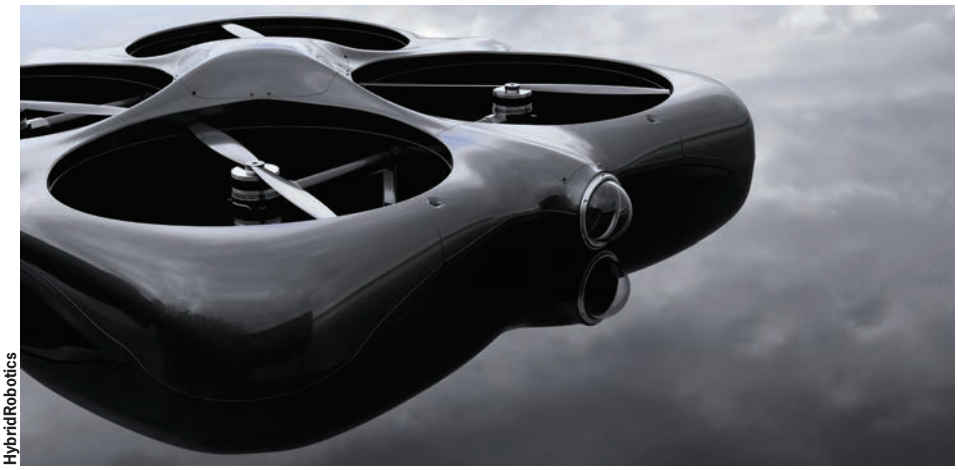
HybridRobotics

Catalina itself. Bottke said that its UAV will have thrusters as a must, but they are still working on the design. I then pointed him toward a Small Water Area Twin Hull (SWATH) design. This will allow for surface propulsion while vastly increasing the stability of the Catalina on the water surface. This will also have a direct impact on helping to solve the Light Detection and Ranging (LiDar) performance issues should it be installed on the Catalina. Poor and intermittent Lidar performance is something that monohull UAV engineers have been struggling with for quite some time now, due to the integrated laser rolling up and down with the rolling UAV instead of staying parallel to the water surface. Bottke took to the idea to heart with enthusiasm. Today, 19 patents of this unique design are pending with the U.S. Patent Office. These are all very impressive accomplishments along with some exciting future goals, but the

Capt. Marc Deglinnocenti

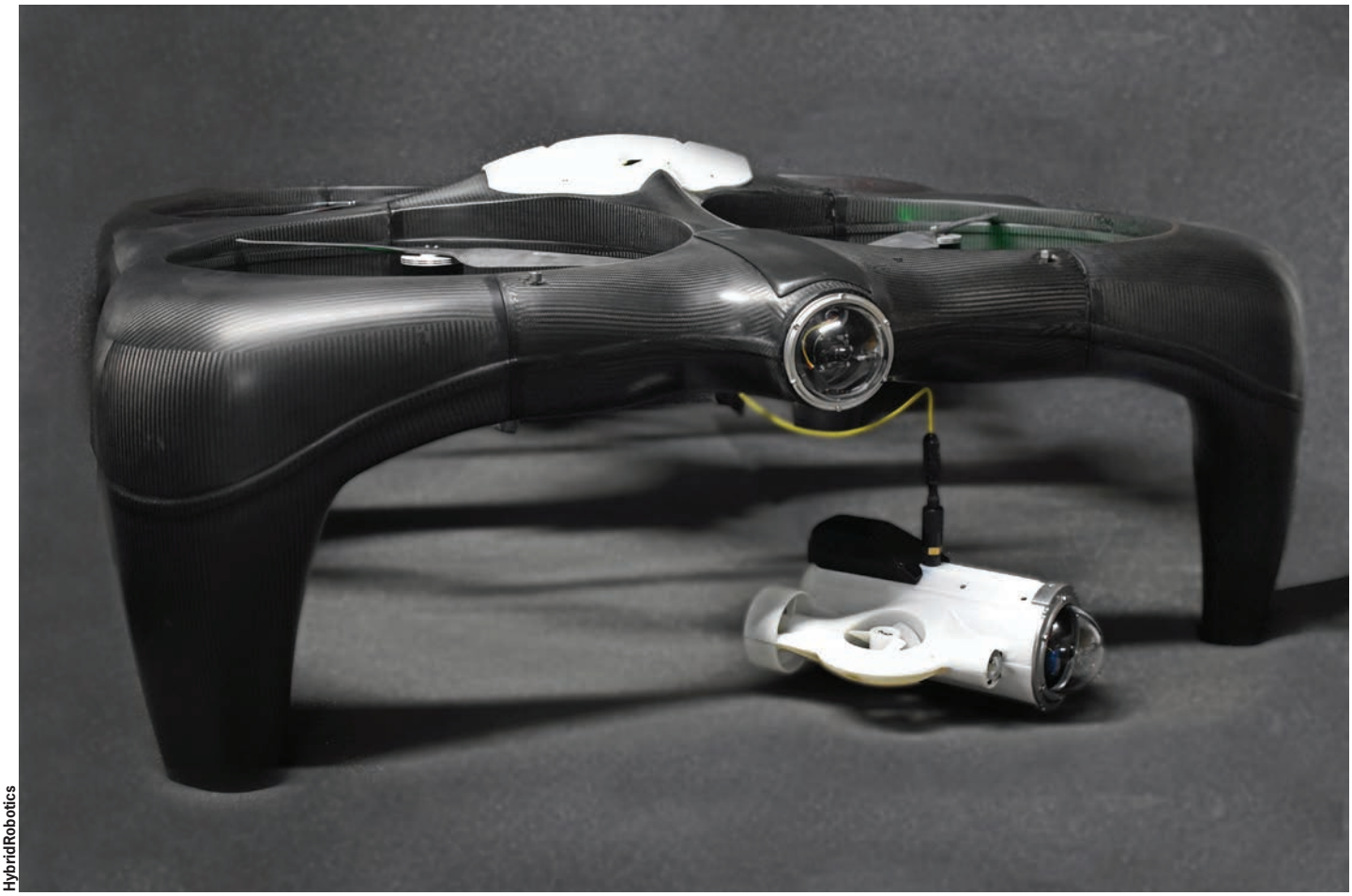
Catalina still made quite the impression on the convention goers in its current configuration.

This is a physically large drone that people are not used to seeing especially with an ROV nestled under it. It measures 1.46 x 1.35 x .58 meters (57.6 in x 53.4 in x 23 in) and will soon be even taller if the SWATH pontoons and thrusters are installed. The four, dual bladed ducts provide a remarkable and redundant lifting power of 77.11 kg (170 lbs) in addition to its own weight. Both the Catalina and its ROV weight is currently totaled at less than 25 kg (55 lbs)! They have managed to keep the weight down so that the Catalina can fly for 15 minutes at 48.28 kph (30 mph) for a range of 12 km (7.5 miles) reduced to 11.26 km (7 miles) when factoring in maneuvering time. That 11.26 km (7 miles) range can easily be doubled with the installation of the solar panels. Additional batteries can also increase the range, but the additional battery weight can also become a limiting factor. Equipment weight is always a critical factor with aerial drones, but this UAS is already equipped with much as is.



HybridRobotics

The Catalina has its own tilting camera, accelerometer, gyroscope, magnetometer, GPS, and soon to be navigation lights, thrusters, and aerodynamic solar panels. Options like Lidar are only restricted by the human imagination and their weight. So, why go with a UAV that is so weight restricted? Why not just spend a little more time getting on station with more capabilities at hand? The answer is a simple one, and it takes the form of emergency responses. If there is a fuel spill, its exact location can be found a lot easier and faster from the air. Its ROV can

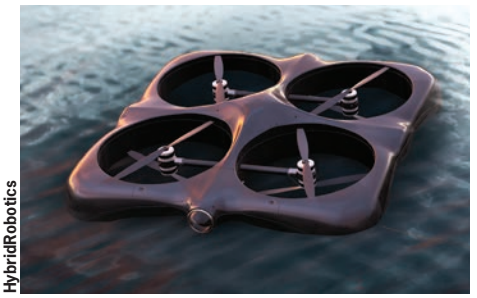


HybridRobotics

then immediately be deployed to find a pipeline leak or assess current speed and direction information in real time. This can be a huge time saving advantage and a great potential reduction of environmental damage. An aerial drone can also quickly spot algae blooms and other water discoloration discrepancies. Fast reporting and communication of environmental threats is one of Catalina's main assets.

The UAS Catalina has a two tiered communication system. The frequency to control the aerial drone is a 900 megahertz one which easily reaches its 11.26 km (7 miles) range. All the other sensor data is retrieved in real time via a 2.4 gigahertz stream. A single pilot can operate everything from a single base station. It even has a semi-autonomous capability with preprogrammed mission profiles possible. It's easily transported and rapidly deployable due to its tough yet light weight carbon fiber construction.

Because of its size and weight, the recommended HybridRobotics safety procedures should be followed at all times. With four sets of twin propellers (8) measuring 56 cm x 17 cm each (22 in x 6.6 in) each, this is not your average toy UAS. Having said that, the Catalina's menacing size and sounds are mostly unfounded. Since it operates primarily over open waters, it's far less dangerous to people, property, and aircraft than its smaller and more numerous aerial drone cousins. This hybrid semi-autonomous multipurpose vehicle has great potential and just might be the wave of the future.



HybridRobotics

Capt. Marc Deglinnocenti

HybridRobotics

Offshore Drilling: It's Going to Get Worse Before It Gets Better

The Offshore Rig Market – At $30 Oil Offshore Drillers May Be Out of Options

By Terry Childs, Head of RigLogix, Westwood Global Energy Group

COVID-19 and low oil prices are already having an impact on the offshore rig market as contractors face crew & logistical challenges and E&Ps attempt to prioritize drilling campaigns

Contract scrutiny has already led to a few contract cancellations and the first claims of Force Majeure

However, contract options are at most risk. Over $1.6 billion in contract value is at stake for options that are due to be exercised this year. Africa, Southeast Asia, and the Middle East make up over 50% of the total

With the oil price crash and COVID-19, the near-term outlook for the offshore rig market is on a lot of minds. RigLogix has contacted a number of rig owners and operators and the consensus seems to be that it's going to get worse before it gets better, especially if current conditions persist. Announcements of operators cutting 2020 capital expenditure plans are coming fast and furious with a 20-30% reduction typical. COVID-19 is also impacting the ability to get personnel and equipment/services to and from rigs. Combined, the number of idle rigs will increase substantially in short order. For rig owners, some of which were in the early stages of making their way back to profitability, the wait will be longer, and some will be impacted more than others. With many companies staring at debt payments due in 2021, one source at one major rig owner said he believes most every public driller will be in Chapter 11 this year or next, not the kind of thing anyone wants to hear.

Currently, rig operations in most areas of the world, where no travel bans or quarantines are in place, continue to be supported by rig owners, albeit with very strict protocols in place regarding crew, equipment, supplies, etc. However, as reports filter in from operators, more are saying they will shut down drilling soon and warm stack the rig. In most of these instances, it is the COVID-19 impact on logistics that is creating the problem. If more countries end up adopting no travel bans or lockdowns, it will only extend the list of idle rigs.

Less than one week ago, there were only a handful of instances where rig contracts had either been suspended or contracts terminated. However, during the 1-2 days of writing of this report, several additional reports of contract amendments have surfaced in various parts of the world. Some included shortening existing programs or contract suspensions, while others involved options not being exercised, and even the start of force majeure declarations. Other reports of operators planning to shut down drilling operations once a casing point is reached are also now coming in, and that list is getting longer, quickly.

Assuming low oil prices and COVID-19 continue in the coming months, the number of rigs going idle will be a key metric. Contracts where options are not exercised, delays to currently planned programs, and Force Majeure declarations and other contract termination options will all result in idle rigs.

The Force Majeure option will become more prevalent in the next few months. How much so will depend on the precise wording in any given contract, but you can be sure drilling company and operator legal teams are poring through contracts to review the language.

According to some, a pandemic could be deemed to fall under an "Act of God", a clause written in many rig contracts, so there no doubt will be much discussion around this topic. In a Force Majeure, a rig usually goes on a reduced rate for a set number of days, often followed by a contract termination or in the best case a rate renegotiation. In this instance, it may not be sickness caused by COVID-19 that brings a force majeure declaration, but rather rig downtime due to inability to get crews and/or supplies and equipment to and from the rig.

Closely aligned with Force Majeure, some recent contract awards for work starting later in the year are expected to be terminated before the work begins. To that end, there are reports that a contract award made just last month for a semi-submersible to work offshore Norway has been withdrawn, but that has yet to be confirmed.

Many operators will not be inclined to

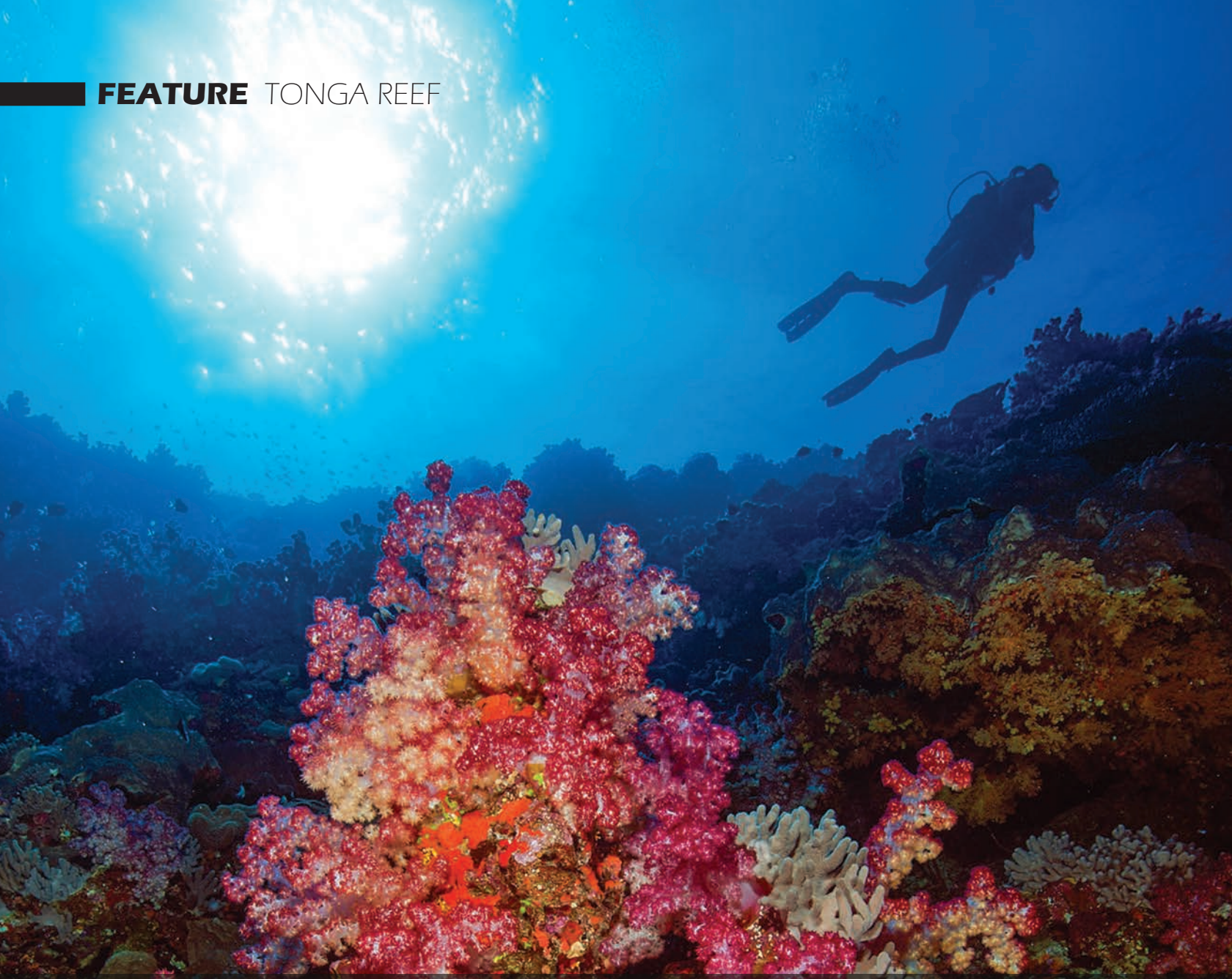
exercise existing contract options, and that has already happened in West Africa and the UAE. Of course, not every rig will have its options declined, but day rates for those that are extended will in most cases be substantially reduced from where they would have been a little over a month ago. However, for operators that do not have the financial wherewithal to withstand the revenue decline that sub $30 oil brings, the decision to release a rig will be an easy one to make.

In looking at contract options where the term is scheduled to begin this year, RigLogix has identified 75 rigs with 95 options (some have more than one) where the term is scheduled to begin this year. Since option rates are not often known, Riglogix used either the existing rate or an internally estimated rate for the calculations. The results show total revenues of over $1.6 billion tied up in the options. As we have already stated, many of these will not be exercised, but those not scheduled to start until later in the year could very well still proceed.

Looking a bit further into the data, Africa, Southeast Asia, and the Middle East have the highest dollar amounts at stake, and the three regions comprise 50% of the total options value. In Southeast Asia and the Middle East, the options consist entirely of jackup contracts, whereas the $136.1 million in the US Gulf of Mexico concerns mainly floating rig options. Rig managers, Valaris ($331 million) and Transocean ($195 million) have the highest dollar amounts of options to be exercised and are the most exposed. Figure 1 shows the calculated 2020 contract options potentially at risk by region.

Most of the nearly 300 drilling programs that currently have 2020 start dates will be delayed. Riglogix has heard that the planning process for some drilling programs is continuing, but at a much slower pace (as if that was even possible in some cases). Conversely, some contract awards, particularly those where drilling is not planned until 2021 or later, should continue but it is reasonable to assume that the number of contracts finalized during the next few months will be minimal. Note, however, during this writing there was a contract signing for a short semi program in the North Sea, so not all is lost!

The world has been transformed in the past month. Many are predicting a prolonged downturn in the oil market but there remains much uncertainty over its duration and depth. COVID-19 is having a catastrophic impact on oil demand and how long the various travel bans and lockdowns continue is anyone's guess. In the meantime, Saudi Arabia and Russia's fallout over oil production has released more supply into the market, and even a reconciliation there will not be enough to reverse the damage caused by the many millions of barrels a day of demand being taken out of the market. History tells us that eventually, the markets will recover but in the meantime, operators, rig owners and services companies will once again have to "hunker down" and ride out the storm.



Global Reef Expedition: Mission to Tonga

Assessing the health of coral reefs in the Kingdom of Tonga

By Alexandra Dempsey

All images: ©Khaled bin Sultan Living Oceans Foundation/Ken Marks

Healthy coral reefs provide critical ecosystem services for millions of people globally, but with climate change and anthropogenic stressors, the landscape of these habitats is regularly shifting. The science and conservation community has realized the importance of baseline studies to help track how these precious reef ecosystems are changing. The Khaled bin Sultan Living Oceans Foundation launched the Global Reef Expedition (GRE)—the largest coral reef survey and mapping expedition in history—to conduct much-needed baseline research on the health and resiliency of coral reefs. This cornerstone study used standardized sampling methods to research the ever-dynamic coral reef benthic and fish communities all over the world. The rigorous five-year scientific mission set out to assess the impact of anthropogenic and natural disturbances on reef ecosystems. Now that the field research for the Global Reef Expedition is complete, scientists from the Living Oceans Foundation are releasing their findings. The most recent findings from the Global Reef Expedition come from the Kingdom of Tonga.

In Tonga, the Foundation quantitatively measured and categorized coral reef environments in three island systems, Ha'apai, Vava'u, and around the island of Niuatoputapu. This scientific mission involved 20 participants from numerous organizations around the world, who worked alongside scientists representing the government in Tonga, to gather the highest quality data. They completed more than 500 benthic coral reef and fish surveys on SCUBA, and over 2,200 km2 of satellite imagery was collected and interpreted into high-resolution habitat and bathymetry maps. The ultimate goal of the Foundation's research in Tonga was to provide scientists, managers, and stakeholders with information and recommendations that could be important for creating successful management strategies for coral reef ecosystems.

Assessing the Heath of Coral Reefs

Scientists on the GRE used a combination of quantitative methods, including belt transects, point-intercept transects, and photo quadrats, to assess benthic and fish communities of reefs in Tonga. This stan-

dardized collection methodology provides robust data that can be compared across sites locally, regionally, and globally.

The underwater surveys were completed using a 'rapid reef assessment' methodology. A rapid reef assessment is a sampling technique that maximizes bottom time (amount of time a person can safely stay at depth below 10 m on SCUBA) to collect as much in situ data as possible.

Coral communities were recorded using the point intercept method to record species of corals, algae, sponges, and other invertebrates. This method required two scientific divers using SCUBA to lay out a 10 m transect line and record the organism and substrate type at every 10 cm mark (total 100 points per transect). Belt transects were used to count and measure reef fish assemblages. This was completed by several scientific divers who would swim 30 meters and record the species of fish and its approximate size.

Perhaps one of the more critical data sets collected was the photographic assessment (photo quadrates) to supplement the point intercept surveys. In this sampling technique, a scientific diver used a 1 m × 1 m quadrat, flipping it over a total of 10 times per transect to capture detailed photographs of a full 1 × 10 m photo transect. Analyzing photos of the underwater landscape required using computer software called Coral Point Count with Excel Extensions (CPCe), which was developed by our partners at Nova Southeastern University's National Coral Reef Institute (NCRI). The images were imported into the software, where 50 random points were overlaid on each photograph. A scientist then defined the organism and substrate type directly underneath the point. For the Kingdom of Tonga, KSLOF analyzed over 3,000 photos for a total of 41,000 points digitized. Photo transects are an excellent record of what the coral community looks like at a point in time. The data derived from these methods yielded important metrics that quantified how much live coral cover was found on the reefs of Tonga, which is a metric that is linked to the overall health of a coral reef ecosystem.

Mapping the Reef

The most novel aspect of the study was the creation of high-resolution habitat and bathymetric maps of Ha'apai, Vava'u, Niuatoputapu. Using multispectral WorldView-2 satellite imagery obtained from DigitalGlobe Inc., in combination with data obtained from aerial surveys and ground-truthing, we created high-resolution maps of the shallow marine environments in Tonga. These maps have been shared with government officials in Tonga and are available to explore on the Khaled bin Sultan Living Oceans Foundation World Web Map Portal (**http://maps.lof.org/lof**).

To verify the accuracy of these maps, an underwater tethered video camera, called a drop-cam, was used to gather video of the benthic composition at each survey site. At each point, the drop-cam was suspended from the survey boat enabling it to "fly" along the sea floor recording video, geographic position, time, date, heading, and speed. Some of these geo-referenced clips

from the drop-cams are available to view on the KSLOF online Map Portal.

Benthic habitat maps are an essential tool in coral reef conservation and marine spatial planning as they provide a snapshot of where reefs are located and give managers an idea of what may be found on the seafloor. The remote sensing data and coral reef maps are useful not only for marine spatial planning, but also as a reference for future research to see how the reefs may change over time.

The State of the Reef

With a combination of all these data products, KSLOF scientists were able to develop a unique grading scale that defines the relative health and resilience of the benthic communities for reefs in Tonga. For each survey site visited, the reef was classified as being in "good," moderate," or "poor" condition. Based upon all of the data collected on the Global Reef Expedition mission to the Kingdom of Tonga, KSLOF concluded that overall, the reefs in Tonga are moderately healthy. While the corals themselves were thriving in some places, the reef fish and invertebrate communities were in poor condition. Although there were many kinds of fish seen on reefs in Tonga, the fish were small and low on the food chain. Few large and commercially valuable fish remained.

To the credit of The Ministry of Fisheries, the Kingdom of Tonga has done substantial work in establishing conservation areas to protect the country's marine resources. The Foundation commends these efforts and hopes this information can aid the establishment of additional protection zones and enhance the enforcement of those that already exist by providing a better understanding of the health of reefs around Ha'apai, Vava'u, and Niuatoputapu. In a place like Tonga, where two-thirds of the people rely on marine ecosystems for food and income, it is imperative that in-depth multidisciplinary coral reef assessments such as the GRE are conducted to relay critical information to coral reef managers so they can effectively identify critical habitats for marine conservation.

Untethered Vehicles at Underwater Intervention: Advancing Autonomy

By Justin Manley

Social distancing is a new fact of life for most, but not long-ago technical conferences brought experts together. In early February, Underwater Intervention provided a series of presentations on developments in untethered vehicles. A powerful trend was the increasing level of "autonomy" found in the sector. While not all the presentations addressed this theme, several helped clarify the many ways this "buzzword" is advancing the capabilities of untethered marine vehicles.

Kongsberg Maritime offered two presentations: "How Autonomous is Your AUV" presented by Richard Mills and "Autonomous Technology for Ocean Exploration," by Arnt Olsen. Together these presentations used the context of Kongsberg's vehicles, especially the Hugin AUV and the Sounder USV, to discuss what autonomous technology means, and is capable of. In the case of the USV there is a clear spectrum of operator control. This has four stages: 1) it begins at line of sight remote control in which an operator uses a hand held remote control for docking and harbor maneuvering; 2) it moves on to remote control beyond line of sight, where an onshore operator controls the voyage and makes changes to speed, heading, and other onboard systems; 3) in supervised mode the USV will follow a pre-set mission plan which the operator may change during the mission; 4) the final stage is fully autonomous where the USV will solve the tasks set in the mission plan, make decisions by itself, and avoid collisions. While this spectrum may be readily apparent to practicing UUV users, it provides a useful construct to discuss the underlying technologies that enable a USV.

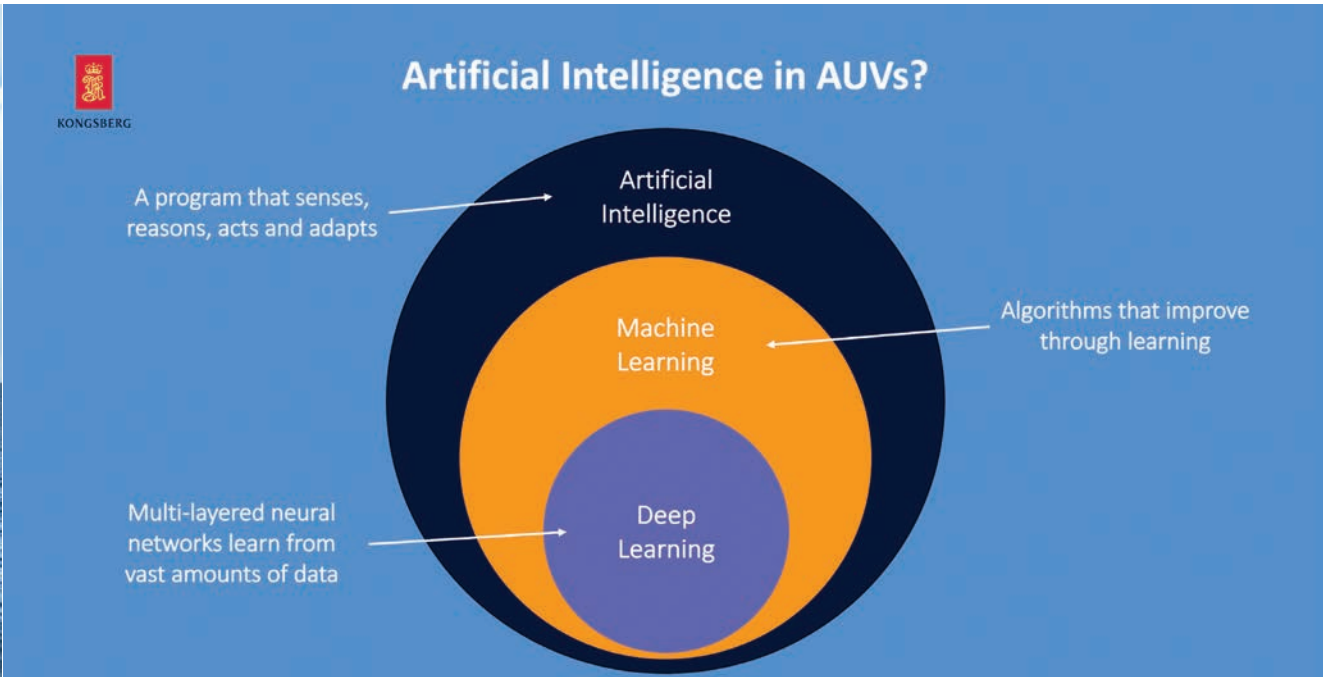
Key elements to successful USV operations include: direct vehicle control and fleet management, a USV world model, and image recognition. The first is perhaps most obvious and a relatively direct transition from crewed vessel operations. But the second and third elements are quite sophisticated. A USV world model draws upon a three-dimensional world model, geo-referencing, image recognition, sensor fusion, and overall evaluation of this model via machine learning and artificial intelligence techniques.

Kongsberg's AUV presentation also addressed these ideas. In that case they have a similar spectrum of autonomy. It begins with mission autonomy, getting from A to B, following a route/mission plan, and managing sensors. The next level is advanced autonomy including reactive behavior, collision avoidance, and mission tasks such as following a pipe. The highest level of function is adaptive autonomy for actions such as proactive behaviors, on-board decision making, and adjusting

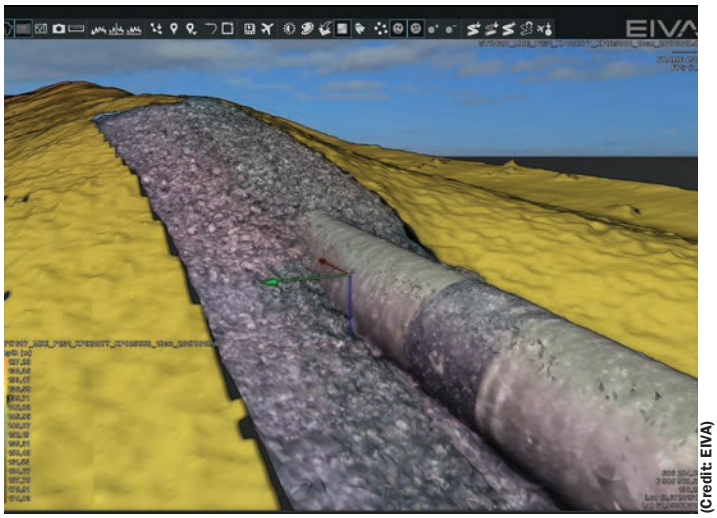
SUNFISH, a new inspection AUV

A USV Demands a spectrum of control and "autonomy"

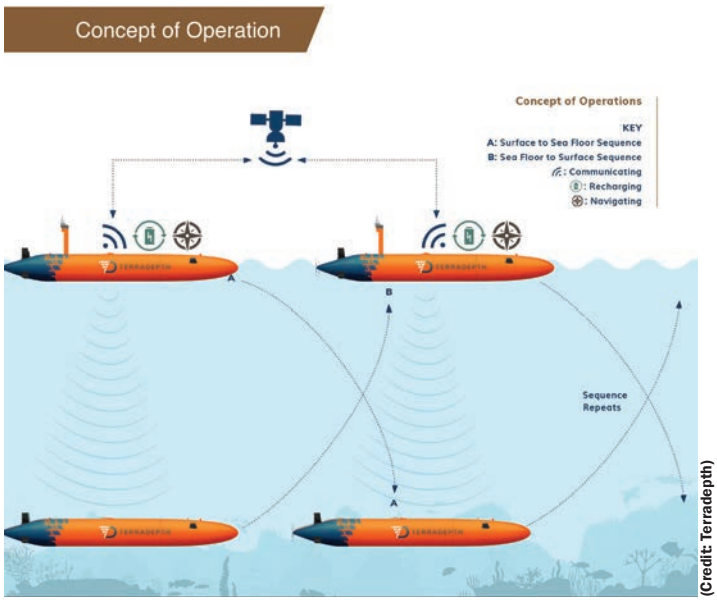
(Credit: Kongsberg Maritime)




(credit: Stone Aerospace)



(Credit: EIVA)



(Credit: Terradepth)

mission outcomes. This culminates in a perspective of nested capabilities, including deep learning, machine learning, and true artificial intelligence.

EIVA's Antonio Felipe Siva presented "Visually Aided Navigation and Automated Subsea Inspection Using Deep Learning and Computer Vision" a briefing on how their software employs machine learning. In particular they use it for advanced subsea feature tracking. They recently released a paper describing a new feature detection algorithm that outperforms current algorithms in the market, which will be used in their software tools. The software tools can generate a three-dimensional mesh from any point cloud or sonar, and from analyzed video data. The end product is a "3D mesh" with the "full resolution of the image" even though the underlying point-cloud has been reduced.

Another presentation of novel ideas came from Terradepth's Ken Childress. This new startup in Austin, Texas is pioneering a networked systems approach for ocean data collection. Their approach aims to extend mission duration with high power payload capacity while limiting offshore personnel through autonomous data collection and quality assurance. They also aim to reduce staffing onshore with autonomous data processing. A key in this vision is efficiency with scale of operations and reliability from many interchangeable vehicles, which they term AxVs.

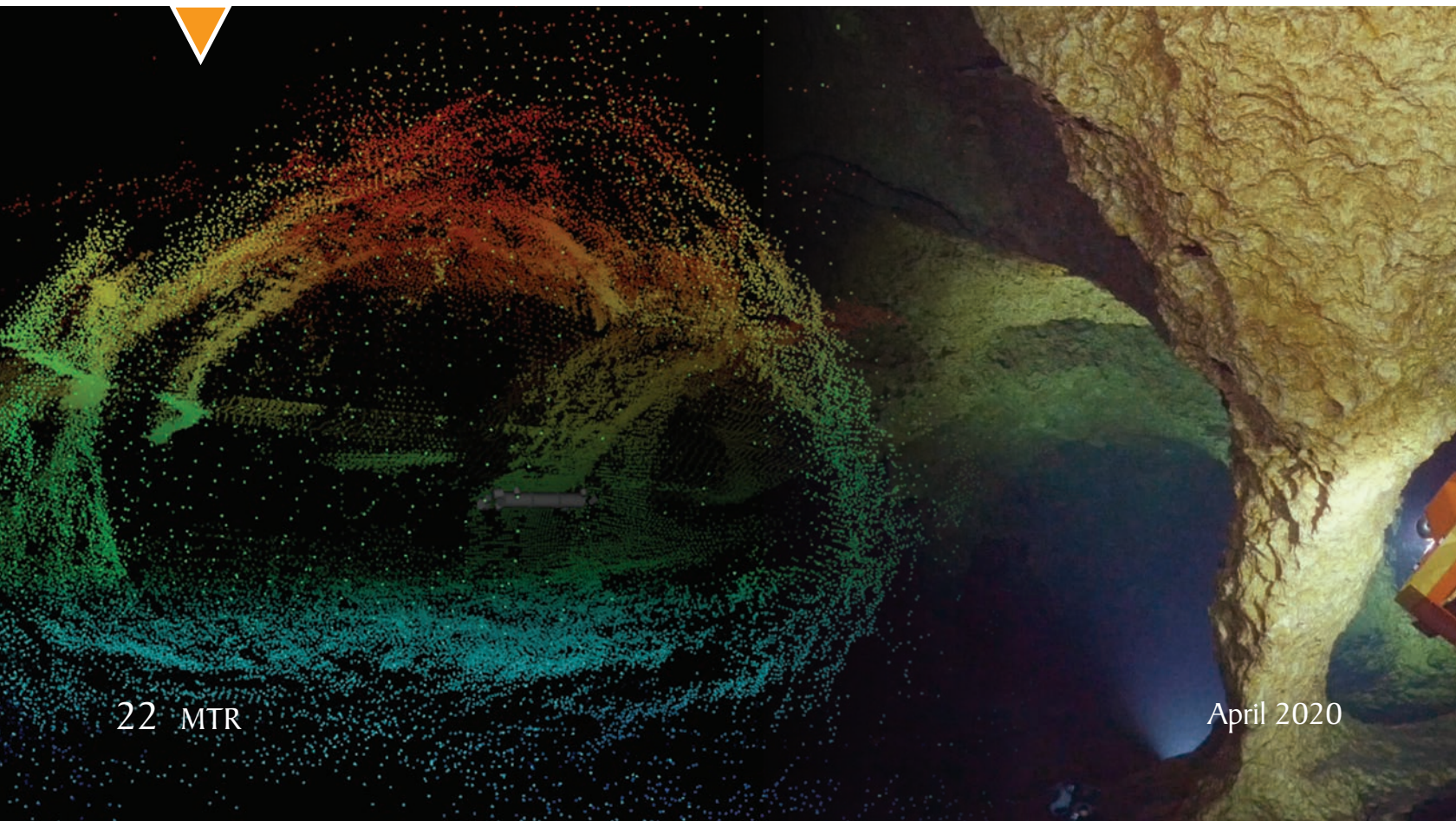
The Terradepth Concept of Operations (CONOPS) includes: 1) surface and subsurface capability, 2) two or more identical vehicles, 3) launch from shore or sea, 4) open ocean transit to survey site, 5) extended time at sea, 6) multi-vehicle cooperation, and 7) Precision data gathering. This is executed via a single configuration of hybrid autonomous marine vehicle surface and subsurface system. Terradepth has a patent pending for this CONOPS and is currently preparing for initial demonstrations in mid-2020. In this concept the individual AxVs employ autonomy concepts similar to the AUV and USV ideas discussed by Kongsberg. But the overall network also offers opportunities for new approaches to fleet management and individual AxV tasking.

While the Terradepth ideas are based on new vehicle designs and Kongsberg focused on discussing the software/autonomy elements of unmanned maritime systems, another new entrant addressed both. Stone Aerospace is also based in Austin, Texas. After many years of specialty research and development projects, most funded by NASA, they introduced their first commercial concept, Sunfish, in a briefing by Kristof Richmond, "Demonstrations of a human-portable hovering AUV for complex 3D environments." This addressed both a new AUV design and a powerful software offering.

The vehicle itself is described as able to fly like a jet and hover like a helicopter. It is a person-portable system that addresses many challenges of autonomous exploration in complex environments. The AUV is designed to operate in a wide variety of undersea environments, ranging from man-made, such as piers or harbors, to natural, reefs or caves. The core vehicle is 1.6 meters long, 0.47 meters wide and only 0.2 meters high. At 50 kilograms in weight the system is highly portable. SUNFISH can stop in mid "flight," hover, and perform proximity operations along objects it has mapped and do so at specified stand-off ranges while acquiring high-resolution photos and geometry. This precision, combined with sophisticated artificial intelligence, makes SUNFISH ideal for complex and combined environments.

During operations SUNFISH can report back, using an optional data-only tether,

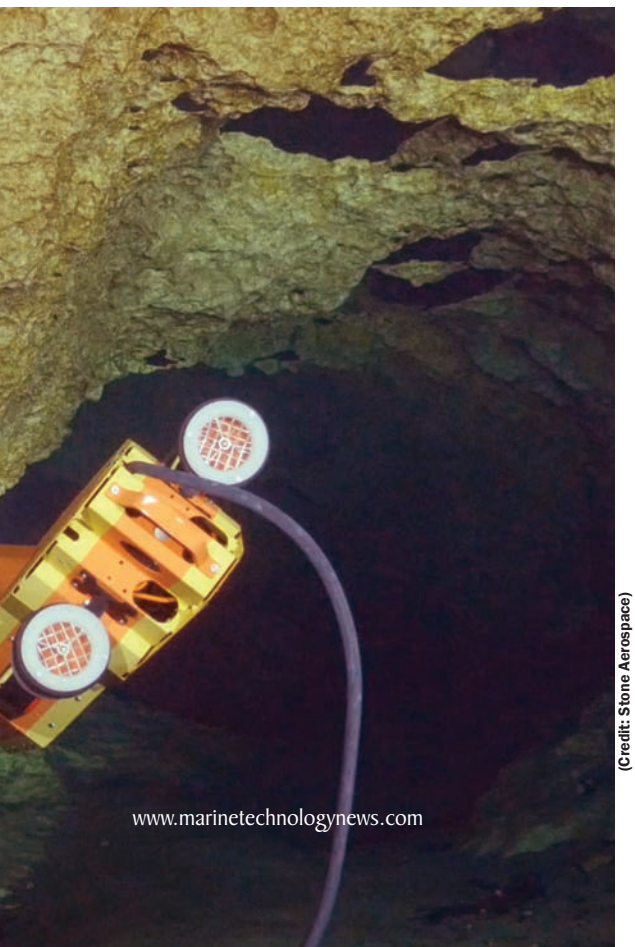
SUNFISH in a Cave, and the Data used for SLAM



allowing a surface-based team to review, and re-task the vehicle. The system can also operate fully autonomously. While the mechanical design of the AUV is interesting, it is the powerful software onboard that is truly innovative. This vehicle employs field proven Artificial Intelligence (AI) and Simultaneous Localization and Mapping (SLAM).

This capability has been used in a series of tests and demonstrations in unstructured labyrinthine cave environments. SUNFISH was able to autonomously explore this environment, creating a real-time map which it used to navigate through the cave. SUNFISH has explored numerous caves, making a map as it proceeds. The robot was then able to autonomously find its way back to the starting point using the map it had just created.

Throughout these presentations the UUV Track served to showcase the growing power of software in new uncrewed marine vehicles. There remains a great deal of room to discuss and define terms such as autonomy, artificial intelligence, machine learning, SLAM, and other terms of art. But regardless of the definitions the new capabilities coming to all manner of ocean robots are impressive. New hardware and software ideas are driving innovation and shaping the future of untethered vehicles in the maritime industry.



(Credit: Stone Aerospace)

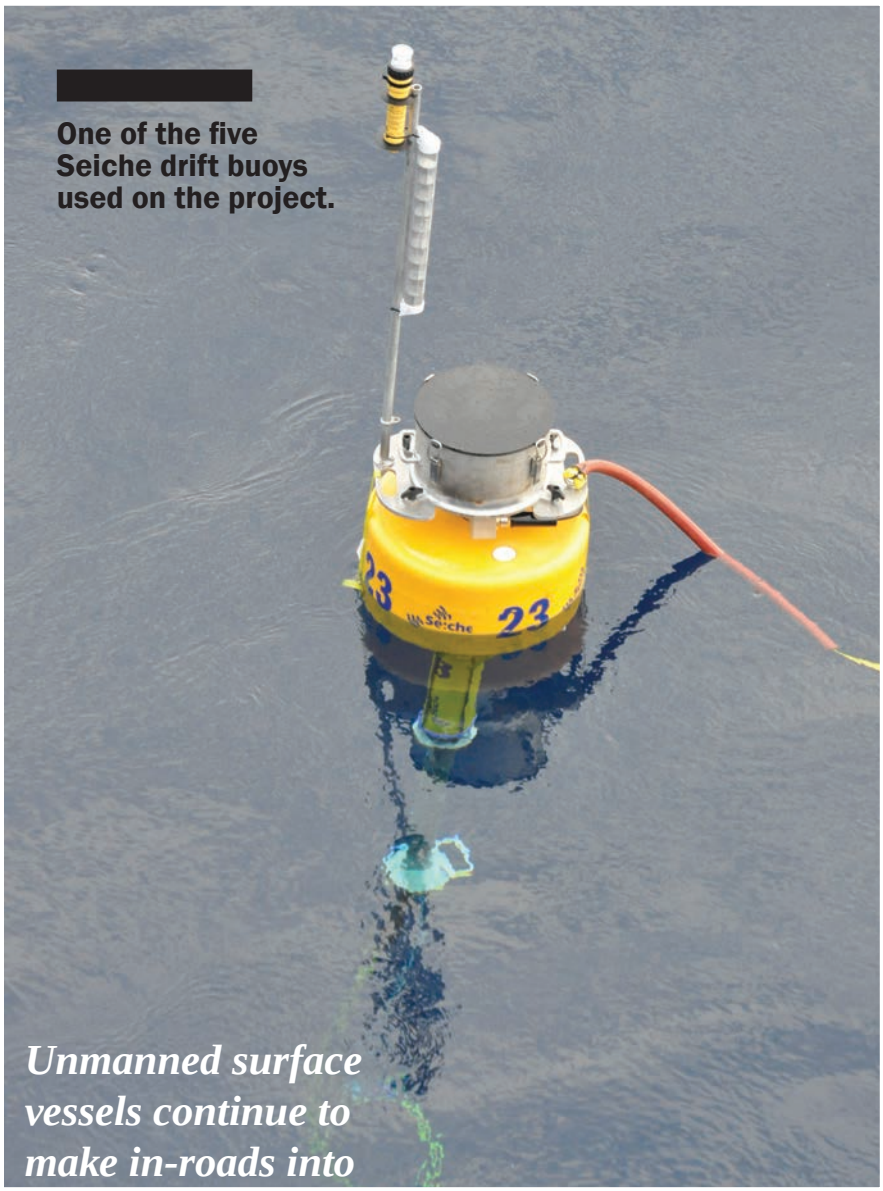
AutoNaut now has 10 of its wave propelled vehicles.

Entering the exclusion zone, quietly

By Elaine Maslin

All images: AutoNaut

Operating up to 140m away from the MODU, within the exclusion zone.



One of the five Seiche drift buoys used on the project.

Unmanned surface vessels continue to make in-roads into new applications and industries. An ability to gather data in otherwise inaccessible locations is both increasing knowledge about marine noise and confidence in marine autonomous systems in the oil and gas industry.

Offshore oil and gas exploration and production activities have been going on since the mid-20th century. But the noise that drilling or production facilities emit into the marine environment and the impact they have on marine life isn't perhaps as well quantified as it could be. That could be changing, thanks to efforts to persuade the industry to use unmanned systems.

Currently, there are efforts to monitoring marine noise, using passive acoustic monitoring (PAM) for marine life, but it's mostly focused on seismic operations, which can emit a lot of noise into the ocean. Other efforts to measure and prevent noise in the marine environment include using the likes of bubble curtains around offshore wind monopiles while piling operations are ongoing. However, the day-to-day noise created by drilling opera-

Handling a buoy from the standby vessel.

tions is less well monitored. This is partly for good reason – there's a 500 m exclusion zone around production facilities to prevent any unwanted interaction with other users of the sea. Where there is data, it tends to have limited sample locations and at distances of kilometres or tens of kilometres from a facility.

Some of the gaps in the knowledge about how much noise these facilities make are now being filled thanks to a project in the US Gulf of Mexico that made use of marine autonomous systems within the exclusion zone of a drilling facility, to enable a much broader understanding of the sound field. The study, commissioned by BP, for a sixth-generation mobile offshore drilling unit (MODU), was undertaken by UK-based underwater monitoring technology firm Seiche and its unmanned surface vessel (USV) business AutoNaut. Seiche thinks it's the first sound field mapping within a 500 m exclusion zone.

Mark Burnett, Seiche's CEO, says the goal was to get rich data, instead of the sparse, discrete data that's previously been gathered, due to the exclusion zone restrictions. But to do this, a number of different data acquisition platforms would be needed, he says, "and that simultaneous operations would be a big consideration, with the MODU and its support and survey vessels." For this proj-

ect, there was another rig to the northeast of the subject of study and a geophysical survey was also being undertaken to the northwest – on top of any passing marine traffic, such as fishing or cargo ships, that might be in the area – resulting in an estimated eight to 10 vessels regularly working in the sound field.

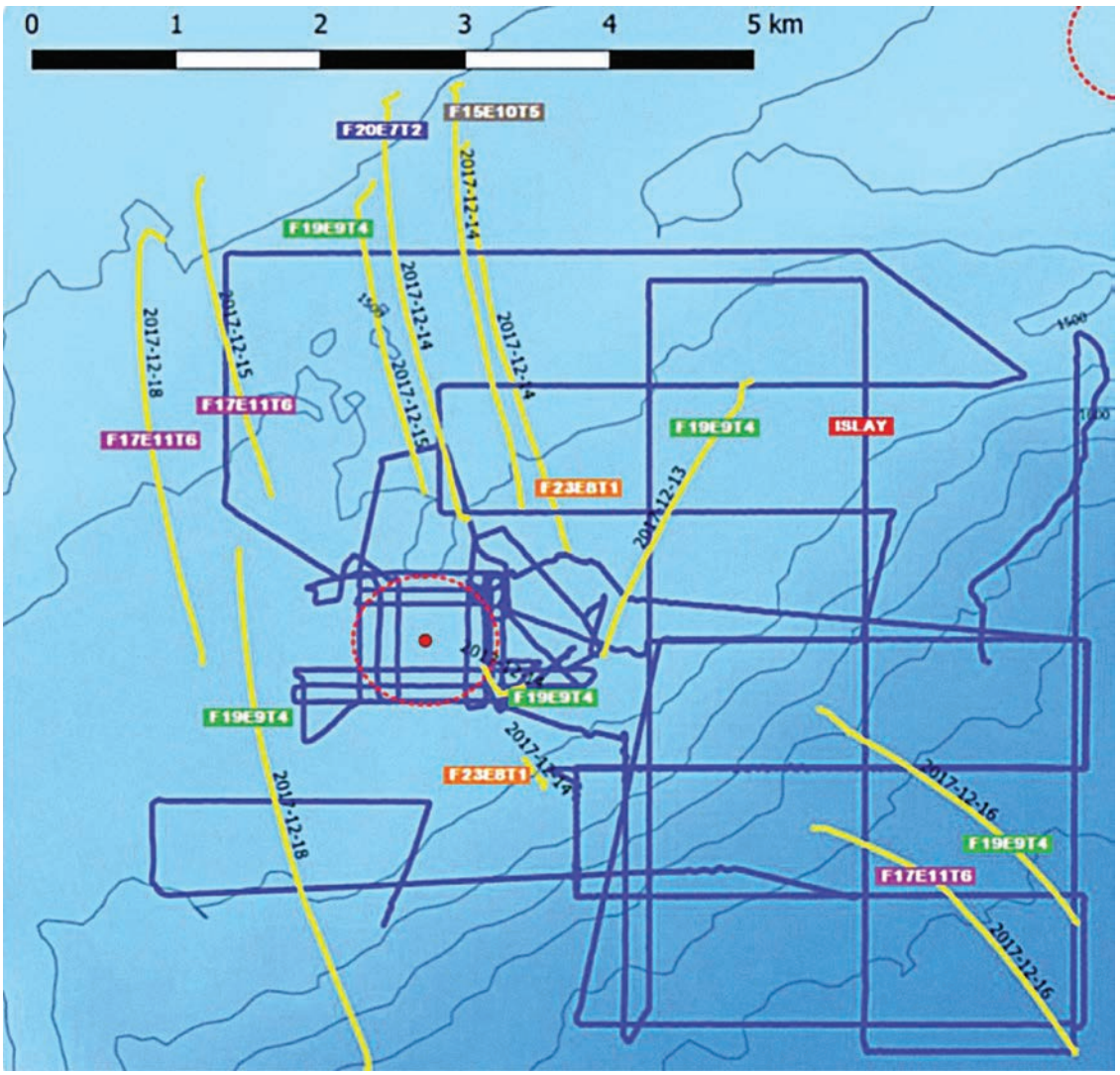
Drift buoys are usually used for this type of audio data collecting, says Burnett. They have a mast, battery, tracking system and a 60m-long cable with four hydrophones placed in pairs at 30m and 60m. But, drift buoys, by their nature, move with the swell and currents, which mean their data can be somewhat random. So, Seiche looked at other platform options.

"We dismissed aerial vehicles and also unmanned underwater vehicles as we wanted constant control and communication," says Burnett. "So, we chose an unmanned surface vessel, which we would have command and control over via Wi-fi within the exclusion zone and an ability to set waypoints for navigation outside the zone. It would have a 10-20% cost saving over a survey vessel."

There is an emerging use of unmanned vessels in the upstream industry. Last year, USV operator XOCEAN used its vehicles to perform hydrographic, pipeline inspection and data gathering services, while L3Harris has been trialling deploying a remotely operated vehicle from one of its USVs. But, despite the emerging use and apparent benefit of unmanned systems, it can still be an uphill struggle to get operators to adopt this technology. "Use of unmanned vehicles (surface/underwater) remains novel technology for the majority of clients, although acceptance and use for growing applications are starting to accelerate," says Burnett.

For this project, the 5m-long AutoNaut system was chosen. The Islay AutoNaut was equipped with a 25m-long two-channel towed hydrophone array and a hull-mounted PAM. It had 1,800 m line of sight control, iridium communications and Wi-fi data access for wireless data transfer at sea. "It has quiet wave-foil propulsion to minimise contamination of the data, needs zero fuel because it harvests energy from waves to move forward and proven command and control," says Burnett. It could be monitored and controlled using iridium communications and via local radio communications. It can also be launched and recovered from a standby vessel, making it easy to deploy and recover. In case it needs to move in an emergency, it also has auxiliary thrusters.

Nevertheless, prior to the mission, Seiche had to work with the operator to identify and agree proposed run-lines for the USV and anticipate drift patterns of the buoys (from predicted regional and localised surface currents). The close cooperation carried on through execution, including demonstrating the capabilities of autonomous line following, remote and local pi-



The five drift buoys and AutoNaut's track during the MODU sound field monitoring mission.

loting and emergency response plans, says Burnett. Throughout, permissions had to be secured to do the work and full command and control capability of the USV had to be demonstrated. Seiche also had to get explicit permission from the respective offshore installation manager to go within the 500m exclusion/safety zone with the vehicle.

And, all went to plan. The mission was carried out in 2017, in 2000 m water depth over seven days. Data was collected over 41 hours at 1-5km from the MODU using five drift buoys equipped with 60 m vertical four-channel hydrophone arrays, while the AutoNaut Islay, operating for 75 hours, moved on transects at between 120m and 5.5km from the rig, recording at 25, 40 and 60m deep on its towed array. The project focused towards the east of the MODU, due to the ongoing seismic survey to the northwest, and each system had its own tracking systems monitored by situation awareness package from ION. In total, more than 117 hours of continuous valid data, including audio, GPS and AIS, was gathered.

"For operations of the AutoNaut outside the exclusion zone, lines were pre-determined with AutoNaut autonomously following; whilst remote pilots in the UK maintained a constant watch in the event of intervention, or direct pilot control required," says Burnett. "During close passes within the exclusion zone, AutoNaut pilots situated on a nearby standby vessel took over the watch (remote piloting), whilst the AutoNaut autonomously followed the pre-plotted track lines. For this project, the standby vessel was used to deploy and recover the AutoNaut (and drift buoys) in proximity to the operating field, then stood off so as not to contaminate the acoustic data acquisition with its own vessel noise."

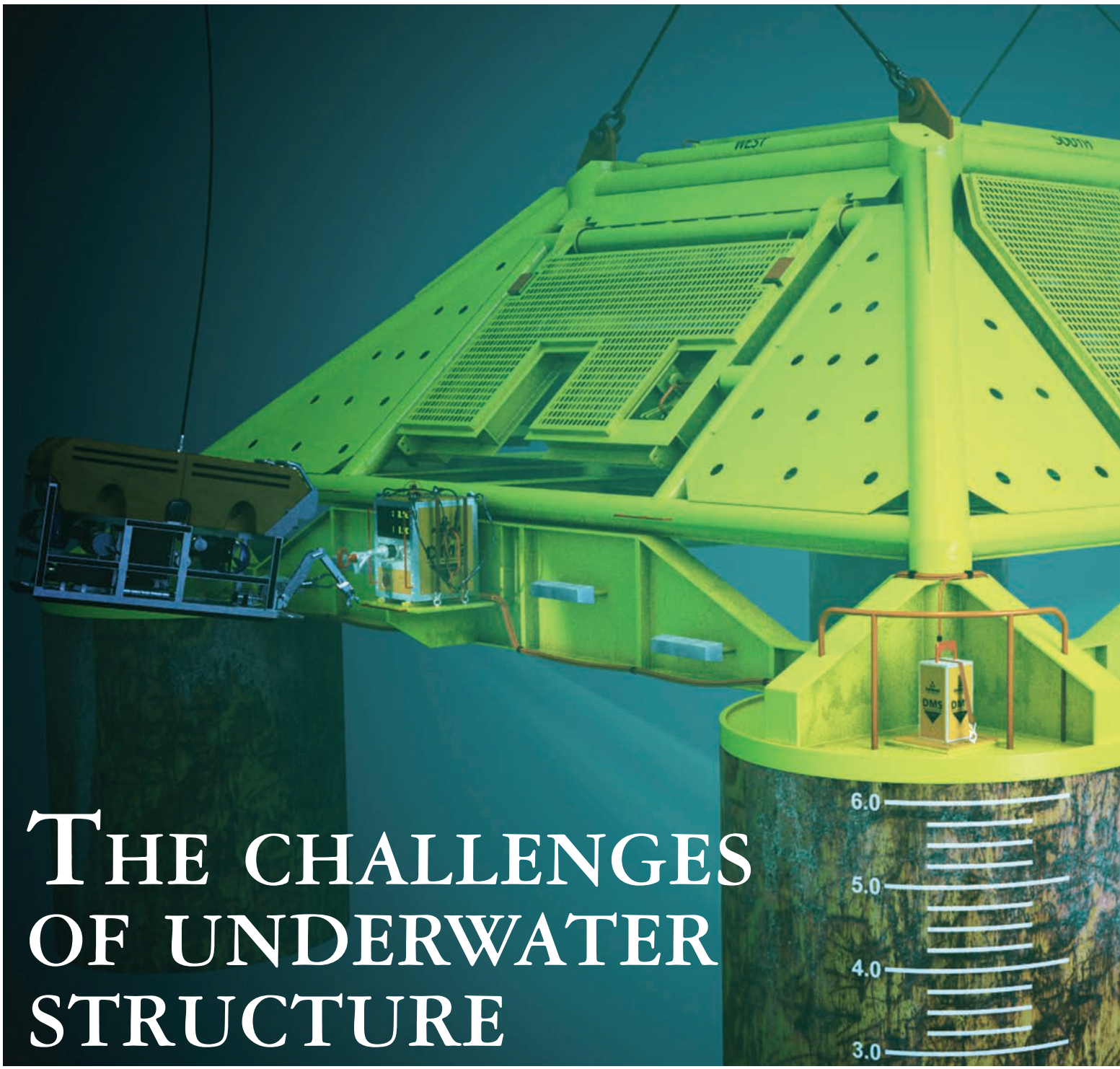
Burnett says this type of project could also be done more efficiently in future, specially, removing the need for involving a standby vessel. "This was a requirement to mitigate potential risk of the AutoNaut losing command/control whilst operating in the exclusion zone. As a consequence, the standby vessel needed to have DP2 capability, and significantly increased the cost of the project," he says. "Unmanned surface vessels should/are capable of operating from being launched from the shore and sailing out to areas of operations, rather than being carried out by support vessels."

It's a technology that's gaining traction. Since 2018, AutoNauts - there are now more than 10 of them, excluding early prototypes - have done more than a year at sea, cumulatively, including three missions that were each more than a month long, in the Atlantic and Pacific oceans. The longest mission to date has been 50 days in the mid-Pacific and one AutoNaut has operated in Force 10 on the Beaufort Scale, during the first Marine Autonomous Systems in Support of Marine Observations (MASSMO) mission, co-ordinated by the National Oceanography Centre and run off the Isle of Scilly and they regularly work in Force 6 and 7.

Projects the systems have worked on include science, civil, energy and defence for applications from fish tracking missions, anti-submarine warfare trials, metocean sensing and water quality monitoring to current profiling and as passive acoustic monitoring. More recently a combined science and research and development project has included deploying a Seaglider from an AutoNaut, to extend its range.

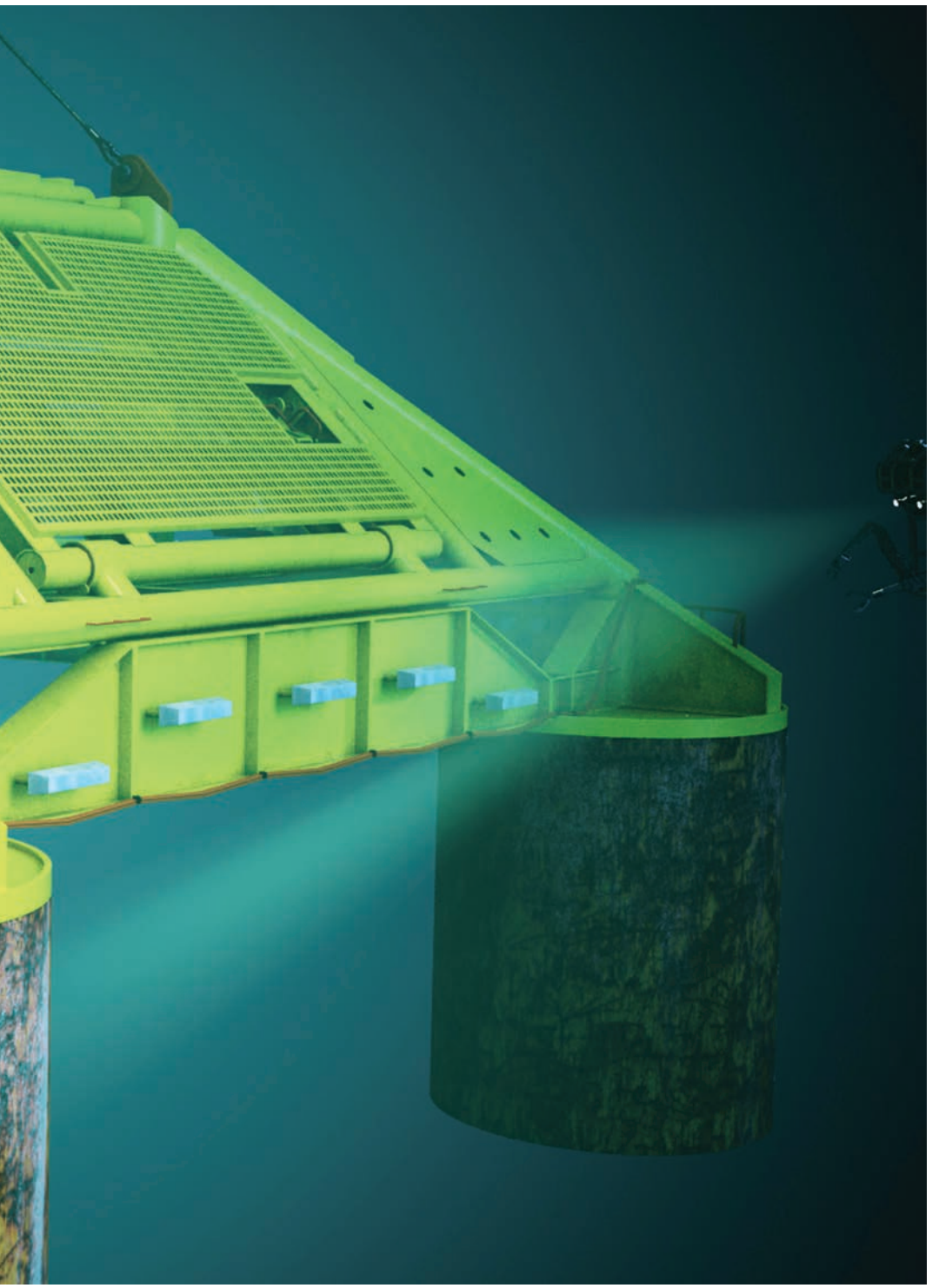
However, "use of unmanned vehicles (surface / underwater) remains novel technology, for the majority of clients, although acceptance and use for growing applications are starting to accelerate," says Burnett, which means there's still a need to work with clients to gain their confidence in the capabilities (and limitations) on the use of unmanned systems, through trials and demonstrations.

In this case, the MODU study "successfully characterised the sound field from a MODU during different operational phases in an environment that was challenging both operationally and acoustically," says Burnett. "The combination of recording platforms provided a large and uniformly distributed dataset, with the USV proven as capable within the 500 m exclusion zone in order to gather novel data that helps to address a significant data gap for sound emissions from large semi submersibles. The value of unmanned systems is clear, through reducing the cost, HSE exposure and increase in value of data sets (quality and quantity). It just takes time and stakeholder engagement to displace existing ways of doing things and to be able to demonstrate that unmanned systems will add value and not be a nuisance that require additional overhead and management (this still needs work)."



The challenges of underwater structure monitoring for offshore operations

By Ross Macleod, Technical Director, Ashtead Technology



As the global energy industry enters a period of increased offshore deepwater exploration driven by economic viability, the demand for international underwater monitoring services looks set to strengthen into the new decade. According to a report from TechSci Research1, the value of global underwater monitoring services for the oil and gas sector is projected to grow from around $1billion in 2018 to $1.8billion by 2024.

With an increasing focus on improving efficiencies throughout the global energy sector, the installation of subsea structures on the seabed can pose complex and costly challenges if handled incorrectly. It is essential that installation work is completed thoroughly and quickly, due not only to the harsh conditions which equipment can face, but also to the traditionally high financial costs of having installation vessels on site. In order to overcome these considerable safety, logistical and financial challenges, it is crucial that the positioning and monitoring of vast subsea structures can be tracked in real time. Global subsea equipment solutions specialist Ashtead Technology has developed technology suitable for subsea installation monitoring, which was successfully deployed for two major projects in the North Sea.

FIRST CARBON CAPTURE AND STORAGE PROJECT FOR ASHTEAD TECHNOLOGY'S DMS

Developed by Equinor in partnership with Shell and Total, the Northern Lights project is the first of its kind in the North Sea and aims to securely collect and transmit CO_2 from onshore sources and store this under the seabed. The project is part of Norway's full-scale carbon capture and storage (CCS) programme, which includes capture of CO_2 from industrial sources in the Oslo-fjord region (including cement and waste-to-energy) and subsequent shipping of liquid CO_2 to an onshore terminal on the Norwegian west coast. From there, the liquified CO_2 is transported via pipeline to an offshore storage location subsea in the North Sea for permanent storage. The CCS project is instrumental in helping to reduce CO_2 emissions and is a step towards the European Union's efforts to limit global warming to 1.5°C above pre-industrial levels.

It marks the first occasion Ashtead Technology has been involved in a CCS programme, providing a leading subsea services company with its integrated Deflection Monitoring System (DMS) - a suite of structural monitoring systems to assist offshore construction and inspection, maintenance and repair operations. Using the DMS, the company's personnel and equipment successfully monitored the installation of an Integrated Satellite Structure (ISS).

During the placement of the structure, the DMS system was configured for au-

tonomous independent operations, communicating data to one of the installation's ROVs. Advanced positioning tools and measuring sensors enhanced the accuracy of the data collected, ensuring the reliability of the data.

The Northern Lights project is a result of the Norwegian government's ambition to develop a full-scale CCS value chain in the country by 2024. As part of this ambition, the Norwegian government issued feasibility studies on capture, transport and storage solutions in 2016, helping to justify the eventual realisation of a full-scale CCS project.

Multiple solutions will be required to reach international emissions reductions targets for CO_2 and, although more imaginative alternatives have come forward over the last few years, CCS appears to be one of few effective, large-scale options at the time of writing.

DMS FOR OFFSHORE OPERATIONS AND COMMUNICATIONS

In September last year, Ashtead Technology completed a two-part subsea installation monitoring project for client Ocean Installer AS in the Northern Norwegian Sea. The company supplied its DMS to monitor the installation of 15 Integrated Template Structures (ITS) in total, located in Equinor's Askeladd and Johan Castberg fields.

Combining powerful software with modular technology, the DMS was deployed alongside supporting technicians over the two phases. The first project for nine ITS was completed within just 25 days, resulting in significant cost efficiencies for Ocean Installer – so much so that the contract was extended into this year for the remaining six.

The suite of products which together make up the company's DMS are used to monitor structural deflection in assets such as manifolds, templates, PLETs, rigid

jumpers and TLP tendons.

During the installation process for Ocean Installer, the DMS calculated and logged structural deflection, heading, pitch, roll, depth and suction pile differential pressures in real-time. This instantaneous method of monitoring is essential during the placement of suction pile-based subsea structures, as it ensures any issues can be rectified immediately before there is any risk of damage or unsafe situations occurring.

Ashtead Technology provides the DMS, which are bespoke and scalable to the needs of any project, with a proven track record around the world. User-friendly graphical software allows for easy interpretation of data, with final analysis of data performed offshore. Combining remote communications systems with responsive technology has allowed the DMS to create a lower CAPEX environment while still preserving the highest level of project support.

In addition, the real-time analysis of data from onshore positions reduces the logistical and personal risks involved in a project of this nature. As less personnel are required to be transported offshore, the inherent dangers of working in a hazardous environment are limited to only essential staff.

Solutions for challenging seabed terrain

During the first Ocean Installer project, the four suction piles of the ITS were lowered and installed on the seabed in turn. This posed a risk that the structure would twist, thus leading to potential stress and integrity issues. To counteract this, the suction piles on each ITS were used to control the descent into the seabed and minimise any out of plane bending. The suction piles themselves ensure stability of the structure in the challenging seabed of the Norwegian Continental Shelf, where the seabed terrain often shifts.

Using the powerful suite of software elements within the DMS, Ashtead Technology's technicians kept a close eye on out of plane deflection, structure level and differential pressures within each suction can. This ensured structural integrity was maintained during installation and the structure was installed within engineering tolerances.

During the placement of the other structures, the DMS was configured for autonomous independent operation, communicating data to one of the installation's ROVs. Measurement sensors and positioning tools were used to enhance the accuracy of the data collected, ensuring maximum performance of the DMS and, once the installation was complete, all equipment was removed via ROV for topside inspection, with data transferred to and interpreted by the offshore team.

The DMS technology has proved invaluable for the safe and efficient installation of ITS during the two projects. With onboard field engineer support, real-time information software and multiple display options, the team were able to continuously react to the changing conditions during operations, with the system proving to be both robust and accurate.

CONCLUSION

Precision is key in the installation of any subsea structure to ensure it operates to its full potential. However, operating in harsh underwater environments with deep water and strong currents, such as those found in the North Sea, can make data gathering both difficult and time-consuming.

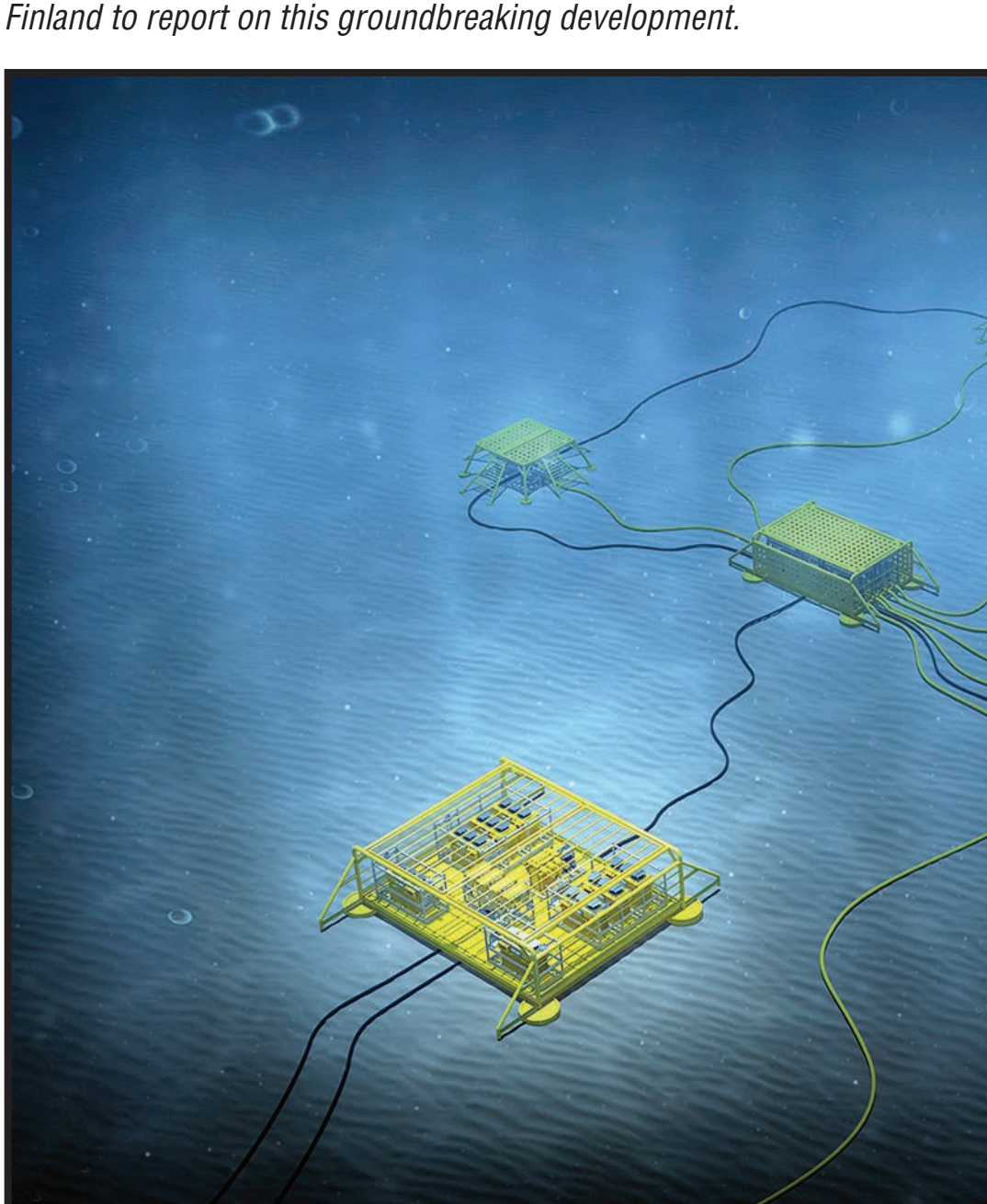
Combining modern technology and intelligent software solutions, the DMS is a reliable antidote to the challenges of structural monitoring in harsh underwater environments. These two projects demonstrate that the company's DMS can be quickly mobilized, enabling critical operations to be completed safely with straightforward access to onshore support.

POWERING THE SEABED FOR A SUSTAINABLE ENERGY FUTURE

Late last year ABB announced the commercial availability of its new subsea power distribution and conversion technology system. Jointly developed by the company and partners Equinor, Chevron and Total and having successfully completed a shallow-water test, the technology means that the majority of the world's offshore hydrocarbon resources can be harvested through the use of subsea electrification. ***Tom Mulligan****, Science and Technology Correspondent, was in Finland to report on this groundbreaking development.*

Offshore oil and gas operators have a clear vision for a safer, more energy-efficient future both for their mature basins and through to new, remote, deep-water frontiers, and to achieve this vision the industry has set goals to reduce emissions and environmental footprints; improve health, safety and security of personnel; and increase productivity and enhance asset cost efficiency. To help the industry achieve these goals, electrical engineering and power systems technology specialist ABB, in a $100 million research, design and development joint industry project (JIP) initiated in 2013 with partners Equinor, Chevron and Total, has designed, developed and tested a new subsea medium-voltage power distribution and conversion system that enables all production operations to be moved to the seabed, thus realizing the dream of a true subsea facility.

In November this year, ABB announced the commercial availability of the new subsea power system having completed a 3000-hour shallow-water test at a sheltered harbor in Vaasa, Finland that demonstrated the validity of the technology. This means that the majority of the world's offshore hydrocarbon resources can be harvested through the use of subsea electrification.



Subsea vs topside operations

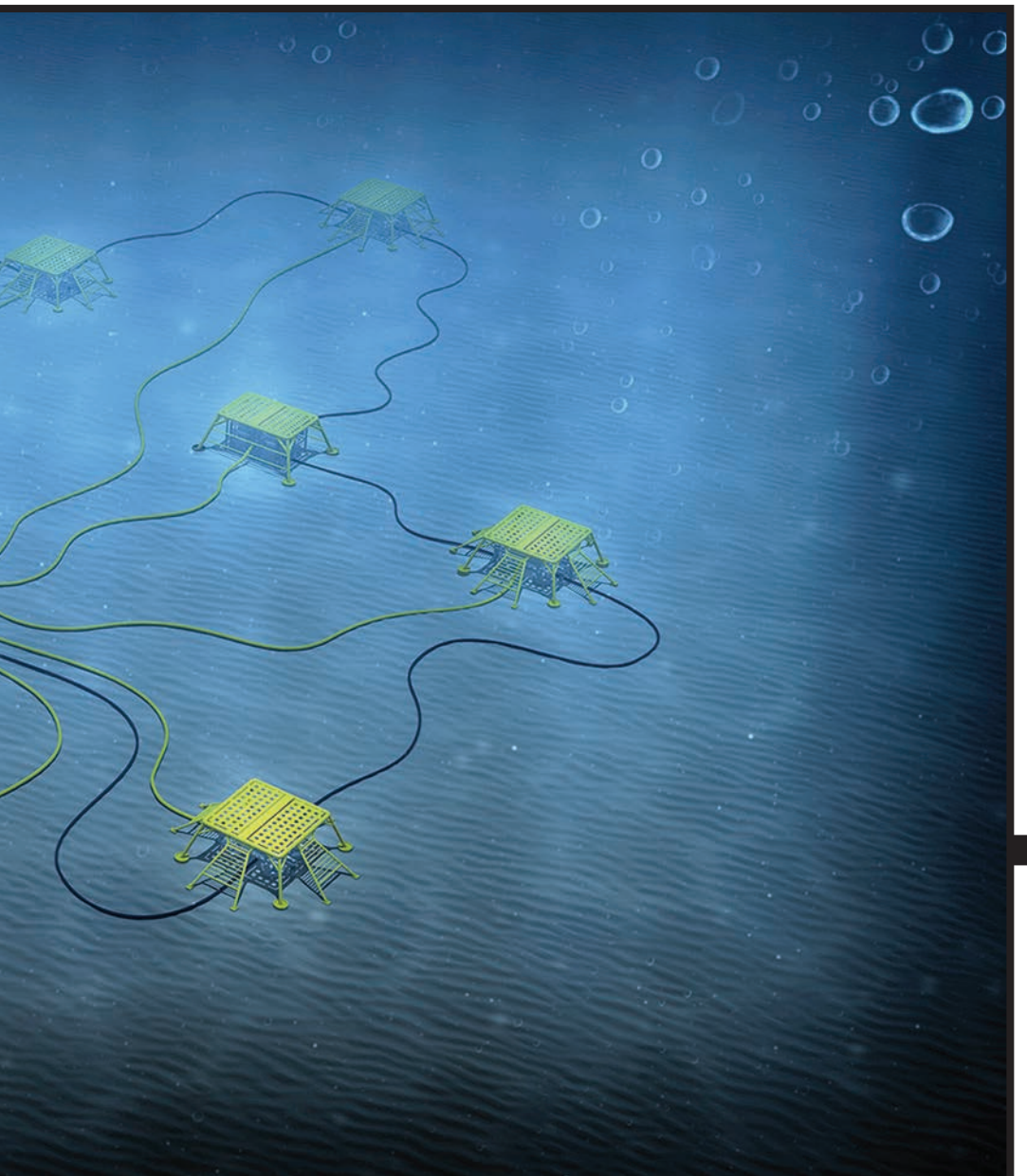
Conventional topside offshore hydrocarbon production systems are typically housed on large, manned floating or fixed structures that are expensive to operate and where space for housing power and control equipment is often constrained. In addition, costly dedicated power and electro-hydraulic umbilical cables are required for each power user on the seabed, creating a topology that is expensive, hard to adapt to new configurations, and restricted in its ability to support digitalization initiatives due to limited bandwidth. Most of today's structures use gas turbines for local power generation, with consequent emissions impacting the environment. Other disadvantages are the exposure of humans to risk and the requirement for constant maintenance and logistics support in addition to the costs of building and operating these energy-inefficient units.

To overcome these problems, over the years oil and gas companies have attempted to install production infrastructure on the seabed in order to benefit from greater production efficiency and greatly reduced environmental impact. However, early subsea power distribution systems suffered from the drawback of limited tie-back distances, which were restricted to less than 150 km. In contrast, the results of the JIP between ABB and its partners show that, for the first time worldwide, energy companies will be able to access a reliable supply of up to 100 megawatts of power over distances of up to 600 km and down to depths of 3000 meters, where ambient pressures are in excess of 300 atmospheres. Power can be supplied through a single cable that can be used for up to 30 years, thereby making oil and gas production in distant and deep ocean environments a reality.

"This milestone marks an outstanding achievement and is the culmination point of an inspirational technology development achieved through tremendous dedication, expertise and perseverance. It is the result of intensive collaboration by over 200 scientists from ABB, Equinor, Total and Chevron in a multi-year joint effort," stated Dr. Peter Terwiesch, President of the Industrial Automation business of ABB.

Electrification of subsea components

The research and development work undertaken in the JIP has resulted in subsea components and systems from actuators to pumps and compressors increasingly being electrified, thereby helping to increase system availability and control and reduce component size, cost and energy intensity, as well as remove personnel from a high-risk environment through the use of remote and unmanned operations. ABB says that by introducing technology that can distribute subsea power over long distances and down to great depths to reach subsea production systems, the full possibilities of this technology can be realized and adds that, based on a specific development case, the new system could offer capital expenditure savings of more than $500 million by linking eight power-consuming units such as pumps and compressors through a single cable over a distance of 200 km from other infrastructure. In addition, the supply of power to such units on the seabed can significantly reduce power consumption, resulting in substantial energy savings and much lower carbon emissions compared with using shore-based systems. The technology can be driven by any power source, including wind and hydro power. A further benefit of the subsea technology is reduced operational risk and increased safety, as fewer offshore staff are required for operations and the benefits of digitalization and autonomy can be exploited.



A simple power distribution topology ensures efficient operation of the ABB power distribution and conversion system.
All images: ABB

"Moving the entire oil and gas production facility to the seabed is no longer a dream," said Dr Terwiesch. "Remotely operated, increasingly autonomous subsea facilities powered by lower-carbon energy are more likely to become a reality as we transition towards a new energy future."

Viable technology with commercial potential

Prior to the JIP and the 3000-hour shallow-water test at Vaasa, only the transmission cable and subsea step-down transformer were proven to operate underwater. However, following the successful completion of the JIP, ABB's subsea power distribution and conversion system now comprises a step-down transformer, medium-voltage variable speed drives (VSDs), medium-voltage (MV) switchgear, control and low-voltage (LV) power distribution, and power electronics and control systems supported with 230/400 V. The expertise behind each of the component parts of the subsea power distribution and conversion system were drawn from various ABB facilities around the world.

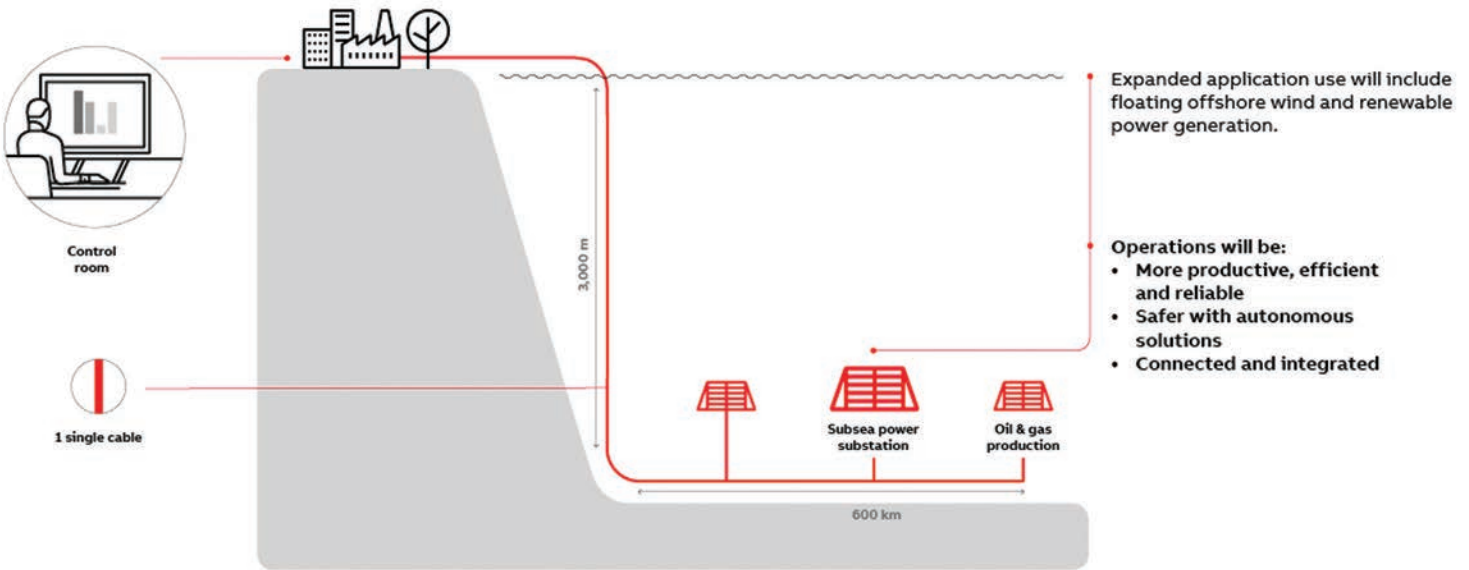
"Our success in reaching this stage is a testament to the deep domain experience of our teams, with a passion and dedication to delivering a game-changer for the industry," stated Kevin Kosisko, Senior Vice President and Head of Energy Industries at ABB. "Full subsea electrification has been a long-time coming. It's not easy, but we've done it. Oil and gas companies now have access to technology that will completely transform how they operate."

A critical area of focus during the JIP was ensuring that the system would be modular, flexible and open. It also needed to meet reliability and availability targets higher than those for topside applications. ABB decided that the project would deploy solutions largely based on existing technologies, thereby ensuring reliability, and that quality control and obsolescence strategies were well established from the outset. This approach also meant that integration with existing topside hardware systems and software would be straightforward and that all failures should be mitigated by design improvement or change rather than by adding simple 'ruggedizing' steps.

To ensure compact and reliable solutions, ABB enclosed the VSDs and MV switchgear in oil-filled, pressure-compensated tanks with each component iteratively honed in a stepwise approach, thus optimizing product assemblies and reducing the number of components and functions to ensure redundancy and high system reliability. In addition, to ensure that electronics and power components could operate in a pressure-tolerant environment and within a dielectric oil, component screening and selection, material compatibility, material interface aspects and thermal performance of components were set at optimum levels.

The electronics and control modules are flexible and modular in design to allow for different sizes to enable easy accommodation within the system. Communications and control are Ethernet-based for ease of interfacing with the rest of the

ABB's pioneering subsea power distribution and conversion technology
Enabling a new era in offshore oil and gas



subsea system and high-speed fiber-optic communications enables responsive remote operations.

Realistic testing

As the resulting power distribution and control system is made up from several hundred unique critical components operating under various stress conditions, a clear and pragmatic testing structure was put in place in order to learn the behaviors and limits of different designs, thus helping to mitigate the risk of failure before prequalifying for full-scale prototypes. Therefore, starting with simulation and laboratory tests, materials, components, sub-assemblies and assemblies were subjected to realistic stress levels in accordance with lifecycle profiles before the final full-system 3000-hour shallow water test was carried out.

All tests were carried out in accordance with API 17F Standard for Subsea Production Control Systems and included temperature, vibration, pressure and accelerated lifetime. The development f the project development followed the recommendations and technology readiness level (TRL) defined in DNV RP-A203, which provides a systematic approach to ensure that the technology functions reliably and within the specified limits.

Benefits for the oil and gas industry

The successful testing of the ABB system has a number of implications for the oil and gas sectors. The use of the system means that the operating lifespan of an existing facility can be extended through more cost-efficient tie-ins, requiring minimal topside modifications. In addition, future developments can be phased in and easily adapted through an inherently more flexible system topology. With full production systems installed subsea, long tie-backs no longer need multiple power cables or complex umbilicals and in addition, electrically powered solutions enable around-the-clock visibility of system performance. By using ABB Ability, the company's digital platform, more precise control and advanced remote analytics can be performed, these digital solutions delivering ABB's deep domain expertise from device to edge to cloud, thus benefiting oil and gas industry customers. Jeremy Cutler, Head of Total's Energy Research & Development Center in Stavanger, Norway, commented:

"This disruptive, transformative technology opens up unexplored areas, and the power of the collaboration, which started with a clear definition of the scope of the work and combined the best talents in a fresh design from the bottom up, resulted in a 'subsea factory' concept employing green power from shore to subsea maximizing the exploitation of potential subsea resources. Partnerships are not new in the oil and gas sector – we compete in many areas but we also collaborate – and in a big project like this the different parties can share the risk and share the rewards An unmanned subsea factory facility provides many benefits, with clean offshore power, more efficient use of energy and reduced carbon emissions."

ABB's sheltered-harbor test facility at Vaasa, Finland, where the JIP 3000-hour shallow-water test validating the new subsea technology and proving its viability was performed.

Tech Files

Innovative products, technologies and concepts

Seamor Marine Debuts New ROV with 3km Capacity

Seamor Marine introduced a new remotely operated vehicle (ROV) with a 3-km capacity, expanding the reach of Seamor's previous systems by one kilometer. A unit recently arrived in western Panama where one of the country's hydroelectric generation companies has begun using it for tunnel inspections of two hydroelectric projects on the Old Chiriqui River. Panama's hydroelectric generation company, Electron Investment SA (EISA), purchased Seamor Marine's Chinook ROV to perform 7.1 km of tunnel and penstock inspection at its Old Chiriqui River hydroelectric project and identify any areas in need of repair. The Monte Lirio project opened in 2014 and generates 51.6 MW of clean energy. The Pando project opened in 2019 and generates 33.3 MW.

"One of the main reasons we chose an ROV to inspect the tunnels was that it was much less costly both financially and environmentally than the alternative of draining the tunnels for inspection," said Iván Parra, Civil Engineer at EISA. "The operation will now be completed with a very small environmental footprint using Seamor technology." The inspections required a deep-water ROV, which is why SEAMOR paired the 3-km fiber optics tether with its Chinook ROV. Able to dive to 600 meters (2,000 feet), the Chinook ROV is equipped with a sensor skid carrying two Imagenex sonars: the 965A digital multi-beam imaging sonar and the DT360 multi-beam profiling sonar.

These sonars are operated simultaneously using an Ethernet switch to the fiber optic tether multiplexer, allowing the EISA team to navigate and inspect tunnel walls in almost zero-visibility conditions. Auto depth and auto heading functions help them safely navigate the tunnel. Once the tunnel inspection is complete, the EISA team plans to use the Chinook ROV for other tasks. Seamor's ROV systems have been designed with a modular platform that allows users to swap accessories or upgrade their ROV with new features after purchase.

Kraken: Ultra High Def Upgrade for AquaPix Imaging Sonars

Kraken

Kraken's KATFISH system back onboard after completing Phase 1 of offshore survey work under the OceanVision project.

Kraken Robotics reports it has achieved a practical resolution of 2 cm with a Commercial-Off-The-Shelf (COTS) Synthetic Aperture Sonar (SAS), Kraken's AquaPix MINSAS.

"For demanding subsea survey missions in mine countermeasures, infrastructure monitoring and oil & gas exploration; data quality is of the essence," said Karl Kenny, Kraken's President & CEO. "Kraken's latest development, the next generation AquaPix Ultra HD processing software, has been designed to advance the state-of-the-art in seabed mapping for both high-speed towed systems and Unmanned Underwater Vehicles (UUVs)."

Kraken's Ultra HD software improves the AquaPix SAS image resolution from 3.0 x 3.3 cm (across along track) to an industry-leading 1.9 x 2.1 cm and maintains constant Ultra HD resolution across the entire swath.

Kraken measures resolution in real-world conditions using a data-driven technique, developed by Kraken's team of sonar scientists. The measured resolution of 1.9 x 2.1 cm includes effects such as aperture shading to reduce sidelobes, UUV nonlinear motion, and acoustic propagation in the ocean environment.

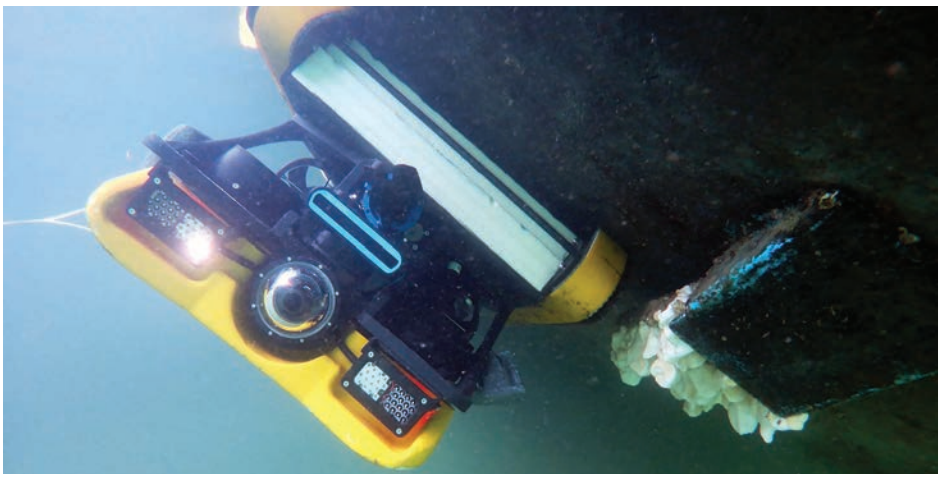
In mine warfare, it is well known that the probability of detecting and classifying a target increases with improving image resolution.

Stinger Technology Inks R&D Deal

Stinger Technology, the next generation subsea marine robotics company, has been awarded an R&D contract with Neptune Energy, for the development, qualification and field trials of autonomous inspection/ intervention subsea drones.

The solutions that will be developed for Neptune Energy aims to save costly vessel operations and reduce risk through continuous availability of versatile intervention tools. This contract helps to solidify Stinger as a supplier of solutions for autonomous and onshore supported underwater drones in the energy sector.

Stinger Technology



Greensea

Greensea's Ship Hull Crawler Tech Launches with VideoRay Defender ROV

Greensea introduces a new hull crawler that attaches a Remotely Operated Vehicle (ROV) to a ship hull without magnetics, allowing the operator to "drive" the ROV and payloads over the hull. Initial hull crawlers are designed to work exclusively with the VideoRay Mission Specialist Defender ROV. The hull crawler represents a milestone in Greensea's hull robotics program, which is advancing navigation and localization capabilities for a fully autonomous robotic hull inspection and proactive in-water cleaning solution. VideoRay and Greensea expect early adopters of the technology will use the Defender with the Greensea hull crawling attachment for hull inspection, surveying, non-destructive testing, and explosive ordnance disposal purposes.

"The stability afforded by a crawler attached to a hull will enable inspection and intervention tasks with a degree of precision not possible with a small free-flying ROV," said Karl Lander, Greensea Program Manager. "Providing a stable base platform for a camera, laser imaging scanner, or manipulator will greatly enhance accuracy, and ultimately safety, by enabling small robotic systems to perform work previously requiring a diver."

In 2019, Greensea was awarded a Phase 2 R&D program through the U.S. Navy to develop a highly accurate navigation and autonomy solution for ship hull robots for the purposes of supporting autonomous proactive in-water cleaning. This program will utilize several of Greensea's core navigation and autonomy technologies including their work with inertial navigation systems in ferrous environments and feature-based localization. The hull crawler technology will provide the delivery mechanism for the advanced software being developed in the Phase II program.

Kongsberg Develops New LARS for HUGIN AUVs

Kongsberg Maritime has developed a new LARS solution for its HUGIN AUVs, which it says will bring "a series of far-reaching operational improvements." Kongsberg has decided to have the new LARS operating from midships, with the release and capture of HUGIN marine robots occurring beneath the sea surface.

"Launching and recovering AUVs underwater, away from the splash zone, lessens the possibility of their being damaged, while midships deployment averts any likelihood of AUVs being run over by the launch vessel," the company has explained.

Further, Kongsberg said that the new LARS' subsea capabilities provide an extra benefit in that launch and recovery processes can be carried out in much higher sea states. This reduces the risk of weather damage to marine robots while boosting productivity to deliver significant cost savings.

The design allows AUVs to be deployed from a hangar or container, and multiple robots may be managed from a single LARS. It is flexible with regards to placement – although midships is optimal – and can be operated from anywhere onboard, including the stern. It may also be installed higher than on the main deck, to accommodate the vessel layout, Kongsberg says.

Kongsberg

Tech Files

Innovative products, technologies and concepts

SubSeaSail Passes the Test

The Engineer Research and Development Center (ERDC) of the U.S. Army Corps of Engineers (USACE) along with logistical support from the US Navy successfully tested their SubSeaSail G6 platform at multiple coastal sites off the Vieques Island, Puerto Rico. Remote sensing applications for monitoring underwater unexploded ordnance were demonstrated by mounting a passive filter assembly to the G6 platform to detect explosive compounds in the water. Additionally, a water quality sensor was mounted to monitor other water quality parameters including temperature, salinity, depth, and turbidity. During the demonstration, the G6 platform was remotely sailed or guided through a programmed GPS waypoint trajectory.

This allowed ERDC researchers to safely complete waypoint navigation missions in study areas. The SubSeaSail G6 platform is a wind-propelled and solar

powered unmanned semi-submersible sailing vessel (USSV) with key patents including a sailing vessel with the hull below the waterline, greatly reducing drag as well as the visual signature. A second patent is for the Passive Wingsail Control Mechanism, which sets the wingsail at the optimum angle without any lines, pulleys, or electronics, significantly reducing complexity and cost. A servo to control the rudder is the only electro-mechanical component needed to sail autonomously, resulting in a "hotel load" to run the entire platform of less than one Watt.

Sonardyne Augments its Product Line-Up

Sonardyne announced new additions to its 2020 product line-up. With a focus on compact yet capable unmanned and vessel instruments, Sonardyne has unveiled SPRINT-Nav Mini, a compact guidance and control solution, as well as ADCP functionality for its Syrinx Doppler velocity log (DVL) and a smaller, lighter version of its popular Gyro USBL transceiver.

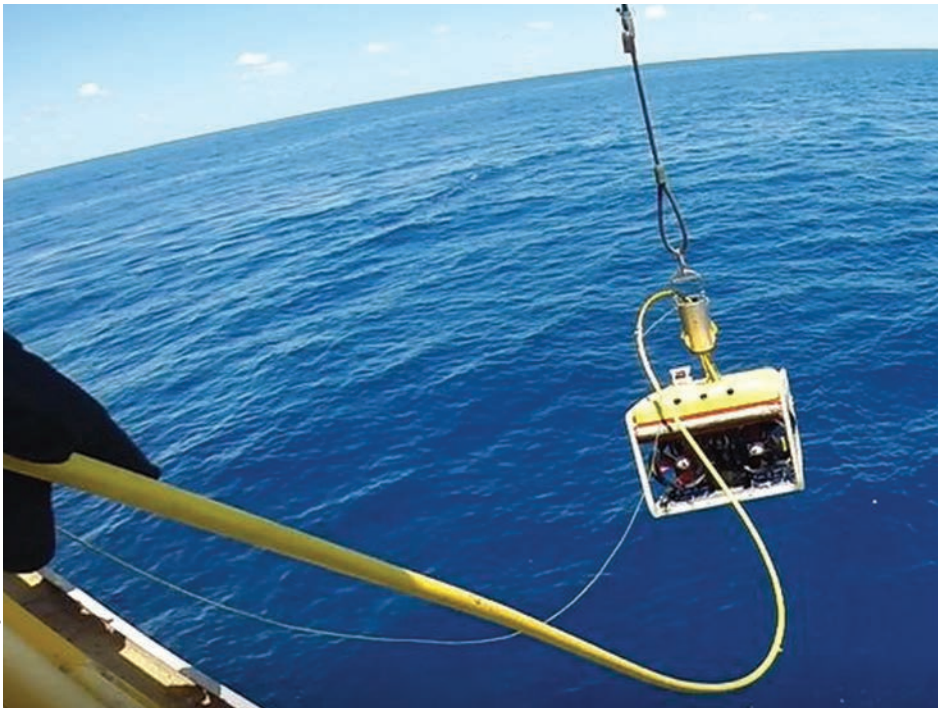
SPRINT-Nav Mini provides guidance and control outputs – orientation, velocity, altitude and depth – in a single instrument that weighs just 0.7 kg in water for the 300 m-rated version. By fusing the information from each of its sensors, SPRINT-Nav Mini provides precise, robust and fixed frequency outputs, independent of each individual sensor's update rates. In replacing the need for three separate instruments; AHRS, DVL and pressure sensors – customers will benefit from reduced cost, less cabling and additional vehicle payload capacity.

Sonardyne

SPRINT-Nav Mini comes in a compact 215 x 149mm diameter housing and is also available in a 4,000 m-rated titanium unit of the same size making it ideal for smaller remotely operated vehicles (ROVs). Sonardyne is also introducing its second-generation Gyro USBL. It combines the vessel heading, pitch and roll data that's critical to Ultra-Short BaseLine (USBL) system performance, with an acoustic transceiver – all in one housing. But, using the experience it's gained from designing complex and compact sensor assemblies, the new Gyro USBL is now 30% shorter and 40% lighter. That means more vessels, including small vessels of opportunity and unmanned surface vessels, can get the best performance from their USBL using an even easier to handle and install instrument.

Gyro USBL is available in two performance levels; a cost-effective version for standard USBL operations and "plus" for long layback tracking and touch-down monitoring. Both versions will be delivered pre-calibrated, in-water, enabling users to get straight to work.

Finally, Sonardyne has also increased the functionality of its Syrinx 600 kHz DVL. Syrinx now has optional acoustic current Doppler profiling (ADCP) capability, as well as dual DVL/ADCP operations, without compromising bottom track. The ADCP data can be viewed and analyzed using the new Echo Observer software.



Saab Seaeye

Saab Seaeye's Falcon Flies High

Saab Seaeye sees its Falcon flying high as its top-selling electric underwater robotic vehicle in its 34-year history. Launched nearly 20 years ago, its design has kept the pioneering concept in step with two decades of technological advances.

The Falcon has helped to open up new sectors to the potential of robotics, from marine science to aquaculture and from wind energy to hydroelectric dams.

Just a meter-long and rated 300 to 1000 meters depth, the Falcon's five thrusters and distributed control system – now enhanced with iCON control architecture - is designed to deliver precise maneuverability while working in strong cross-currents and among complex structures.

A key breakthrough concept for the vehicle was its distributed intelligent control which uniquely gave each device on the Falcon its own individually controlled microprocessor. This eliminated interface cards, jettisoning the conventional electronics pod and making the vehicle smaller and lighter.

Intelligent distributed control meant that tools and sensors could be easily added or changed, and custom options readily integrated. More interchangeable equipment could also be fitted on a small vehicle than ever before possible.

Amman Mineral Orders Forum ROV for Subsea Mining Support

Indonesian mining firm Amman Mineral has ordered an ROV from Forum Energy Technologies to support its mining operations at Indonesia's second-largest copper and gold mine. Forum Energy Technologies said that, under the order, it would supply one of its observation-class remotely operated vehicles (ROVs), to be deployed at Batu Hijau on the island of Sumbawa, Indonesia, for subsea mining operations.

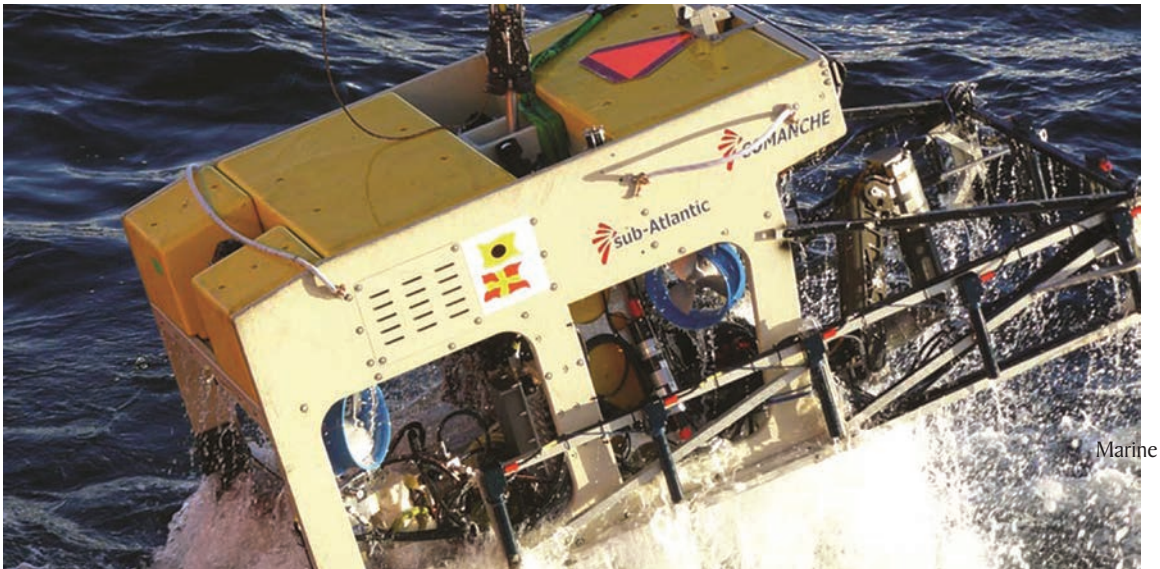
The Sub-Atlantic brand Super Mohawk II ROV system will be equipped with two five-function manipulator arms for complex underwater procedures. The new asset will replace the company's current Super Mohawk ROV and incorporates much of the existing surface equipment.

Per the ROV company, the Super Mohawk II is well-suited for all inspection and light work tasks including non-destructive testing, seabed analysis, scientific survey, and data sample collection.

According to Forum Energy Technologies, this is the second time Forum has delivered one of its observation-class ROVs for work relating to the mine, having supplied the quarry's previous owners, PT Newmont Nusa Tenggara, with a Super Mohawk previously.

Amman Mineral successfully completed the purchase of Newmont Mining Corporation's ownership stake of PT Newmont Nusa Tenggara in 2016.

The ROV system will be manufactured at Forum's UK facility at Kirkbymoorside in Yorkshire and delivered in the first quarter of 2021. This will be the company's 37th Super Mohawk system deployed for global operation and the fourth to be built at its Kirkbymoorside manufacturing facility since the first one was produced in 2002.



Forum Energy Technologies

New Products

Innovative new products, technologies and concepts

GeoSpectrum Launches TRAPS-USV

GeoSpectrum Technologies launched a new and compact version of its Towed Reelable Active Passive Sonar (TRAPS) suitable for unmanned surface vessels (USVs). Dubbed TRAPS-USV, this lighter-weight variant is designed to fit on almost any size vessel, including patrol boats and USVs, while retaining full active sonar acoustic capabilities and providing low frequency active submarine detection off smaller platforms. With overall system weight reduced to approximately 40% of the already compact TRAPS, TRAPS-USV allows surface vessels and USVs as small as 12 meters long, to be equipped with powerful, long-range active sonar ASW capability. This enables the USVs to perform ASW operations on the move while conducting independent missions or augmenting manned ASW assets including opportunities for advanced techniques such as bi-static and multi-static operation. Similar to its "larger brother" TRAPS, TRAPS-USV is a Low Frequency (LF) variable-depth-sonar intended for detection, classification, localization, and tracking of submarines in ASW operations. TRAPS' advantage is that its' projector array is reelable and stows on the winch drum with the receive array and tow cable. This feature eliminates the need for a dedicated active over-boarding system saving, weight, space, complexity and cost. Both TRAPS and TRAPS-USV also have the capability to swap out and exchange active sonar projectors allowing O-level adaptation of the system to different active sonar frequencies in the 2 to 10 kHz range. The containerized version of TRAPS first went to sea onboard Royal Canadian Navy ships in 2019.

Lateral's New cleaning solution for small ROVs

Lateral launched a new marine growth removal tool for use by smaller ROVs to reduce costs and save time. The FlexiClean Micro is a 'little brother' to the Norway-based company's larger FlexiClean innovation, which was launched in 2014. Lateral said it was responding to the customer demand by introducing a downsized version of FlexiClean for deployment on smaller observation class ROVs. The Micro has a single layer of polyurethane fingers that remove growth more efficiently than many jetting and conventional brush options.

Electrically-powered, it reduces the need for using large-scale workclass ROVs (WROVs).

Lateral co-founder and technical manager Keith Robertson, said: "Our pitch to clients is that Flexi Clean can do 95% of the cleaning projects in 5% of the time. This has been proven time and again. Ten FlexiClean Micro systems are currently in build with three pre-production units already out with regular clients undergoing integration, reliability and performance testing. In addition to the FlexiClean range of products, Lateral has developed a series of efficient and cost-effective innovations in recent times. FlexiCal is an electrically-driven subsea vernier primarily for chain metrology; FlexiTrim is designed to clean and inspect flexible risers and wire mooring lines, supported by video inspection and sensors; FlexiTric is a tubular and riser cleaning tool that requires no interface to the ROV except a tether cable, and FlexiClip is used to repair sheath damage on mooring lines in-situ.

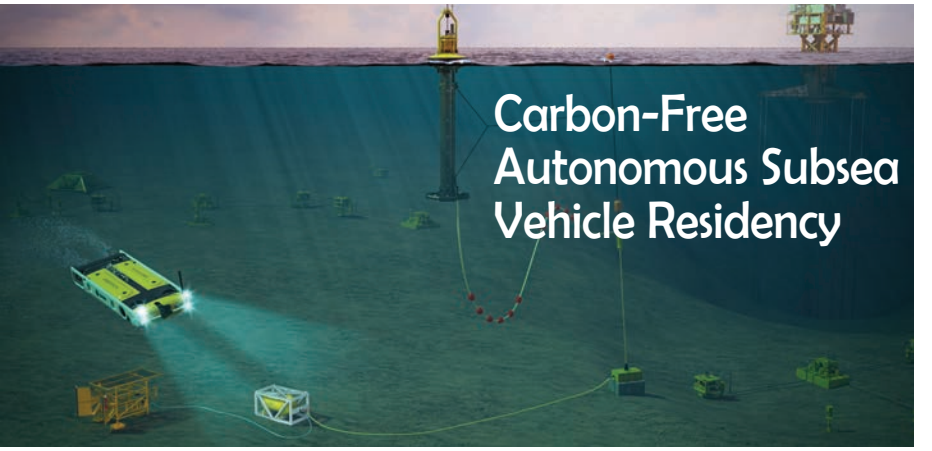
JW Fishers Helps to Uncover History

In November of 2018 two archaeological maritime discoveries were made near the Upper Florida Keys by individuals who federal scientists lauded for reporting, rather than disturbing, their finds.

Jennifer Kerr, owner of Sailfish Scuba, mile marker 103.1, was exploring the Hannah M. Bell shipwreck near Key Largo when she noticed a cannon on Elbow Reef that is now believed to be nearly 200 years old. The find comes the same month that Homestead commercial trap fisherman Jose Antonio Lopez Ruiz was looking overboard from his vessel and spotted what turned out to be the wooden wreckage from an unidentified ship from the 19th century near Alligator Reef off Islamorada. The wreck lies in about 25-30 feet of water.

The Pulse 8X from JW Fishers was purchased by Sail Fish Scuba in attempt to verify the cannon and to search the surrounding area for any other debris. Since the purchase, Jen states; "our staff, using the Pulse 8X, have found now the carriage the cannon came off of, and many more parts of the old Spanish Galleon Ship." A second cannon was also found covered in silt using the Pulse 8X. Jen shared that, since they received the Pulse 8X, there have been two occasions where engagement rings have been lost and found using their detector.

JW Fisher



Carbon-Free Autonomous Subsea Vehicle Residency

As the concept of subsea residency gains steam, Ocean Power Technologies (OPT) is working with Modus Seabed Intervention and Saab Seaeye to develop a new solution for carbon-free subsea autonomous underwater vehicle (AUV) residency that would provide long-term, persistent deployment without support from manned vessels.

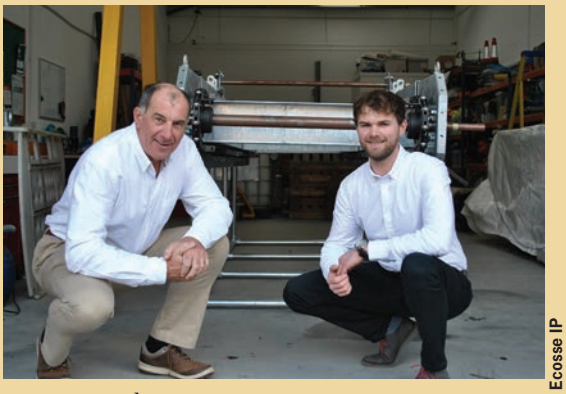
"We believe a self-contained system powered by an OPT PowerBuoy and exempt from existing ocean infrastructure has the potential to revolutionize the industrial use of AUVs and make long-term residency a cost-effective reality," said George Kirby, OPT President and CEO. "Modus Seabed Intervention's experience with advanced technology development efforts in subsea docking with Saab Seaeye's hybrid AUV (HAUV) enables autonomous offshore operations and we believe it is a natural fit for our environmentally sound PowerBuoy ocean power and communications technology."

Remote operation without the need for surface vessel support or complex power and data umbilical cable systems to offshore platforms or land has the potential to offer tremendous savings over operations that would otherwise require manned vessels – including long-term environmental monitoring, frequent subsea equipment integrity inspections, and interaction with seafloor assets.

This system is designed for carbon-free autonomous offshore operations with the OPT PowerBuoy power and communications platform at its core. Via an innovative integrated mooring and subsea power/data transmission cable, a PowerBuoy can provide carbon-free power to a seabed docking station to recharge an autonomous underwater vehicle while enabling secure data transmission to and from shore-based operations located anywhere in the world.

Ecosse IP Launches New Renewable Energy Tech

Ecosse IP (EIP) debut its latest product, Mass of Water Turbine (MOWT), designed to generate energy from slow-moving water. The MOWT technology, patent-pending, was developed by EIP to provide a cost-effective method of generating energy from slow-moving water. MOWT is designed for use in rivers, estuaries and subsea current & tidal environments, offering an energy solution with minimal environmental impact.



Ecosse IP

Currently, MOWT measures 5m long x 1m high, weighs less than 1 ton, and can be fitted with an integrated battery pack and built-in Ambient lifting technology. Modules can be added to MOWT to increase its size, and larger utility-scale MOWTs are planned for the future as an alternative to tidal barrages. Due to its unique low-speed energy capture, it has no detrimental effects on fish and other subsea creatures.

MOWT is positioned using a small vessel such as a multi-cat, and the in-built Ambient lifting technology allows for simple installation and recovery. MOWT can generate power when floating on the surface, semi-submerged or on the river/seabed. The existing MOWT model can generate between 5-10kW in 1m/s flow to power subsea assets. Large-scale MOWT will have a power output of several megawatts.

New Products

Innovative new products, technologies and concepts

Klein Marine Systems

Klein Chooses RadarWatch for Korean Offshore Wind

Cambridge Pixel, a developer of radar display, tracking and recording sub-systems, has supplied its RadarWatch coastal surveillance software, target tracking and radar recording technology to Klein Marine Systems, a subsidiary of Mitcham Industries, Inc. as part of a project to protect an offshore wind farm and its associated submarine transmission line off the coast of South Korea. Cambridge Pixel's radar display, tracking and recording technology has been integrated with the radar, daylight/thermal cameras, an AIS receiver and long-range acoustic device (LRAD) as part of Klein's HarborGuard maritime security and surveillance solution. The local integrator is Seoul-based company iSENTECK. The surveillance system monitors vessel traffic around the wind farm and along a 10km submarine transmission line carrying power from an offshore platform transmission station to the onshore distribution facility. For the Korean wind farm project, an offshore platform hosting a Simrad Argus X-band radar, dual thermal/daylight camera from MOOG Mercury and an AIS receiver was supported by Cambridge Pixel's SPx tracking server, which generates radar tracks corresponding to vessel movement in the monitored area. These track reports, along with camera video and AIS reports, are transmitted to the shore-based facility where the RadarWatch surveillance application presents the combined radar, camera and AIS transponder data in a unified display.

Trimble Outfits New Teledyne Unmanned Survey Vessel

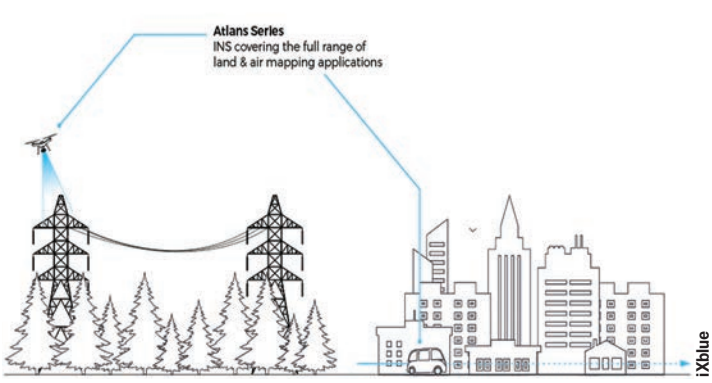
Teledyne Marine

Teledyne Marine released a new unmanned survey vessel – the Teledyne Z-Boat 1800-T. The survey vessel will be equipped with Trimble's GNSS heading receiver and is compatible with Trimble Marine Construction (TMC) software, enabling marine construction/dredging projects to be monitored in real time anywhere in the world. THE Teledyne Z-Boat 1800-T, designed and manufactured by Teledyne Oceanscience, is a high-resolution shallow water hydrographic unmanned survey vehicle with the new Odom Hydrographic Echotrac E20 Singlebeam Echosounder and dual antenna Trimble BX992 GNSS heading receiver.

"Trimble's experience in GNSS guidance systems, and Teledyne's leadership in shallow-water hydrographic surveying provides an ideal solution for marine construction contractors and surveyors," said Kevin Garcia, General Manager of Trimble Civil Specialty Solutions. "The Teledyne Z-Boat 1800T release means that near-shore construction workflows now have a quick mobilization tool to identify sub-surface obstructions, provide ad hoc inspections and increase site safety. This feature-loaded solution makes the unmanned surveying vessel affordable for all sizes of customers."

iXblue Launches the Atlans Series

iXblue launched the Atlans Series, a new range of FOG-based INS dedicated to land and air mobile mapping applications. Based on iXblue's FOG technology, it is a scalable range of North seeking and North keeping Inertial Navigation Systems. They are designed to provide FOG performance to the full spectrum of land & air mobile mapping applications and offer accurate positioning (up to 0.01m) in all conditions, including within GNSS-denied environments. The new Atlans Series INS offers "set-and-forget" operations for a wide range of land and air applications including asset inventory, pavement condition survey, vehicle automation, HD mapping, automotive testing, ground-truth, airborne surveys (UAVs, planes, helicopters), as well as precision pointing.



iXblue

Turner Designs

Turner Designs C-FLUOR Probes Offer Digital Output

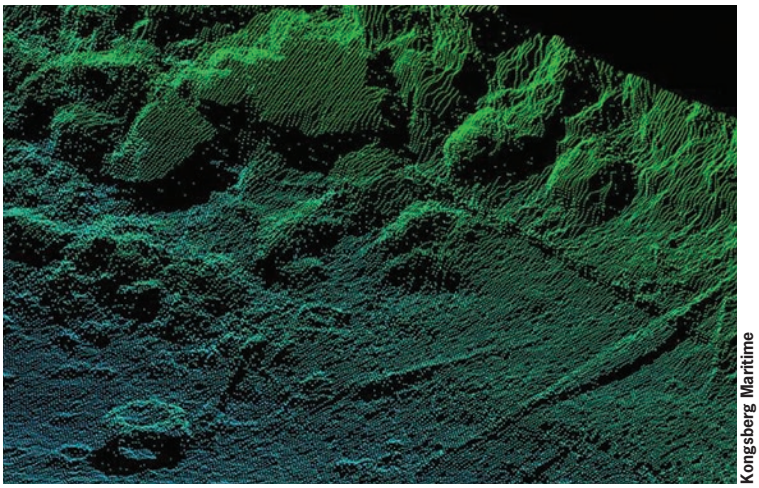
C-FLUOR probes are sensitive single-wavelength in situ fluorescence and turbidity instruments that are now available with a Digital Output option. ASCII data can be polled every 0.5 seconds or streamed at variable rates as fast as 16 readings per second. Combining a maximum requirement of 22mA current draw at 12VDC input with a T99 of less than 0.6 seconds, Digital C-FLUOR probes require very low levels of power. Factory-calibrated, each C-FLUOR ships with a calibration certificate that specifies the calibrated range and minimum limit of detection as fluorophore concentrations. Titanium construction allows for a depth rating of 2,000 meters as well as superior resistance to corrosion, an important factor with the capability for extended deployments. Digital C-FLUOR probes are very small -- 5.2” length x 0.9” diameter (13.24cm x 2.23cm) and weigh 3.3 oz (95 grams). They can easily be integrated with data loggers that accept ASCII data strings via RS-232. Probes are available for estimating concentrations of: in vivo Chlorophyll, Crude Oil, CDOM/fDOM (dissolved organic material), Blue/Green Algae, Fluorescein Dye, Rhodamine Dye, Optical Brighteners, and Turbidity. Available accessories include Flow-through Cap for in-line sampling; Shade Cap to minimize affects from ambient light and offer protection for the optics; Solid Secondary Standards for checking instrument stability; various cable lengths; and a programming cable for utilizing software calibration functions if custom calibrations are desired.

Kongsberg Releases Improved Multibeam Echosounder

Kongsberg Maritime released two new features on its EM 2040 MKII multibeam echosounder. The first enables the use of dual high frequencies to survey wide swaths of the seabed at much higher resolutions than before, while the second facilitates simultaneous collection of back scatter data using multiple frequencies.

The EM 2040 MKII is a broadband multibeam echosounder system, which uses frequencies from 200kHz to 400kHz to yield a wide swath of up to 170 degrees. With the new high frequency feature, the EM 2040 MK II will additionally employ 600kHz and 700kHz frequencies to give enhanced detail over a swath of up to 120 degrees. This will enable the user to carry out bathymetric survey, inspection and wreck mapping at the highest resolution possible today. Seabed classification will also be more accurate due to the added ability to simultaneously collect back scatter data at multiple frequencies – an enhancement of the single-frequency facility standard to all EM systems.

As part of a new EM technology platform designed for future challenges, the EM 2040 is compatible with a new Kongsberg-developed datagram format, which supports several new features such as extended back scatter calibration, with more features already in development.


Kongsberg Maritime

iXblue Launches the Gaps M5

The new Gaps M5 joins the Gaps (now Gaps M7). Gaps M5 integrates an Attitude and Heading Reference System based on iXblue FOG technology for stable heading roll and pitch compensation and a true north reference. Gaps M5 is ready-to-use and calibration-free. It offers an accuracy better than 0.5% up to 995 m operating range, making it free of export restrictions for fast and easy shipment. Gaps design has been kept in the M5 version with slightly shorter legs to reduce its size. The 3D 4-hydrophone antenna has different legs lengths to enhance horizontal tracking capabilities. With the Gaps M5, no need to tilt the antenna, the acoustic offers maximum aperture and allows up to 200° omnidirectional coverage. This is efficient in shallow water and horizontal tracking conditions.

iXblue

Gaps M5 is suitable for any tracking operation, from diver- to multiple subsea assets- or inspection ROV-tracking while Gaps M7 remains the best asset for highest survey requirements, subsea multibeam and laser scan positioning.

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