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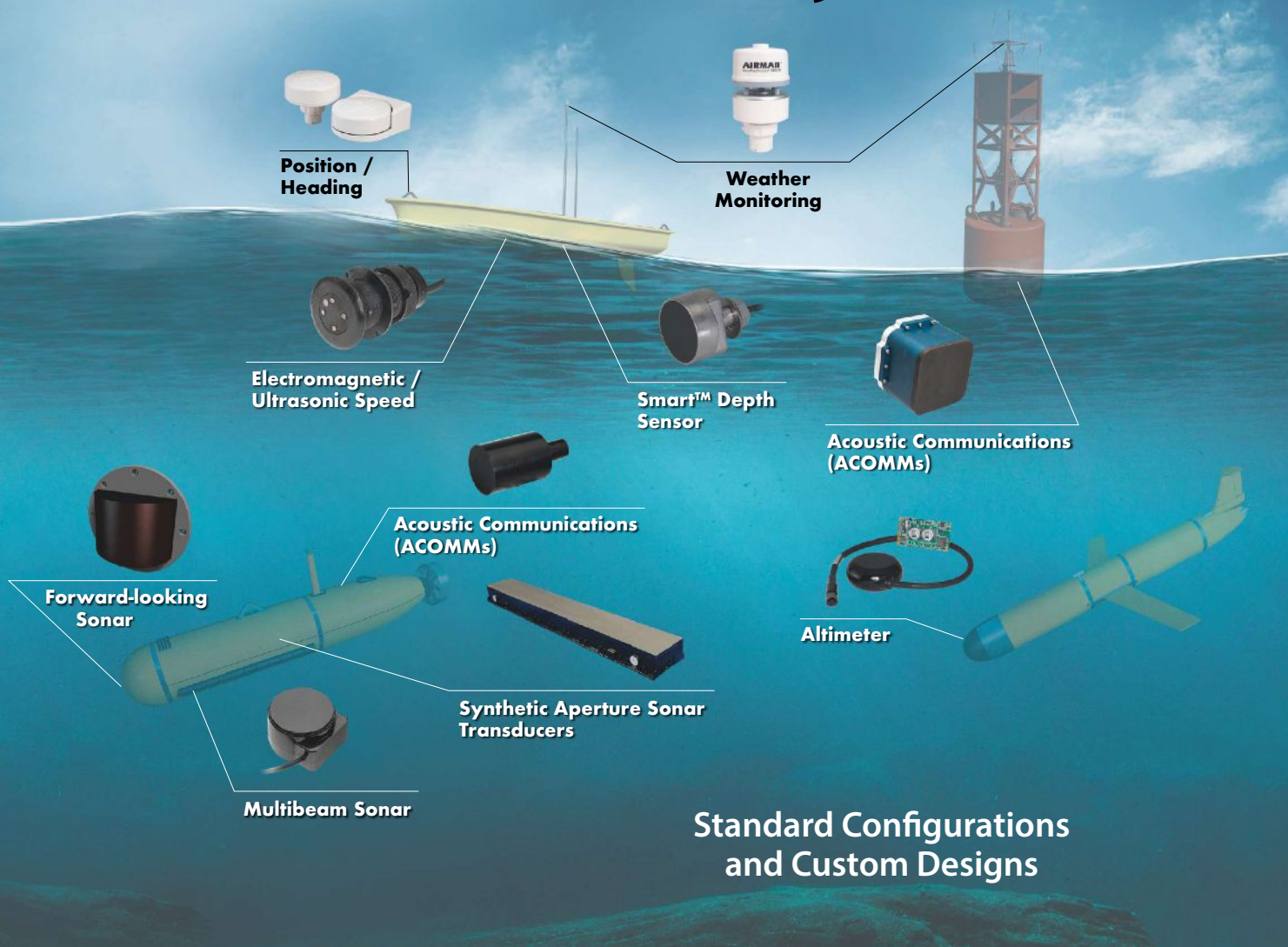
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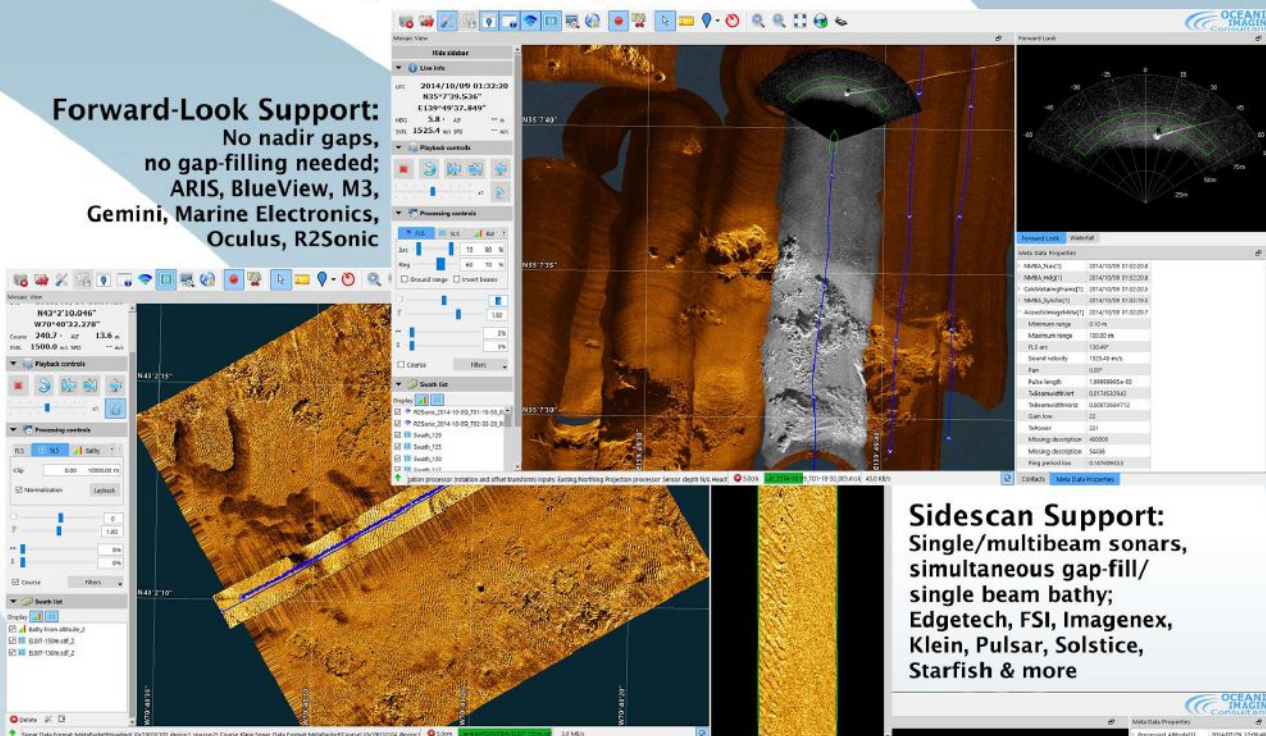
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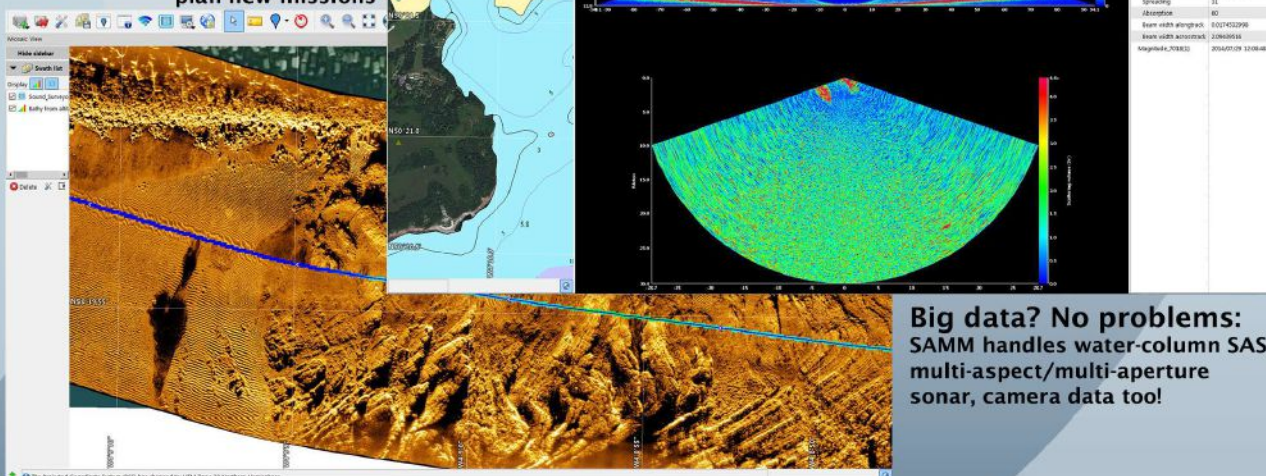
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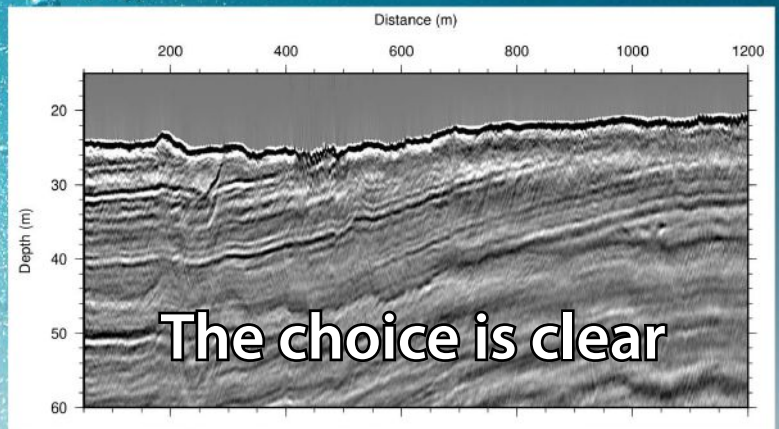
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The eDNA Revolution

Marine environmental DNA (eDNA) promises a widely applicable method for monitoring ocean animal life. Results demonstrate loose DNA in small volumes of saltwater suffices to identify reliably the species nearby and to provide an index of their abundance. eDNA is easy and cheap to collect and costs little to analyze, and collection does not harm animals or their environment.

The first steps are collection of water (typically 1 liter), filtration to concentrate particulate matter, and extraction of DNA. DNA can then be analyzed by a "metabarcoding" approach that targets all species in a taxonomic group (such as vertebrates), or by assays that target single species. Typical cost is \$20 to \$50 per sample, and turnaround time is days to weeks for metabarcoding and hours to days for single-species assays. Hundreds of experiments have now proven the method, and all steps will improve. Kits will become smaller and software for analysis more user-friendly. Within a few years, devices on underwater instruments could filter and sequence "on board."

eDNA will help meet demand for environmental assessment associated with increases in aquaculture, oil extraction, wind energy and shipping, for example. We expect eDNA will be a routine component of fish stock assessment, detection of invasive species, and monitoring effects of coastal storms and climate change. The method will facilitate a shift from episodic surveys to ongoing monitoring, a future with eDNA "weather stations" reporting daily on local marine fauna. It revolutionizes the ability for people to know, affordably, what lives in the waters near them.

Limits include absence of information on individuals, for example, size, weight and age. More work is also needed on how presence of eDNA relates to nearness and abundance of organisms, and differences among species, by season, local weather and DNA dispersal and degradation in different environments. Other factors possibly modifying eDNA signals are: presence of eggs, sperm or larval forms; dead or injured individuals; substances that interfere with DNA analysis; extraneous DNA from wastewater; and potential deliberate contamination.

Integrating eDNA into existing marine surveys can efficiently lift understanding and identify study priorities. Ongoing research is examining whether quantifying eDNA is better done by precisely measuring the DNA in a single sample or by analyzing presence/absence in multiple samples; the choice may differ by environment and species.

The method is as good as existing genetic reference libraries. For scale, consider that for nearshore fishes in northern temperate regions, 90 percent of species have reference sequences in GenBank. Pelagic, deepwater and tropical fishes are less well represented. Some closely related species cannot be distinguished by the short (100 to 200 base pair) mitochondrial DNA segments typically analyzed in eDNA studies. The enormous diversity of marine invertebrates challenges broad approaches.

About 100 American ocean scientists and associated stakeholders assembled in New York City for a conference (bit.ly/2HR4xTI) sponsored by the Monmouth University-Rockefeller University (MURU) Marine Science and Policy Initiative in November 2018. Participants came from academe, government, nongovernmental organizations and the private sector. Discussions proved the maturation of the U.S. marine eDNA community, revealed fast-increasing applications, and called for a national marine eDNA program sparked by the National Ocean Partnership Program, which embraces the many federal agencies for which eDNA will become indispensable.

For 30 years, genomics has been a sea technology on the horizon. eDNA is now rushing into our pipes, channels and ducts. It excites the marine science community and public with the capacity for current information on what lives where and could greatly improve operational decision making and regulation. For the marine eDNA community and stakeholders, the message is clear: Get going. **ST**

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)) Oceans Highlighted at ADB Annual Meeting in Fiji. Ocean health in relation to sustainable development was a major theme of the Asian Development Bank's (ADB) Annual Meeting, held on Denarau Island, Fiji, May 1 to 5. ADB President Takehiko Nakao announced the launch of the ADB's \$5 billion Action Plan for Healthy Oceans and Sustainable Blue Economies during the meeting. The plan will support the efforts of ADB's developing member countries related to the UN's Sustainable Development Goals (SDGs), particularly SDG 14 on ocean conservation and sustainability. ADB will expand financing and technical assistance for ocean health and marine economy projects to \$5 billion from 2019 to 2024, including co-financing from partners. The action plan focuses on four areas: creating inclusive livelihoods and business opportunities in sustainable tourism and fisheries; protecting and restoring coastal and marine ecosystems and key rivers; reducing land-based sources of marine pollution, including plastics, wastewater and agricultural runoff; and improving sustainability in port and coastal infrastructure development. Ocean ecosystems around the world are suffering from climate change, pollution and illegal and unregulated fishing. The Asia-Pacific region contains eight of the 10 rivers transporting 88 to 95 percent of plastics into the sea worldwide. Unless immediate action is taken, about 90 percent of Asia-Pacific's coral reefs will be dead by 2050, and all commercially exploitable fish stocks will disappear by then. This will significantly threaten food security, the global economy and livelihoods, especially among millions of poor and vulnerable communities in the region. ADB will launch the Oceans Financing Initiative to create opportunities for the private sector to invest in bankable projects that will help improve ocean health through instruments such as credit-risk guarantees and capital market "blue bonds." On the same day that Nakao announced the ADB's Action Plan for Healthy Oceans, a seminar on ocean health was held at the ADB Annual Meeting. The speakers were: Nakao; the Indonesian Minister for National Development Planning Bambang Brodjonegoro; Global Environment Facility CEO and Chairperson Naoko Ishii; World Resources Institute President and CEO Andrew Steer; and Pacific Islands Forum Deputy Secretary General Cristelle Pratt. Craig Leeson, director of "A Plastic Ocean," moderated. Ocean resources are valued at \$2.5 trillion, but they are threatened by 8 million tons of plastic being dumped into the oceans every year, *Sea Technology* reported from the seminar. "The ocean is suffering from tragedy of global commons," said Ishii. However, "If we do shift our economic and financial paradigms, we can create a healthy ocean," said Leeson, who brought up the example of his home town in Tasmania, which he witnessed transform from a heavily polluted coastal industrial town to a clean-water tourist destination. Raising awareness and monetizing values that promote ocean health are key. Steer emphasized that the narrative needs to change from helplessness to positive action; we already know the solutions to, for example, overfishing. Brodjonegoro explained how Indonesia has been successful in regulating overfishing by cracking down on illegal activities (partly by blowing up fishing vessels for deterrence). The Indonesian minister also said that both consumer and manufacturer behavior have to change to address the plastics problem; single-use plastics must be reduced. Ocean health is a large global problem, but it is not insurmountable, Leeson argued. With awareness, legislation and manufacturers' involvement, ocean conservation and sustainable development are possible.

)) Autonomous Maneuvering Vessel Trials in North Sea. Autonomous operations trials were held in the North Sea, about 5 nautical mi. off the coast of Den Helder, Netherlands. *SeaZip 3*, a Damen Fast Crew Supplier 2610 Twin Axe from SeaZip Offshore Services, was outfitted with collision avoidance technology to determine how the vessel would interact with seagoing traffic. The trials are part of the Joint Industry Project Autonomous Shipping, a two-year research and innovation project started in 2017. The testing demonstrated the decision-making process of an autonomous system in ensuring safe sailing and avoiding collisions with other vessels. Further development of autonomous systems is needed to cope with complex marine traffic situations more efficiently. The demonstration provides input for an autonomous shipping road map to define the lessons learned, obstacles, technology, potential and next steps.

)) Global Data Utilization Platform. Ship Data Center Co. Ltd. (ShipDC), ClassNK's wholly owned subsidiary, has launched IoS-OP (Internet of ships open platform) for data distribution and utilization under common rules. The aim is to create a new maritime cluster in the digital age to continue throughout future generations. In order to accomplish this, IoS-OP distinguishes cooperative domain and competitive domain. In the cooperative domain, IoS-OP users will collect and safely store data at ShipDC, and ShipDC will distribute the data under common rules agreed by the stakeholders. In the competitive domain, IoS-OP users will utilize the data and create data-driven innovation.

)) International Cooperation on Offshore Wind. Offshore wind regulators for Australia, Canada, Denmark, Germany, the Netherlands, Norway, Scotland, the U.K. and U.S. shared best practices and lessons learned with the goal of strengthening international cooperation at the U.S. Bureau of Ocean Energy Management (BOEM)-hosted first meeting of the Global Offshore Wind Regulators Forum in New York City. Topics included offshore wind planning, leasing and oversight. The forum intends to meet annually, next up in Denmark in 2020. The U.S. and the Netherlands also signed a memorandum of understanding in New York to further strengthen bilateral cooperation on offshore wind, reinforcing each country's commitment to share information, experiences and best practices. **ST**

Advancement in Sonar Technology

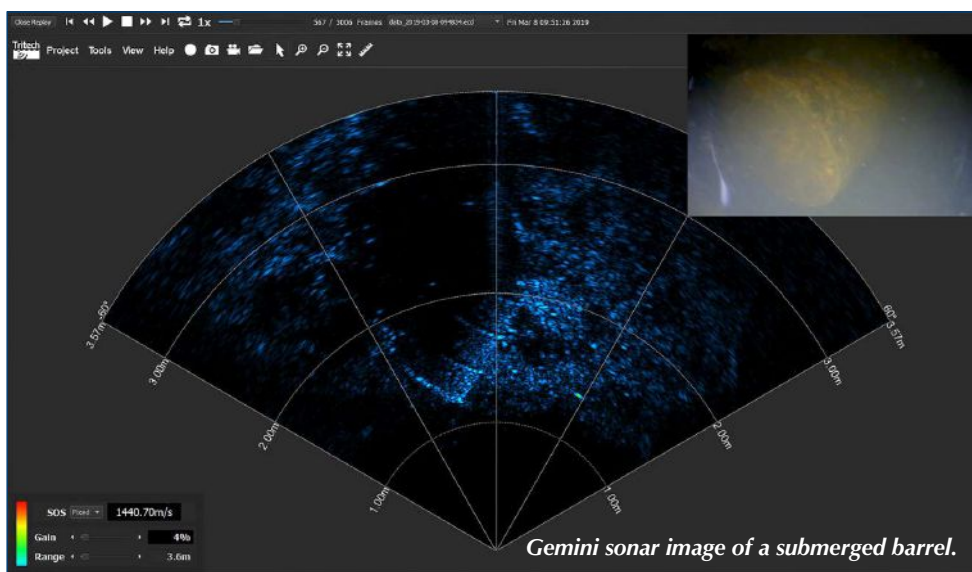
Gemini 1200ik Pushes Boundaries with Wide-Angle Field of View

By Asim Azad • Sandy Stephen

Tritech's latest multibeam sonar, the dual-frequency Gemini 1200ik, is based on the reliable Gemini platform and offers significant advantages for applications where higher resolution imaging is required at an affordable price. The small, compact size is perfect for diver solutions, small ROVs or any application where size, weight and cost are critical.

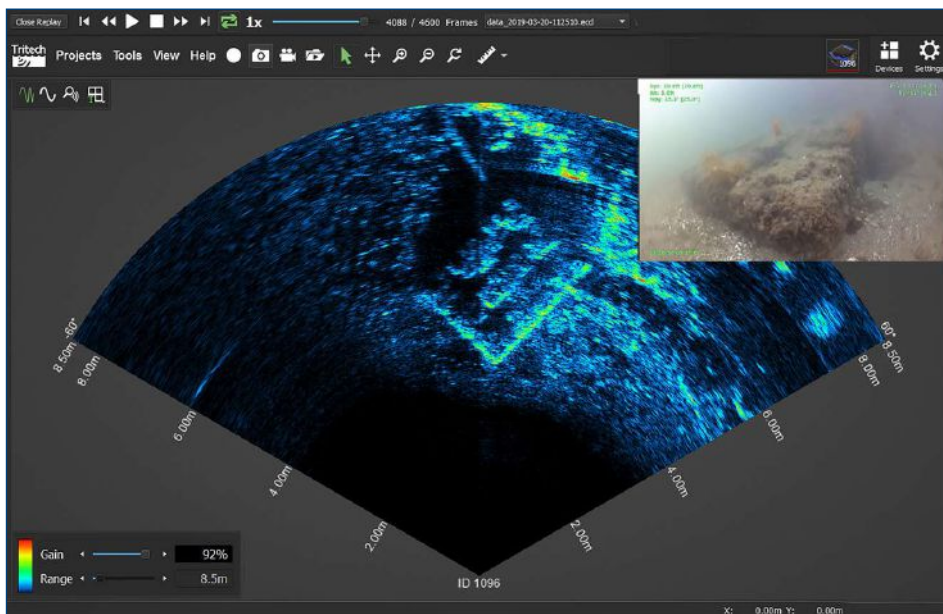
The engineering team at Tritech was challenged to create a product with significant advancements beyond existing solutions and to deliver a feature set unrivaled within the target price range; our desire to continually improve helps us lead the market in developing solutions and bringing meaningful, real-life advantages to our customers. Tritech encourages innovation, resulting in technological advances that inspire our product road maps, and the company has continued to invest heavily in research and development during the prolonged downturn in subsea energy markets, with the Gemini 1200ik, along with the Gemini 720im, being the early fruit of that labor.

The Gemini 1200ik not only offers improved imaging capability with the introduction of a higher acoustic frequency mode of operation, it also offers advantages that set a new standard. Our culture, which promotes agile development, means that with these newly developed features, our engineers are already working on exciting new products off the back of the experience and knowledge gained from developing the Gemini 1200ik and the Gemini 720im. Imaging enhancements on the Gemini 1200ik are plentiful. The sonar now offers 4-mm-range



resolution in 720-kHz mode, improving to an impressive 2.4 mm in 1.2-MHz mode. The angular resolution of 1° at 720 kHz, with an effective resolution of 0.25° due to the creation of 512 beams across a horizontal aperture of 120°, is improved to an angular resolution of 0.6° in 1.2-MHz mode, with an effective resolution of only 0.12°. In 1.2-MHz mode, the Gemini 1200ik produces an incredible 1,024 beams during acoustic reception and beam-forming.

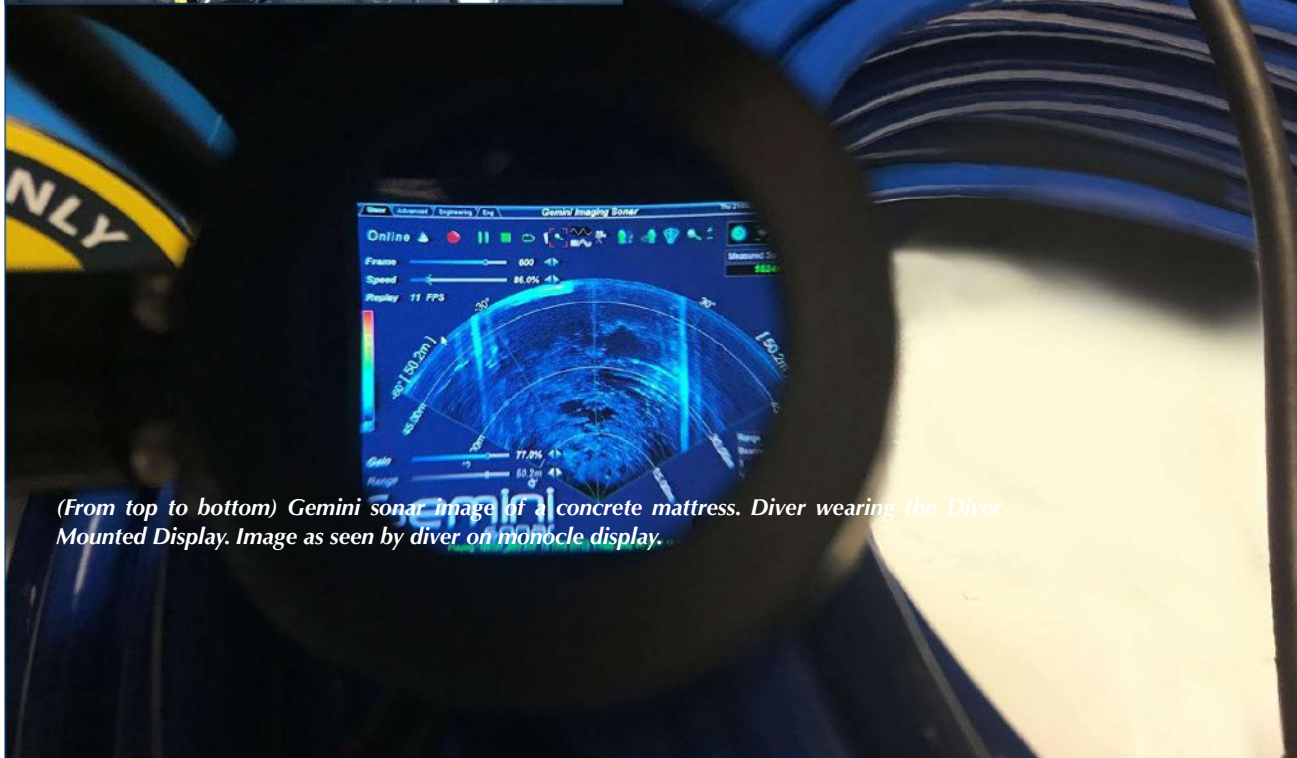
Our advanced electronics, designed with future product requirements in mind, has ample processing power to handle significant increases in data throughput and digital signal processing requirements to support the move toward higher acoustic frequencies. The powerful hardware architecture allows the Gemini 1200ik to support compressed high-intensity radar pulse (CHIRP) capability as standard in both low and high acoustic frequency modes for improved target discrimination at long range. Also, through careful consideration of internal electrical noise sources, and deliberate enhancements to reduce



noise coupling mechanisms and net effects, we are confident that the Gemini 1200ik has a superior signal-to-noise ratio performance that many operators would appreciate, leading to clearer and crisper images.

At Trittech, we continually engage with customers, and one of the common complaints raised by users of existing dual-frequency sonar solutions is that the switch from a lower acoustic frequency mode to a higher acoustic frequency mode either results in a reduction in horizontal aperture that limits the operator's field of view, or, if the horizontal aperture is maintained, there is no remarkable improvement in resolution at the higher acoustic frequency due to the fact that the angular resolution remains constant.

The Gemini 1200ik is the first dual-frequency sonar in the world to offer the same wide horizontal aperture of 120° at both low and high acoustic frequencies while also offering a considerable improvement in angular resolution at the higher acoustic frequency. From a customer's perspective, the significant improvement in resolution in the higher acoustic frequency mode while maintaining the wide 120° horizontal aperture reduces the time spent in water during operations, ultimately saving cost. The Gemini 1200ik is also pin-for-pin compatible with the Gemini 720ik and retains all of the auxiliary



(From top to bottom) Gemini sonar image of a concrete mattress. Diver wearing the Diver Mounted Display. Image as seen by diver on monocular display.

“An integrated velocity of sound probe guarantees accuracy of displayed targets for size and range without relying on additional external sensors.”

functions of the 720ik, including output power connections to supply power to additional subsea equipment, serial communications, and general-purpose inputs and outputs for control. An integrated velocity of sound probe guarantees accuracy of displayed targets for size and range without relying on additional external sensors. The ability to measure inertial, magnetic field, acceleration, roll, pitch, heading and yaw is another new feature that opens up new possibilities.

The Gemini 1200ik dual-frequency sonar will be offered in conjunction with Trittech's new software package, Genesis. With a stylish and intuitive new appearance, all the latest industry features for nav-

igation and target tracking, the latest charting capability with Google Maps and nautical charts, support for remote sensor control via several displays, available software development kits for common operating platforms, plug-and-play sensor automation, and a design that supports all major operating platforms, including Linux, Windows and Android, the Gemini 1200ik system has a lot to offer.

The flexible Gemini 1200ik platform can also be tailored for specific customer applications and operational requirements.

For example, one future configuration in the pipeline at the moment, to meet the growing demand by a key customer, is a variation

with an increased depth rating beyond the current 350 m.

With a number of industries already showing keen interest, and great feedback from recent field trials with important customers, we are excited by the new opportunities on the horizon, and we look forward to working in partnership with existing and new customers.

Gemini Diver Mounted Display

Another recent technical advancement from Trittech is our Diver Mounted Display (DMD) system, designed to operate with diver helmet/mask-mounted or hand-held Gemini 720ik/720im multibeam sonars. The integrated system enables a diver to view live sonar images on a monocular LED display while allowing the surface dive supervisor to see the same images, transferred over diver cable, on a surface PC. The lightweight DMD diver cable supports simultaneous transfer of all images, sonar control and power directly to the diver and supervisors.

The DMD system comprises: topside (surface) equipment; an electrical diver cable up to a length of 80 m; and diver-carried equipment.

Current DMD system topside equipment includes a 36-V battery pack, topside control box and Trittech's new Genesis software package (installed on user laptop). The diver cable is a lightweight assembly made up of two small-diameter robust sonar subsea cables twisted and taped together. A high-resolution monocular display, display helmet-mounting arrangement, multibeam sonar and subsea vessel containing electronics and electrical interconnect make up the list of diver equipment. Compatible sonar types for use with DMD are the high-performance 720ik and the smaller, compact 720im. Support of

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the new Gemini 1200ik will provide enhanced target resolution.

The current DMD system sonar display is controlled by the dive supervisor at the surface. With the aid of an additional diver audio communication link, the dive supervisor can help guide the diver during a search exercise, adjusting sonar display for suitable gain and range to pinpoint search targets.

This packaged integration of subsea components enables significant operational improvements, particularly when deployed in applications such as hazardous material (hazmat) diving, site clearance, search and recovery, and ship hull inspection.

“Key controls are gain and range, which the supervisor will adjust when the diver is in position subsea.

Updated sonar images and audio control, currently available through a third-party diver cable, are used to aid the diver.”

In harbors and inland waterways, where search and recovery are typically performed, visibility can be very limited, sometimes to less than 2 m. Sonar image viewing extends the diver's ability to “see” what is in front of them despite visibility limitations. The sonar range can be up to 120 m, providing significant operational and safety enhancements.

In these scenarios, a steady image is essential for low-stress viewing and easy interpretation. The DMD system provides a real-time multibeam sonar high-quality diver display (800 by 600 pixels) with excellent refresh rates. No viewing lag is experienced with sonar position change, allowing the diver free and safe movement.

The system is designed to operate hands free when using the helmet-mounted sonar, providing improved diver concentration and allowing the diver to move in a more natural manner, thereby minimizing risk of injury. The system is configurable and is compatible for use with most popular helmets/face masks.

Ease of monocular display (flip) attachment and removal is a key system feature. In these operational environments, the diver may not wish to use the display at all times during a dive so it is essential a robust, simple-to-use mechanism is in place to facilitate eyepiece attachment and removal. Simple lightweight assemblies

make the system easy to store, transport and connect/disconnect on site.

The DMD system is typically assembled on site and is deployed from land or boat. Reaction to feedback from early equipment demonstrations to police departments and search organizations operating from land and boat have resulted in a product suitable for use in often very challenging environments.

Subsea, the diver has the option to make use of the display or remove it from the helmet/face-mask viewing surface. There is also a focusing control on the monocular display arrangement to optimize the diver viewing of display.

At the surface, the dive supervisor can more comfortably view sonar images the diver sees. The sonar, with the exception of direction, can be fully controlled by the supervisor. Key controls are gain and range, which the supervisor will adjust when the diver is in position subsea. Updated sonar images and audio control, currently available through a third-party diver cable, are used to aid the diver.

A single high-performance diver cable will support DMD, diver audio communications and diver recovery. This covers all diver subsea electrical requirements, making the diver cable easy to use alone when scuba diving with tank or twisting with air and pneumo hoses in a composite umbilical arrangement, as used in airline dives. Diver communications support equipment needed at site is subsequently limited to surface communication equipment and that inside the diver helmet/mask. Use of the enhanced umbilical also removes the need for other diver recovery lines on site. All in all, the composite umbilical saves users unnecessary rental and maintenance costs. Alongside this, development of a diver cable with a top-end splice add-on will allow consolidated topside interconnect, with the only additional surface equipment needed being diver communication support, DC power supply/battery and dive supervisor laptop.

Greater diver control of the sonar display is being integrated, which will enable the diver to change gain and display, required when operating the DMD system without diver cable as in tank diving, or after requesting control be passed from the surface dive supervisor.

The Gemini series of sonars offers affordable performance with ease of use. Introduction of the lighter weight Gemini 720ik and Gemini 720im variants in recent years has enabled diver hands-free DMD system deployment. Launch of the Gemini 1200ik will further enhance Trittech's capability in multibeam sonar and extend performance options available for use with the DMD system. **ST**

Asim Azad is a design engineer at Trittech International, a Moog Inc. company, which he joined in April 2012. He holds a master's degree in electronics and electrical engineering from the University of Edinburgh, Scotland. After previously working in the consumer semiconductor industry as a design evaluation engineer, over the last seven years he has been involved in the design of Trittech's mechanically scanned and multibeam sonar systems.

Sandy Stephen is an embedded designer at Trittech International, which he joined in 2013. He has more than 30 years' experience in defense, industrial and high-end commercial product design.

Green Shipping

Drawing Fuel on Demand from Hydrogen in Seawater

By William H. McGill, Jr. • Traver Kennedy

The marine industry faces a major challenge as it seeks to prevent harmful emissions from the 53,000 merchant ships in operation today. Hydrogen, the universe's smallest and most abundant element, may have a major role to play in transforming shipping from being a major source of pollution to being among the greenest of transport mediums. A recent agreement between Joi Scientific, a leader in green hydrogen technology, and the world's largest boat retailer, MarineMax, may point the way for the rest of the industry.

The Green Challenge

The International Maritime Organization (IMO) is committed to a 50 percent reduction in CO₂ emissions by 2050, a vital step to bring the maritime industry in line with the Paris Climate Agreement. The IMO has also

called for emissions reductions to begin as soon as possible and for plans to be drawn up that will phase out carbon emissions entirely.

Alongside this, the industry is fast approaching the IMO's 2020 sulphur cap, requiring the desulphurization of bunker oil for more than 70,000 vessels—an expensive and inevitably temporary process as the marine industry weans from its dependency on hydrocarbon fuels altogether.

For these CO₂ and sulphur regulations to be met, it is imperative that the maritime industry looks at alternatives to fossil fuels for both propulsion and auxiliary power.

Batteries make sense in some niche applications and for small craft, while nuclear has a role in the very largest of vessels. However, neither is practical for the vast majority of seagoing maritime vessels.



Joi Scientific's Hydrogen 2.0 is the world's first hydrogen production process based on the clean and affordable extraction of hydrogen directly from untreated seawater, on demand, at the point of use.



(Top) The ability to generate power from the water that surrounds your vessel is transformative. (Bottom) In partnership with NASA and Space Florida, Joi Scientific is headquartered at the Kennedy Space Center Space Life Sciences Lab.

Green hydrogen has a major role to play in the sector's reduction of CO₂ emissions, as it is a highly energy-dense fuel but entirely clean—with the only byproduct being water. It is also highly adaptable; the same source of hydrogen can be used in fuel cells for auxiliary power and internal combustion engines for propulsion.

The IMO's decision to implement a 0.50 percent sulphur cap on marine fuel starting next year is one of the industry's most defining moments since the shift away from coal. The current global sulphur cap is 3.5 percent, while the average sulphur content of today's heavy fuel oil (HFO) bunkers, by far the most common type of marine fuel burned today, is around 2.7 percent. Only vessels that equip themselves with exhaust-gas cleaning systems (scrubbers) will be able to continue burning these same bunkers from 2020 onward. A survey by Drewry Maritime Research in April 2018 estimated that only around 20 percent of shipowners are planning to install these systems; everyone else will have to adapt their propulsion engines to meet the sulphur gap.

The logic is that the vessels reliant on heavy fuel oil today should look to switch directly to hydrogen rather than adapt to compliant, low-sulphur bunker oil as an interim measure.

The environmental forces are clearly there to render major fuel-source changes in the maritime industry, and hydrogen looks to be a big winner.

The Electric Ship

Somewhat surprisingly, the concept of electrically powered vessels was alive and active in the pre-internal combustion engine (ICE) era. From 1880 to 1920, the electric boat thrived as a passenger vehicle for rivers and lakes. A recharging network was even set up in the 1890s along the Thames from Chiswick to Reading. While the electric boats proved popular for a few decades, they could not compete with the onset of the ICE

and its far greater range. A major limitation was the battery technology of the time with its inherent low energy density and short range for the vessel, and the fact that the lead-acid batteries of the day were highly corrosive and extremely dangerous on board a boat.

A small renaissance of electrically powered boats was seen in the 1980s as inventors looked at the possibilities enabled by photovoltaics and new battery technologies. However, it has only been in the last decade or so, in response to concerns over global warming and environmental damage caused by sulphur, that the marine industry has turned to green alternatives to the ICE. The reservations about batteries continue, although this time, they do not focus on the corrosive nature of the battery electrolyte but on the highly flammable and sometimes unpredictably self-igniting nature of today's lithium-ion batteries. Until a safe, non-flammable battery is available, it is unlikely that most shipowners would entrust their vessels to this still nascent technology.

The Hydrogen Alternative

Hydrogen is the ideal zero-emissions fuel, as the only byproduct of its combustion is water. It is already in use in buses, trains and cars from California to Japan to Europe, but its adoption in the marine environment has been a little slower than its terrestrial cousins.

“Initially, MarineMax intends to use the hydrogen production system to power boats through a hydrogen fuel cell that efficiently creates an electrical current from hydrogen.”

A major challenge is the storage and supply of hydrogen. Traditionally this has been done by keeping hydrogen in a liquid form through cooling and pressurization, which is both technically challenging and also expensive, as cryogenic cooling alone uses up 18 percent of the available fuel.

New hydrogen production methods, such as the new Joi Scientific Hydrogen 2.0 system, would see the hydrogen produced on demand and on board the vessel, thereby, eliminating the storage problem. Moreover, since the fuel-stock for the on-demand production of hydrogen is seawater, this makes maritime applications perfect for the adoption of clean hydrogen.

To date, hydrogen has been used as fuel in experimental craft as a proof of concept, such as aboard ferries. What is needed is a greater uptake of hydrogen on larger ships, which requires more than the scaling of existing technologies.

There are three means of using hydrogen for marine vessel propulsion: the direct combustion in an engine to drive a propeller shaft or electric generator; the combustion to drive a steam turbine; and the use of a fuel cell. All have been successfully tested, and all have proponents who preach their virtues.

Direct combustion could theoretically use existing ICE engines, although the minuscule size of the hydrogen molecules would create its own challenges in the seals and manifolds required. Furthermore, direct combustion of hydrogen in the air causes the creation of NOx molecules through side reactions (one of the very pollutants the industry is trying to eliminate by moving away from diesel), which would require scrubbing of the exhaust fumes.

Turbine conversion delivers greater efficiency but would require new equipment and suffers the same problems of NOx production and the need for exhaust scrubbing.

Fuel cells have historically been inefficient (60 percent at best) and problematic through their need for extremely pure hydrogen. A new generation of alkaline fuel cells is coming to market that offers higher efficiency with the ability to handle lower-grade hydrogen.

There are many different approaches to be considered depending upon where and when a vessel type will be used. For instance, for larger vessels, a suitable combination of technologies may be a steam turbine for propulsion and a fuel cell for auxiliary power (so the turbines do not need to be turning when the vessel is stationary). Hybrid-powered hydrogen/electric propulsion, hydrogen auxiliary power, hydrogen absorption evaporators for heat and cooling, and other energy designs are being widely discussed and debated.

The Storage Conundrum

The storage of hydrogen has been one of the most difficult challenges in its adoption as a clean marine fuel, as the fuel must be contained at -253°C to keep it from evaporating. There are certain constraints when it comes to accessing large-scale production of liquid hydrogen. Until recently, it has also been a relatively expensive fuel due to supply constraint.

The problem with hydrogen is that its small atomic size means that highly specialized materials have to be used to contain the molecules. Also, its low inter-molecular attraction means that hydrogen has a low liquification point. In practice, three approaches have been used to store hydrogen: cryogenics, where the hydrogen is kept at -253°C ; pressurization of the gas; and containment in metal hydrides or other molecular solid structures. All have their drawbacks. The need to keep liquid hydrogen at such low temperatures means that the equivalent of nearly 20 percent of the hydrogen produced is lost to compression and cooling. Gaseous pressurization requires triple-layer, carbon-fiber-reinforced tanks that are bulky and expensive. Metal hydrides and other containment solids are often difficult and dangerous materials to work with.

One approach offering much promise has been the use of electricity from photovoltaics and wind turbines to electrolyze water, with the resulting hydrogen then used as the propulsion fuel for the vessel via a hydrogen fuel cell. While this sounds great in principle, it is not practical today due to the 50 percent inefficiency of the renewable generation, combined with the 25 percent energy overhead for hydrogen storage (required as renewables are not dependable so the energy must be buffered) and the 60 percent efficiency of the fuel cell, resulting in an overall efficiency of just 22.5 percent. One day, this energy yield may improve, but for now, the daisy chain energy production system from renewables is not yet an efficient solution.

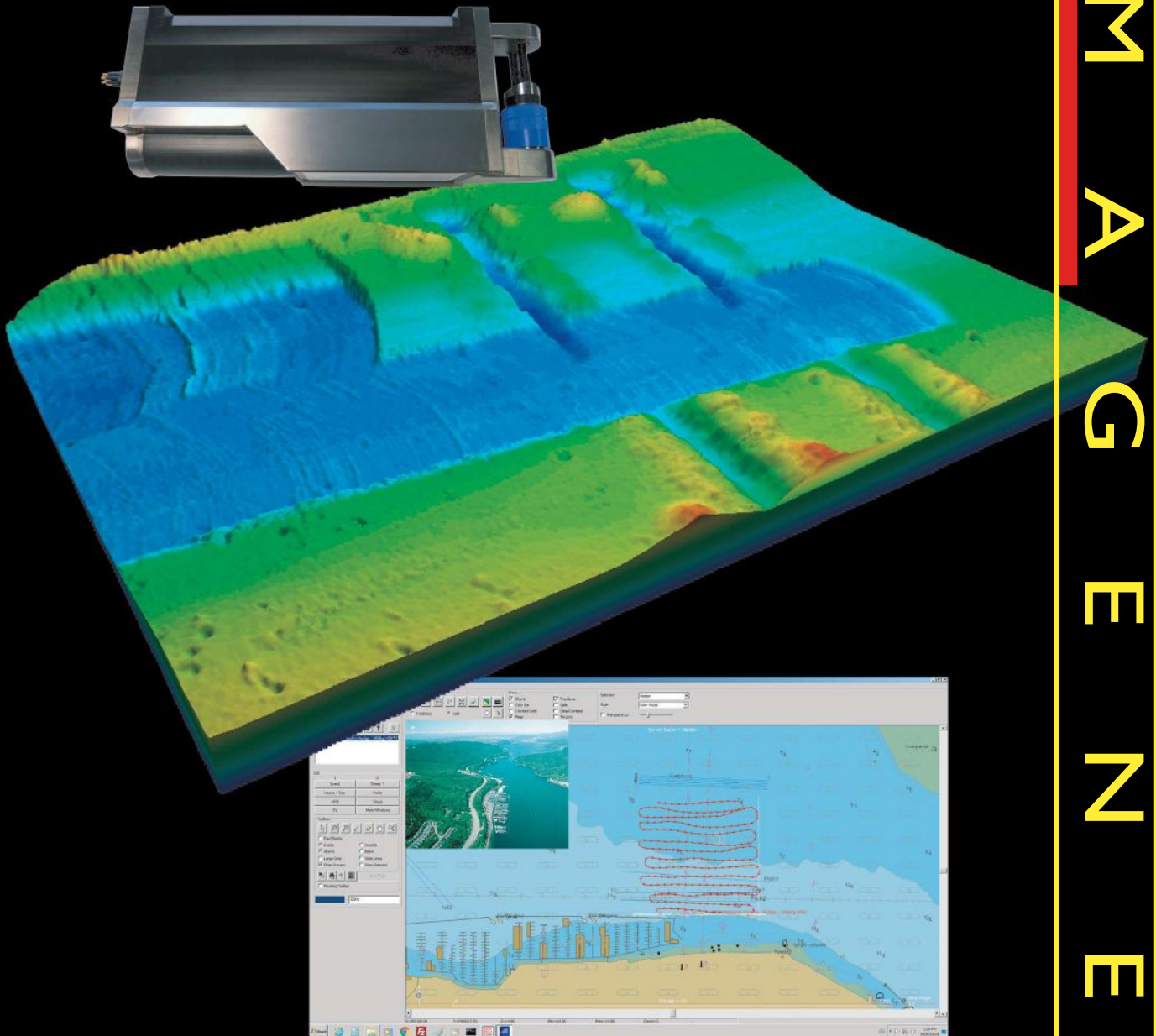
Joi Scientific's approach is the on-demand production of hydrogen from seawater. The system uses a proprietary process that is not traditional electrolysis to produce hydrogen gas. The elimination of traditional storage buffer for the hydrogen also improves safety since you extract the hydrogen gas from seawater as you go without requiring large stores of energy.

Putting Hydrogen into Practice

Each of the different approaches to using hydrogen for marine vessels has adherents, and each has been tried. Fuel cells on a luxury yacht would be far quieter, but an internal combustion engine might be more efficient and a turbine generator more reliable, for instance. The reali-

DT101Xi Multibeam

Survey of dredged area, including removal of two old pipelines,
near Reed Point Marina in Vancouver Harbour



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ty is that many vessels will end up using a combination of different hydrogen-powered technologies, with batteries alongside as an energy buffer.

There are several projects underway that explore hydrogen as a marine fuel in the passenger-shipping industry. This has mostly been seen in ferries, and the technology is still in its infancy. More recently, both Viking Cruises and Royal Caribbean have announced plans to build hydrogen-fuel-cell-powered cruise liners. What will undoubtedly make the biggest impact on marine hydrogen uptake is a low-cost source of hydrogen where the gas is produced on demand so that no storage is required.

Joi Scientific is actively working to make the vision of low-cost, on-demand hydrogen a reality. In September 2018, the company announced a licensing and joint development agreement with MarineMax. The agreement will enable MarineMax to develop propulsion and auxiliary boat power systems using the hydrogen produced by Joi Scientific's Hydrogen 2.0 system from seawater. Working together, MarineMax, Joi Scientific and several global marine supply chain partners will undertake joint development to bring hydrogen-based energy solutions to the pleasure boat market, followed by expansion across the entire marine industry—from the smallest pleasure craft to the largest freight vessel or cruise liner.

Initially, MarineMax intends to use the hydrogen production system to power boats through a hydrogen fuel cell that efficiently creates an electrical current from hy-

drogen. Development work on the initial product design is underway as the two companies work with supply chain partners. First-generation product is expected to be tested in 2020. The electrical power generated from the fuel cell is expected to be used for auxiliary power for lighting, navigation and cabin services. Heating and cooling using evaporative systems are being envisioned. In time, the primary propulsion of the vessel may be through an electric motor, making the vessel a true hybrid.

Since the Joi Scientific hydrogen production system uses seawater as the base fuel stock, it is very readily available to marine vessels. No additives or water processing are required. As well as improved safety and reliability, the process will also bring specific benefits to the recreational and superyacht categories, where the use of a hydrogen fuel cell and batteries will eliminate the noise, smell and vibration caused by traditional diesel gensets.

The development of onboard power systems using the technology will be undertaken jointly by MarineMax and Joi Scientific, and the first deployment of the technology is expected within a few years. Development work on hydrogen production systems is underway, with the promise of auxiliary power systems for yachts and use in slow-speed cruising propulsion as early as year-end 2020.

Full Speed Ahead

As Bill Gates once observed, the world is always frustrated by how little happens in two years but amazed by how much happens in a decade. The shipping industry is on the cusp of a radical transition from hydrocarbons to hydrogen. The technology to render this transition is becoming available, and the entrepreneurs to help drive the change are up for the challenge. In 10 years' time, we could well be looking back at an outstanding decade of transformation. **ST**

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William H. McGill, Jr. is the executive chairman of the board at MarineMax Inc. (NASDAQ: HZO), the largest recreational boat and yacht retailer in the U.S., with approximately 70 retail locations, representing more than 20 premium brands, in 16 states and a charter operation in the British Virgin Islands. McGill is an award-winning industry leader with more than 40 years of experience. He has been a member of the Governor's Florida Council of 100 since 2000 and a director on the Joi Scientific Inc. board since 2016.



Traver Kennedy is the chairman and CEO of Joi Scientific. He is a technology and social entrepreneur, recognized for his contributions as an early cloud-computing architect. Formerly, he was chief strategist for Citrix (NASDAQ: CTXS), helping to establish the company into the S&P 500 and NASDAQ 100 rankings in record time. The World Economic Forum named him a "Technology Pioneer" for his contributions to technology and society. He was also ranked by Network World as one of the "25 Most Powerful People" in technology.



Delivering Water Security

'Grand Challenge' to Stoke Innovation, Collaboration

By Andre de Fontaine

Safe, affordable and abundant water is fundamental for human society. Without water security, health suffers, commerce slows and agricultural productivity declines.

Plentiful freshwater supplies in most regions of the United States have helped lay the foundation for growth and prosperity. But current trends suggest a future of increased water stress in many regions with limited water supplies. Already, drought in regions of the U.S. West and Southeast have impacted the livelihood of residents and businesses, and 40 out of 50 state water managers expect water shortages in some portions of their states in the next 10 years, according to the U.S. Government Accountability Office. Globally, the situation is more severe. According to the World Health Organization, more than 2 billion people around the world lack access to safe, readily available water at home.

Water Security Grand Challenge

While the projections provide challenges, they also present an opportunity for innovation. Smart public investments matched with private ingenuity and entrepreneurial drive can deliver the technologies and other solutions needed to ensure water security for generations. Late last year, United States Secretary of Energy Rick Perry launched the Water Security Grand Challenge, a White House-initiated and Energy Department-led effort, to meet the global need for safe, secure and affordable water.



The five specific 2030 goals under the Water Security Grand Challenge are to: launch desalination technologies that deliver cost-competitive clean water; transform produced water from the energy sector from a waste to a resource; achieve near-zero water impact for new thermoelectric power plants and significantly lower freshwater-use intensity within the existing fleet; double resource recovery from municipal wastewater; and develop small, modular energy-water systems for urban, rural, tribal, national

security and disaster response settings.

The Department of Energy will deploy a coordinated suite of programs to address the goals of the Water Security Grand Challenge, including prize competitions, early-stage research and development and critical partnerships. While DOE is leading this effort, the department is working closely with important partners throughout the federal government, including the U.S. Environmental Protection Agency, U.S. Department of Interior and U.S. Department of Agriculture, to holistically address the goals.

Desalination

Desalination has emerged as an early and important topic under the Water Security Grand Challenge, for good reason. Cost-effectively treating seawater and brackish groundwater would make a huge difference for coastal and inland communities currently facing water stress. One of the major barriers to achieving cost-competitive desalination processes is the high energy requirements.

“DOE is taking a leadership role in the Water Security Grand Challenge due in part to the obvious and significant nexus between energy and water systems”

Energy costs can be up to 10 times higher for purifying seawater than treating freshwater to the same standards, according to the California Energy Commission.

In December 2018, DOE announced \$100 million to establish an Energy-Water Desalination Hub, which will focus on early-stage research and development for energy-efficient and cost-competitive desalination technologies including manufacturing challenges, and for treating nontraditional water sources for multiple end-use applications.

Earlier this year, DOE announced the launch of the Waves to Water Prize, which seeks to advance new technologies that use the power of the ocean to produce potable water from seawater. These technologies could play an important role in serving remote island communities,

forward-operating military bases and disaster response needs.

Similar prizes and initiatives to support the other goals of the Water Security Grand Challenge will be announced in the future. DOE is taking a leadership role in the Water Security Grand Challenge due in part to the obvious and significant nexus between energy and water systems, as well as the department's traditional role in advancing science, innovation and technology solutions.

As DOE moves forward, we welcome collaboration and participation from interagency partners and key stakeholders, including private industry, academia, non-governmental organizations and state and local governments, to stimulate and adopt the innovation needed to deliver water security for all. **ST**

Andre de Fontaine manages the Technical Partnerships group within the Department of Energy's Advanced Manufacturing Office. AMO's technical partnerships support the development and validation of technologies and practices to increase the productivity and competitiveness of American manufacturers and other large energy-using facilities. He is also the staff lead on the Water Security Grand Challenge. De Fontaine was previously a senior adviser in DOE's Office of Energy Efficiency and Renewable Energy, where he served as the office's energy-water nexus lead and supported the department's Better Buildings Initiative. Prior to joining DOE, he worked on business and clean energy issues in the nonprofit sector and, before that, was a journalist covering energy and environmental policy in California.

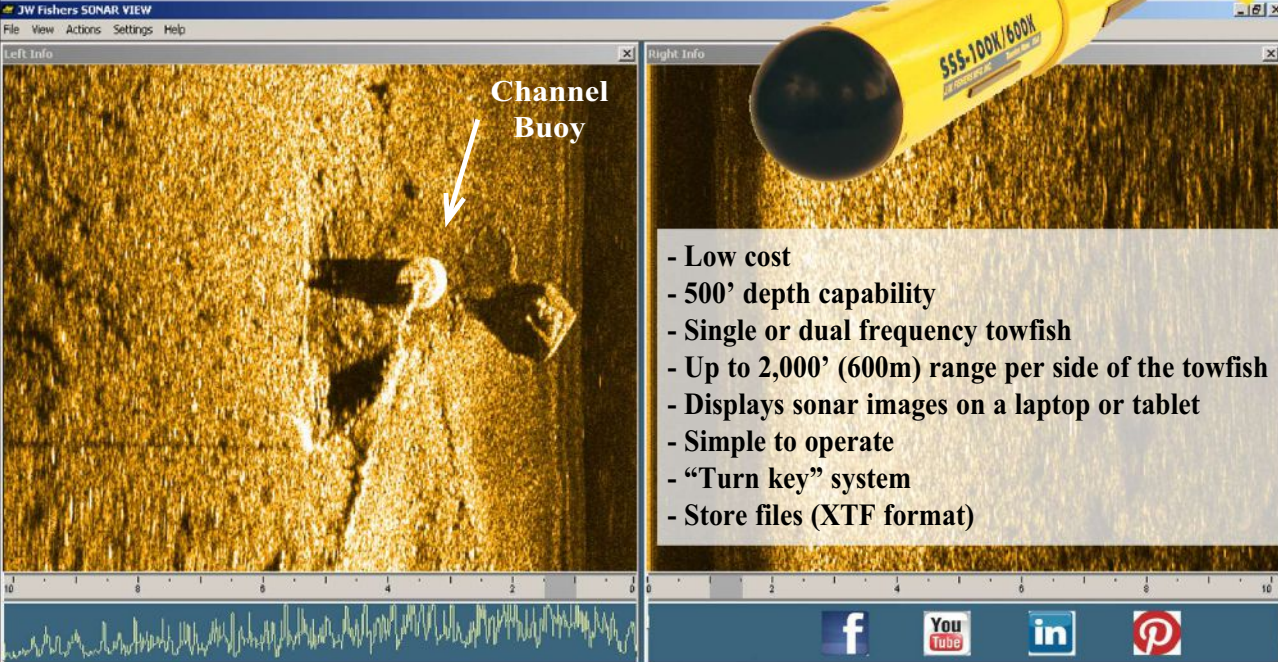




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Coastal Seafloor Observatory

China's Penglai Platform for Long-Term Environmental Monitoring

By Yan Li • Xuye Luo • Rui Zhu

Coastal environmental and security monitoring are vital to sustainable development. Maritime disasters, such as algal blooms (*Enteromorpha prolifera*), oil spills and storm surges, can threaten fishing, transportation, entertainment and other nearshore activities. How to deal with disasters and improve the capability of offshore resources management are important challenges for maritime countries.

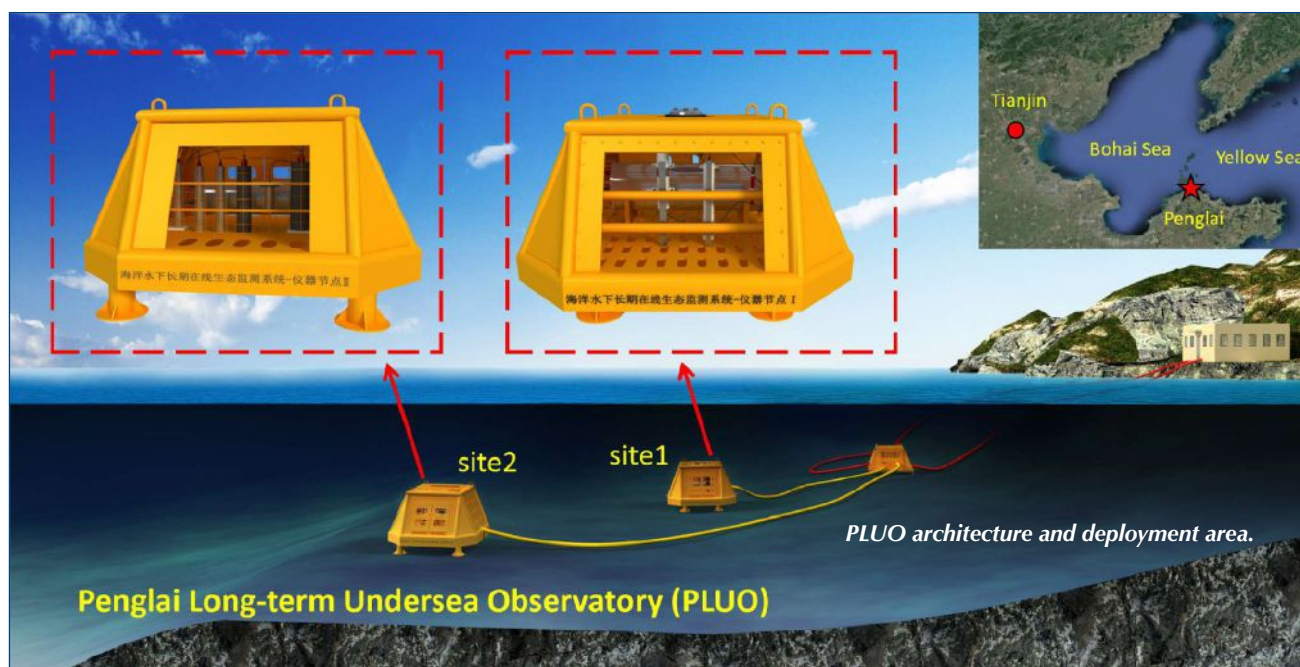
Traditional ship-borne investigations cannot synchronously observe key marine processes that are characterized by multi-spatial and -temporal scale distribution.

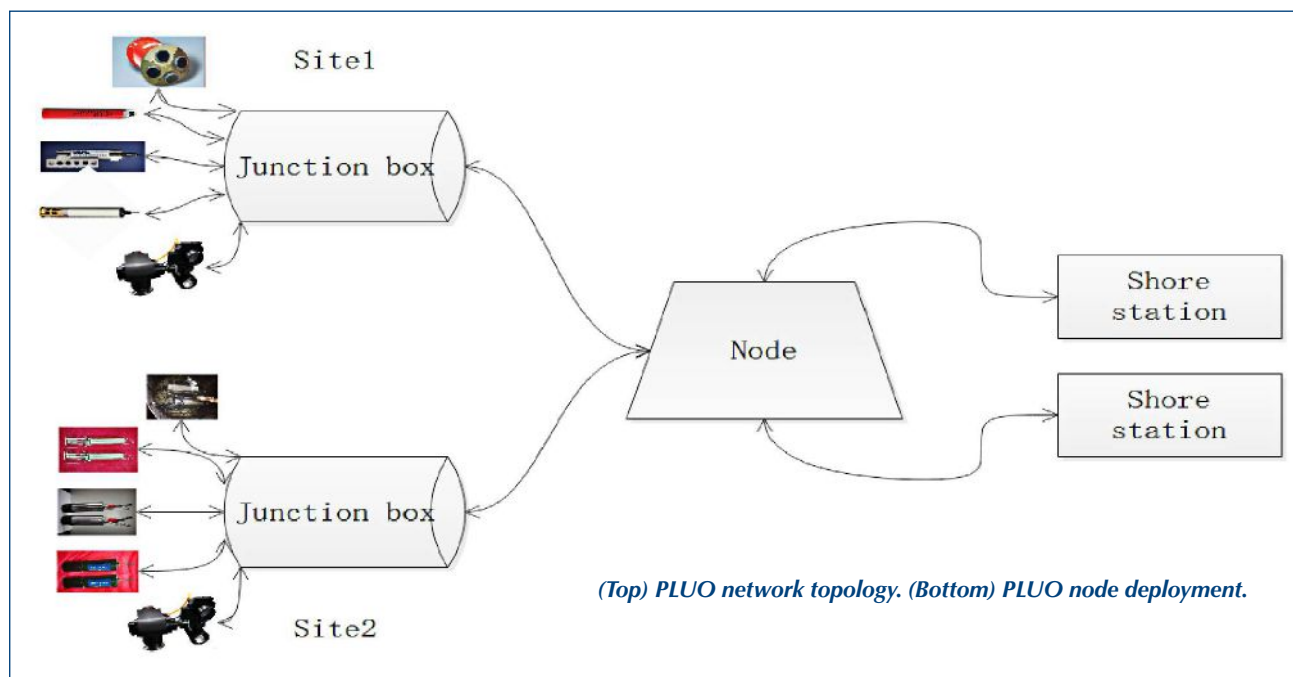
In contrast, a coastal cabled observatory enables continuous in-situ observation of long-term variable ecosystem processes, which helps explain the causes, evolution and effects of instantaneous disaster events, and prevent and mitigate the effects of natural disasters. A few cabled observatories are in operation worldwide for different

scientific objectives. Large-scale ones include NEPTUNE Canada (now within Ocean Networks Canada), OOI Regional Scaled Nodes in the U.S., and EMSO-ESONET in Europe for multidisciplinary research. DONET and SNET in Japan are for earthquake monitoring. Small-scale observatories include MARS in the U.S. and VENUS in Canada as technical test sites, ALOHA in the U.S. as a deep-sea observatory, and Xiaoqushan in China for technical experimentation.

A new addition is China's Penglai Long-term Undersea Observatory (PLUO), designed for marine environmental monitoring for coastal zone management and scientific research.

Bohai is the only inland sea in China and faces increasingly serious ecological, environmental and security pressures, such as pollution and degradation of marine ecosystems due to frequent ecological disasters. The pro-





portion of good water quality in Bohai decreased from 95.7 to 78.3 percent, and the proportion of seriously polluted marine areas increased from 1.8 to 5.2 percent, from 2001 to 2015. These environmental investigations relied on ship-based sampling and later laboratory analysis, which far from meets the needs of marine ecological protection.

In order to timely monitor water quality and make effective decisions while providing long-term data to scientists, PLUO was designed with these main objectives: a life span of at least 15 years; obtaining real-time water quality monitoring data online 24/7/365, including sea temperature, salinity, pH, DO, turbidity, chlorophyll, nitrate, current and tide; providing early warning of regional marine biological and physical environmental events; providing data to verify regional marine model results on spatial and temporal distribution of ecological environments in Bohai; and obtaining data to assist in coastal marine and resource management policy development and decision making. PLUO is the first coastal cabled observatory supported by China's State Oceanic Ad-

ministration (SOA) and led by the National Ocean Technology Center (NOTC) in China for water quality monitoring and event early warning in the coastal zone of the Penglai Sea, located in the boundary area of the Bohai and Yellow Seas, between the maritime port zone and a tourist resort, 800 m offshore.

PLUO comprises a seafloor ring network composed of one shore station, 3-km cables, one bidirectional power supply and communication node, two observation sites in the ocean, and one data management and archiving system. PLUO was installed in June 2018 and is operated by the Yantai Marine Environment Monitoring Central Station, SOA.

System Architecture

Stable, real-time operation is the basic requirement of PLUO. A ring-network architecture was adopted, with redundant backup through a two-way power supply and communication node in the backbone network of two submarine cables.

The network node has two directions of power supply, and input and output are 375 V. Two-way communication and relay switches are within the node to ensure the management of the two-way power supply channel. This includes real-time monitoring of voltage, current, insulation, overvoltage, overcurrent, leakage, inclination, temperature, humidity and pressure.

In PLUO, each observation site has two sets of sensors to monitor CTD, pH, DO, turbidity, chlorophyll and nitrate. Some of them are COTS products, including LinkQuest ADCP, RBR tide gauge, Sea-Bird CTD, Satlantic nitrate sensor, YSI water quality instrument and Syscustom underwater camera. Other sensors are built in house by NOTC, including CTD, pH, DO, turbidity,

chlorophyll and nitrate sensors, plus the node and junction box.

Science Sensors

Science sensors on the PLUO observatory network total 10 instruments connected to two seabed observation sites extending almost 1 km offshore from the Penglai shore station at a depth of 15.7 m.

Sensors for long-term, stable underwater operation are one of the challenges for cabled observatories. In the process of sensor development, improvements have been made to adapt to long-term underwater work. For example, the SZF CTD adopts the principle of electromagnetic induction measurement. Temperature measurement accuracy is better than 0.01° , and conductivity measurement accuracy is better than 0.05 mS/cm. In addition, copper mesh and ultraviolet sterilizer are installed to inhibit biofouling. The pH and DO sensors have a measurement accuracy of ± 0.2 and ± 0.3 mg/L with automatic correction function. Another new ISFET pH sensor was developed at lower cost. Sensors for turbidity, chlorophyll and nitrate are optical, with the enhanced function of automatic cleaning for longer operational periods on the seabed. CTD and ADCP provide sustained basic background parameters for dynamic and biological process studies. The camera records biofouling of scientific instruments and marine life behavior.

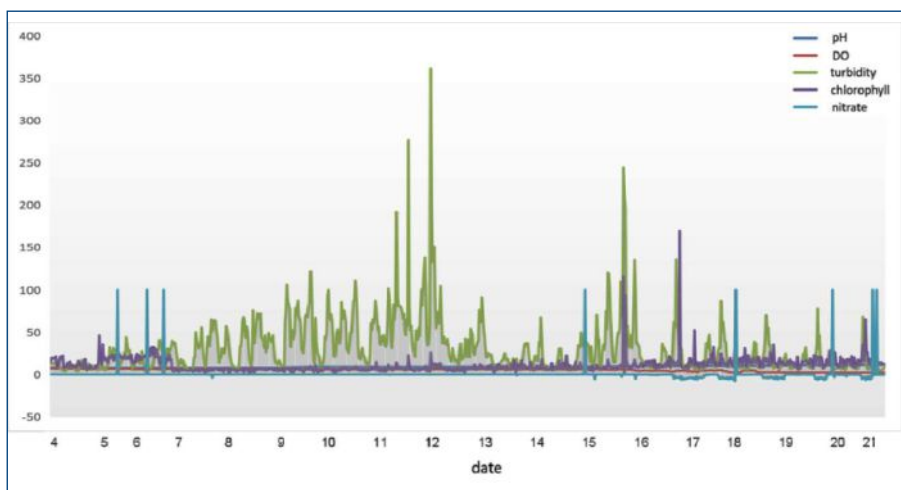
Cabled Infrastructure

Continuous power supply and communication and a high-pressure-resistant structure are key factors of a cabled observatory. PLUO selected 375-V DC power and 1-Gbps bandwidth from the shore station to supply the main network node on the seafloor via two electro-optical cables, which make up the ring backbone to improve the operational stability of the system. The main node provides 375-V power to the environmental observation sites, which is distributed by instrument nodes at suitable lower voltages, such as 12, 24 and 48 V, for the particular scientific sensors. The anti-trawl frames for the nodes are constructed to resist fishermen's activities.

The power system has a unipolar DC power supply mode. The anode is made of high-silicon-ferrochrome material with a cylindrical structure, which can avoid the end and neck effect of the electrode. The cathode uses a titanium plate as the substrate, and platinum is plated on the surface to enhance the corrosion resistance of the electrode.

The submarine cable was designed as a double-layer steel wire armored structure with eight-core optical fiber and one-core conduction to ensure that the submarine cable can withstand potential damage, e.g., from ship anchors, fishing trawls and strong current.

The mechanical part of the seabed node structure is composed of a sealed pressurization cabin and an un-



PLUO data chart on seawater quality parameters of pH, DO, turbidity, chlorophyll and nitrate.

derwater frame structure. The design of the sealed pressure hull and the underwater frame structure is the key point of the mechanical structure. The sealed pressurization unit adopts a cylindrical cabin structure, which is installed on the underwater platform. The cylinder seal is made of a cylindrical O-ring. The heat dissipation inside the cabin adopts a bulkhead-cooling mode to prevent failure of the electrical equipment in the cabin due to high temperatures. The underwater frame structure adopts a trapezoidal steel frame, with anti-overturning, anti-sinking, anti-towing and anti-corrosion features.

Data Management

The data management system accommodates the synchronous collection and storage of multisource heterogeneous data, including those from scientific instruments and system-monitoring sensors. It provides web-based data services, including real-time data display and query, data statistical analysis and visualization, underwater video viewing, etc. By configuring VLAN, sensitive underwater scientific instruments and their data acquisition servers are isolated from other parts of the network, and sensitive data are classified as second-class data, while nonsensitive data are classified as first-class data.

Depending on the particular deployment location, the data management system is composed of three subsystems: landing point, ocean station and National Central subsystem. Each subsystem includes several functional modules, which interface with each other. The landing point uses SQLite real-time database to save the environmental and engineering data, and the database logic table.

The GPS clock server is configured as the clock source to obtain the standard time. The times of the servers, switches and observation devices in the seafloor network are synchronized with the clock server. The network equipment obtains 10-ms synchronization precision by NTP protocol, while the serial scientific instruments obtain 1-sec. synchronization precision by timing instruction.

“PLUO provides scientists and government agencies with valuable real-time data to study both the spatial and temporal distribution of Bohai’s ecological environment and to help formulate effective policies for ecological and environmental protection.”

Installation/Deployment

In order to ensure smooth construction and deployment, NOTC organized several on-site coordination meetings with the Penglai municipal government, the Ocean and Fisheries Administration, the Maritime Administration and the Port and Navigation Administration before installation. Yantai Yin Hai Energy Co. Ltd. was responsible for the deployment.

Observatory installation occurred in June 2018 and lasted three days for cable laying, connection of cable and node, and scientific node deployment using three ships and one diver. The three ships were the four-point anchor navigation positioning ship *Changdian16*, the lifting equipment ship *Changdian7* and the diver special ship *Changdian1*. The diver completed the wet-mate connection of underwater cables and nodes after the node arrived on the seabed.

For chemical parameter sensors, on-site rapid replacement technology facilitates maintenance. With the ongoing continuous operation of the system, some new sensors will be mounted, and the scale of the system will be expanded with longer cables, more nodes and observation sites across the Bohai Strait.

Data

The PLUO observatory has been operating successfully since June 24, 2018 and has obtained more than 2 TB of scientific data. Comparison of data from the pH, DO, turbidity, chlorophyll and nitrate sensors was done by instrument and GB methods. Comparison of the SZF CTD and Sea-Bird CTD results showed strong data correlation (temperature $R=0.99996$, pressure $R=0.9984$, conductivity $R=0.6797$). The results showed that the changing trend of the average value was basically the same. The data for the dissolved oxygen, turbidity and nitrate sensor method and the national standard method were strongly correlated ($R > 0.5$). In contrast, the pH and DO data from the two methods were weakly correlated ($R=0.0095$); the reason is unclear, and the change range was small (measured range of seawater pH 7.95 to 8.25), or less than the accuracy of the sensor.

In addition, the ADCP and chemical sensors successfully recorded the corresponding changes between sea current and bottom chemical environment, and the underwater camera recorded the behavior of seafloor organisms.

Summary

PLUO is the first cabled operational observatory supported by SOA and led by NOTC in China, and jointly

supported by seven other partners. It was successfully installed in June 2018 in the boundary area of the Bohai and Yellow Seas of China. The observatory is run by Yantai Marine Environment Monitoring Central Station, SOA, and supported technically by NOTC. Obtaining funding for ongoing operation for its anticipated 15-year life span will be one of the next key tasks.

PLUO provides scientists and government agencies with valuable real-time data to study both the spatial and temporal distribution of Bohai’s ecological environment and to help formulate effective policies for ecological and environmental protection. It will provide long-term continuous dynamic and chemical data for sensing environmental threats and preventing or mitigating the effects of natural disasters, and for sustainable resource development to government, institutes and scientific agencies. PLUO data will play a key role in the management of marine environmental protection in the Bohai Sea, especially in addressing serious coastal pollution, degradation of the marine ecosystem and frequent marine ecological disasters, as well as advancing public policies.

Acknowledgments

Deep appreciation is given to professor Li Jiabiao, the director general of the Second Institute of Oceanography, and professor Christopher R. Barnes, former director of NEPTUNE Canada, University of Victoria, for their help with this article. Acknowledgment is also to given Chao Li, Yuze Song and Lei Yang, team members from NOTC, for the development of the system and Ping Xin, manager of Yin Hai Ltd., for the installation of the engineering infrastructure of cables and nodes for PLUO.

References

For a list of references, contact Yan Li at yanli885@tongji.edu.cn. **ST**

Yan Li is a Ph.D. candidate in geophysics at Tongji University, China. She was the vice director of the Department of Marine Strategy Research & Planning (2010 to 2018), National Ocean Technology Center, China. She joined NEPTUNE Canada (2012 to 2013) with DMAS team as a visiting scholar.

Xuye Luo received a master’s degree in marine environmental engineering from Ocean University of China in 2005. He was the director of the National Ocean Technology Center (2008 to 2017), China and continues his research on marine environmental monitoring technology in NOTC. He was previously the secretary of the National Marine Information Center (2004 to 2008), China.

Rui Zhu received a master’s degree on port coastal and offshore engineering from NOTC in 2010. He is a data collection and management engineer of ocean observation systems at NOTC.

NOIA Annual Meeting

The National Ocean Industries Association (NOIA) held its Annual Meeting in Washington, D.C., April 10 to 12, 2019 at the Ritz-Carlton. The meeting brought together more than 140 energy executives with policy makers and business and thought leaders.

Safety in Seas Awards

NOIA awarded its 2019 Safety in Seas Awards to Core Laboratories and Era Helicopters. Outgoing NOIA Chairman John Gellert presented the awards.

Core Laboratories received the Safety Practice Award for its Iron CoreHand Lifting Assist System. The system allows well-site crews to be entirely hands off during core tube handling operations. Since its implementation, the system has lowered lifting injuries, hand injuries and dropped core tubes to zero. Core Laboratories Vice President Evelyn Medvin and Manager of Field Operations Jason Ashby accepted the award.

Era Helicopters won the Culture of Safety Award. Era Helicopters instituted a robust safety culture that resulted in a drop in the company's total recordable incident rate from 1.78 to zero, and a reduction in lost-time injury cases from 0.78 to zero, within the last five years. Era Helicopters President and CEO Chris Bradshaw accepted the award.

Compass Publications Inc., publisher of *Sea Technology*, sponsors the Safety in Seas awards.

Congressional, Administration and Other Policy Makers

During the Safety in Seas lunch, U.S. Coast Guard (USCG) Vice Commandant Admiral Charles W. Ray



(From left to right) John Gellert, CEO of SEACOR Marine and outgoing NOIA Chairman; Chris Bradshaw, president and CEO, Era Helicopters; Bud Danenberger, offshore industry safety consultant; Evelyn Medvin, vice president, Core Laboratories; Jason Ashby, manager of field operations, Core Laboratories; U.S. Coast Guard Vice Commandant Admiral Charles W. Ray.

gave a sweeping overview of everything the USCG does to keep Americans safe. Ray also discussed priorities for the USCG, from recruiting under-represented groups to strengthening cybersecurity; it will be a busy few years for the Coast Guard. Ray also praised the offshore industry's response to the last few hurricane seasons. There were zero offshore injuries and zero spilled oil from offshore production during the last few hurricane seasons.

NOIA gave a rousing welcome to Rep. Dan Crenshaw (R-Texas). The Republican freshman talked about his life as a Navy SEAL and as a sixth-generation Texan who

has family in the energy industry. Despite the partisan climate in Washington, D.C., Crenshaw discussed his optimism for Congress in the next two years. While there will always be policy disagreement between Republicans and Democrats, the Congressman is hopeful that there is enough common ground to begin to legislate meaningful change for Americans.

Newly confirmed Environmental Protection Agency (EPA) Administrator Andrew Wheeler joined NOIA for a wide-ranging talk that repeatedly underscored the U.S. ability to produce energy under the strongest environmental regulatory regime in the world. Wheeler's work at the agency in the coming months is cut out for him, as EPA works to ensure that regulations are written in the clearest and most concise manner and that state actions comply with the intent of the law.

U.S. Department of the Interior Assistant Secretary for Lands and Minerals Management Joe Balash gave a

“One of the most memorable speakers in NOIA meeting history was former astronaut Captain Scott Kelly. Accompanied by a spectacular slide show of photographs from his time in space, Kelly gave an inspiring message of leadership, grit and accountability.”

timely update of Interior’s priorities, speaking as the Senate voted to confirm David Bernhardt as the next Interior secretary. Balash discussed how Interior, under the leadership of Bernhardt, will continue to successfully balance energy and natural resources production with environmental stewardship and protection. Balash provided a status update on offshore policies, including the Five-Year Program, Atlantic seismic permits and other key policies.

NOIA also welcomed back Bureau of Safety and Environmental Enforcement (BSEE) Director Scott Angelle, who shared his goals for BSEE. Offshore energy is becoming a globally competitive industry, and if the U.S. is to remain the global leader in production and in safety and environmental standards, BSEE will need a new era of management. Angelle said that it is imperative that BSEE build partnerships with every type of stakeholder, including energy producers, coastal residents and environmental groups.

U.S. Energy Information Administration (EIA) Deputy Administrator Stephen Nalley discussed the EIA’s recently released Annual Energy Outlook. The report includes several energy production and consumption models that track what the U.S. energy portfolio will look like in 2050. While the models cannot take into account policy changes or technological advances, Nalley stressed that energy demand, particularly oil and natural gas demand, will grow in the coming decades.

Discussing state-level politics, Louisiana Attorney General and President of the National Association of Attorneys General Jeff Landry shared insight into how attorneys general can both encourage and discourage regulatory over-reach. Landry also discussed his time in the House of Representatives and the time he spent advocating for offshore access and development to other members of Congress.

Thought Leaders and Business Executives

As always, NOIA brought a strong stable of thought and business leaders and industry executives to the meeting sessions. One of the most memorable speakers in NOIA meeting history was former astronaut Captain Scott Kelly. Accompanied by a spectacular slide show of photographs from his time in space, Kelly gave an inspiring message of leadership, grit and accountability.

Kristian Johansen, CEO of TGS, gave a much-anticipated outlook of the geophysical industry. While the number of seismic companies is near an all-time low and exploration spending is at a record low, rising energy demand hopefully means the worst is over. Johansen also updated NOIA members on the status of U.S. seismic

permits in the Atlantic. This has been a major area of concern for the seismic industry, as the federal government is still delaying the issuance of seismic permits and environmental groups have already filed lawsuits to block exploration.

For some offshore service companies, offshore wind development has been a financial bright spot. Avangrid Renewables Vice President of Offshore Wind Alejandro de Hoz updated NOIA members on the state of the U.S. offshore wind industry and shared insight on when and where the Bureau of Ocean Energy Management (BOEM) expects new offshore wind projects will come online. Using Avangrid’s U.S. portfolio as an example, de Hoz gave NOIA members a case study in the regulatory and operational timelines for offshore wind projects.

NOIA members also heard from American Blockchain Council Executive Director Jack Shaw, who discussed how blockchain will revolutionize the energy industry. Using real-world examples, Shaw showed how blockchain technology is increasing security and improving supply chain transparency for almost every industry. For the oil and gas industry, Shaw described how the Oil & Gas Blockchain Consortium is finding new ways to improve supply chain logistics, develop living contracts, improve capital projects, help with joint-venture data and provide cybersecurity solutions for new AI and digital-based equipment.

One of the most topical sessions during the Annual Meeting featured U.S. Chamber of Commerce Senior Vice President of International Policy John G. Murphy, who tackled U.S. tariffs and trade. Murphy discussed how trade conflicts, namely between the U.S. and China, are slowing down global trade growth. Murphy also gave a detailed look at Section 232 and Section 301 tariffs and shared his expectations for trade resolutions between the U.S. and other countries in the near future.

Finally, David Huber, senior vice president of business development for Ocean Minerals LLC, talked about the growing industry of deep-sea mining.

The world is becoming “tech heavy” and more dependent on rare minerals such as cobalt, magnesium and scandium. A former deepwater engineer for Exxon and founder of Deep Gulf Energy, Huber showed how the principles of deep-sea oil and gas production can be used for ethical mineral extraction to meet growing global demand.

Next Meeting

The next full NOIA gathering will be the Fall Meeting that will take place October 9 to 11, 2019 at The Broadmoor in Colorado Springs, Colorado. **ST**

international

FarSounder Receives Japanese Patent

FarSounder, a creator of 3D forward-looking sonar, received its fifth patent, issued by the Japanese Patent Office, one of the largest in the world. The patent relates to the company's invention of integrated sonar devices that integrate forward-looking sensors with down-looking echosounders, side scan sonar or both. It includes a forward-looking sonar device that operates in an integrated fashion with one or more sonar devices. It is FarSounder's first patent issued in Japan.

V.Group Pushes for Proactive Approach to 2020

Vessel management and support services provider V.Group is urging shipowners and operators to take a proactive approach to compliance with the 2020 IMO fuel sulphur rules. It is predicted that most ships will burn ultralow sulphur fuel oils (ULSFOs) to comply with the sulphur cap legislation, switching from high-sulphur fuel oil (HFO) to ULSFOs with a sulphur content at, or below, 0.50 percent, unless equipped with scrubbers.

With less than nine months before the 2020 rule goes into effect, growing numbers of shipowners and operators are developing ship implementation plans (SIPs) to mitigate risks and minimize disruption, a trend V.Group says it supports.

Fleet Data IoT Service Launched

Inmarsat and NAPA, a provider of maritime software, services and data analysis, have signed an agreement to enable shipowners and managers to access and analyze real-time onboard data efficiently through a dedicated application hosted on Inmarsat's Fleet Data IoT service.

Developed by Inmarsat and Danelec Marine, and made commercially available earlier this year, Fleet Data collects data from onboard sensors and pre-processes and uploads the data to a central cloud database equipped with a dashboard and an API. NAPA will then use this data to offer services for vessel performance monitoring, analytics and optimization.

Modular and Hybrid Scrubber Systems Available

Unique Group has become a major shareholder in Kamelia Cleantech to offer end-to-end integrated scrubber solutions for removing sulphur dioxide from vessel exhausts for the global shipping industry. Kamelia Cleantech will combine its technical knowledge with Unique Group's global presence to provide scrubber systems that are modular and offered as open-loop, hybrid and hybrid ready.

Cooperation Yields Integrated Engine Monitoring

WinGD and ExxonMobil have announced a new collaboration that will see WinGD's Integrated Digital Expert (WiDE) predictive maintenance technology join forces with the Mobil Serv Cylinder Condition Monitor-

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- **Infrared analysis of CO₂ concentrations.**
- **Automatic calibration.**
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- **Integrated GPS location and atmospheric conditions.**
- **Satellite data transmission.**

<http://generaloceanics.com/home.php?cat=69>

General Oceanics Inc.

1295 N.W. 163 St., Miami, FL 33169
Tel: (305) 621-2882, Fax: (305) 621-1710
E-mail: Sales@GeneralOceanics.com
<http://www.GeneralOceanics.com>

ing service. The agreement will provide vessel operators a range of performance benefits during a period of unprecedented change in the lead up to the IMO's 2020 sulphur cap rule.

WAM-V Marine Robotics Enter Australia

Blue Zone Group will be the exclusive distributor of the Marine Advanced Robotics WAM-V product line in Australia. BlueZone Group has been a supplier of sub-sea equipment and systems to industry, science and academia for more than 40 years and has introduced a number of innovative technologies to the Australian market in support of maritime unmanned systems for customers in defense, offshore oil and gas and oceanographic science.

Marine Advanced Robotics is a provider of unmanned and autonomous ocean robots and the designer and manufacturer of the WAM-V, a vessel technology designed to provide stability, portability and scalability.

Hydro Group Partners with Japanese Company

International underwater connectivity manufacturer Hydro Group established a new partnership with Japanese electrical and optical products company Riken Dengu Seizo Co. Ltd. The Tokyo-headquartered firm will be the official distributor and business partner for Hydro Group's subsea connectivity product range, including subsea electrical/optical cables and connection assemblies, in the Japanese market.

Riken Dengu Seizo caters to the defense and aerospace sectors.

Global Shipping Groups Increase Cooperation

The International Chamber of Shipping (ICS), the Asian Shipowners' Association (ASA) and the European Community Shipowners' Associations (ECSA) signed a joint memorandum of understanding that codifies the level of cooperation that currently exists between the international trade associations and provides a framework for closer cooperation. The three associations represent more than 90 percent of the world merchant fleet.

New Engine Simulator at Indian Training Center

Kongsberg Digital has completed the delivery, installation, site acceptance test and handover of a K-Sim Full Mission Engine Simulator to the Institute of Marine Engineers (IMEI) in India. The simulator was installed in IMEI's head office and training center in Mumbai, India, in February to prepare post-sea marine engineers for their certificate of competency examination, conducted by India's Directorate General of Shipping.

DeepOcean Celebrates 20th Anniversary

Established as DeepOcean AS in Haugesund, Norway, in 1999, DeepOcean has since expanded globally, serving all major oil and gas and offshore energy markets, with its main operations based in the North Sea, Africa and the Americas, and new corporate headquarters in Oslo, Norway.

Since 2016, it has been owned by Triton. It acquired Searov in 2017 and Delta Subsea in 2018. **ST**



International Federation of Hydrographic Societies

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Newport, Oregon, Named Coast Guard City

The city of Newport, Oregon, has been designated as a Coast Guard City for its support of more than 100 U.S. Coast Guard (USCG) active-duty and retired members. The Coast Guard City designation remains effective for five years. After that time, the city must provide an updated package for recertification describing its ongoing relationship with the USCG, including examples of recent programs and projects.

Ashtead Acquires Aqua-Tech

Ashtead Technology has acquired Louisiana-based subsea equipment rental and cutting services specialist, Aqua-Tech Solutions, as part of the company's international growth plans in the U.S. The combined business will see clients in the Gulf of Mexico region benefit from an enhanced offering, allowing more timely and cost-effective access to the group's range of equipment and services from locations in Broussard and Houma, Louisiana. The acquisition significantly strengthens Ashtead Technology's ROV and mechanical tooling offering.

Mitcham Industries Opens Second Office in Texas

Mitcham Industries Inc. has relocated its corporate headquarters to The Woodlands, Texas, from Huntsville, Texas.

Mitcham's existing phone numbers and email addresses remain unchanged.

Operations have been expanded at the company's Huntsville facility to support equipment leasing and marine technology products.

Energy Harvesting Instrument Demo Successful

Seatrec Inc. recently demonstrated that instruments used for ocean exploration can be improved by pairing them with the SL1 thermal engine, which harvests energy from temperature differentials in the ocean and converts it to stored electrical energy for future use. The demonstration connected SL1 with a Sea-Bird Scientific Navis float. The combined Navis-SL1 float completed 42 profiles to depths ranging from 50 to 750 m in the ocean northwest of Kailua, Hawaii. The field effort was successful in confirming the ability of the combined Navis-SL1 float to operate autonomously.

US Coast Guard Uses Drones to Inspect Navigation Structures

The U.S. Coast Guard (USCG) Civil Engineering Unit (CEU) in Providence, Rhode Island, recently used an unmanned aerial system (UAS) to monitor the construction of steel structures being built as aids to navigation. The UAS was launched from a boat assigned to the USCGC *Bollard*.

The structures serve as markers at Housatonic River, Black Rock and Duck Island, according to AUVSI (the Association for Unmanned Vehicle Systems International), who reported the use of UAS by USCG.

Contributions to American Exports Awarded

WFN Strategies was selected to receive this year's President's "E" Award for Export. The award recognizes fewer than 50 firms nationally that have made significant contributions to the increase of American exports. WFN Strategies announced the award at the SubOptic 2019 event and formally accepted the award at a ceremony in May.

Electric Submersible Pump Company Reaches Milestone of 250 Systems Installed

Borets, a company involved in engineering, manufacturing, sales and service of electric submersible pump (ESP) systems, successfully installed its 250th permanent magnet motor (PMM) ESP system in the U.S.

Used in conjunction with the dually compatible (PM and IM) Axiom II variable-frequency drive, Borets PMMs can reduce ESP power consumption by up to 20 percent. Permanent magnet motors experience lower heat rise than induction motors, which benefits motor reliability and longevity. Higher rotor horsepower density means the PMMs support deeper pump setting depth capabilities.

City Governments Purchase Dredge Systems

The City of Whiting, Indiana, and the Illinois Department of Natural Resources (IDNR) purchased Ellicott Dredge Technologies (EDT) 2019 IMS Model 5012 LP Versi-Dredge systems to complete dredging projects at their boat ramps, marinas, channels and harbors. The dredge is 42 ft. long and 11 ft. wide, so it is small enough to easily store and use. It floats on two pontoons, has a draft of 30 in. and can dredge to 28 ft.

Opsealog and FUELTRAX Now Compatible

FUELTRAX, a pioneer in electronic fuel monitoring systems (EFMS), has made formal its compatibility with data integration service provider Opsealog. FUELTRAX is a marine fuel management solution that protects assets and ensures security of fuel, compliance and optimized vessel performance. Opsealog integrates with FUELTRAX data and generates analysis and controls for upstream level management. Opsealog and FUELTRAX currently work together on three vessels, and they plan to expand.

Chevron Purchases Anadarko Shares

Chevron Corp. entered into a definitive agreement with Anadarko Petroleum Corp. to acquire all of the outstanding shares of Anadarko in a stock and cash transaction valued at \$33 billion, or \$65 per share. Anadarko shareholders will receive 0.3869 shares of Chevron and \$16.25 in cash for each Anadarko share. The total enterprise value of the transaction is \$50 billion.

IMTRA Provides BCM Lighting In North America

IMTRA is now the exclusive North American distributor for BCM-Benedetti Lighting. The two companies will provide an expanded LED lighting offering to OEM boat builders in the U.S. and Canada.

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System to Increase Safety Around Niagara Falls

A system commissioned by Ontario Power Generation (OPG) and New York Power Authority (NYPA) will detect, track and identify boaters who venture into hazardous areas around the International Control Dam above Niagara Falls. Designed by Accipiter Radar, the system features active target detection with a 25-kW Furuno FAR2127BB radar. Combined with high-resolution video detection and audio alerting, the system will help authorities detect and track recreational boaters who venture into the hazardous conditions of the exclusion zones around the International Niagara Control Works.

New Vessels Join British Columbia Fleet

Two 81-m road ferries for Canadian operator BC Ferries have been launched at Damen Shipyards Galati and will enter service next year. The ferries were built to Damen's Road Ferry 8117E3 design after a multi-phased, international tender process. BC Ferries is undertaking a fleet renewal program for new vessels to operate in British Columbia on Canada's Pacific coast. The vessels will serve the Northern Gulf Islands off the coast of Vancouver, replacing vessels that are more than 50 years old.

NOAA Employs Aquaculture Protection Tech

McLane Research Labs' Imaging FlowCytobot (IFCB) is part of a NOAA Fisheries Saltonstall-Kennedy program to study rust tides of *Cochlodinium polykrikoides* and protect aquaculture. The IFCB will enable automated protection of juvenile shellfish that are vulnerable while growing within nursery systems. The project will develop a *C. polykrikoides* bloom-forecasting ability and establish automated, end-user customized notification networks for dissemination of HAB abundance estimates to regulators, farmers and other stakeholders.

Oceaneering Receives Subsea Construction Vessel

Oceaneering has taken delivery of the subsea construction support vessel *Ocean Evolution*. The vessel completed sea trials and received ABS and U.S. Coast Guard certifications and is currently in Port Fourchon, Louisiana, preparing for project work to begin this month. The *Ocean Evolution* is the most advanced U.S.-flagged, multiservice vessel (MSV) in the market. It has a 250-mT active heave compensated (AHC) crane, two work-class ROVs with AHC launch systems, survey systems and subsea tooling for work in up to 4,000-m water depths.

New York Harbor's New Marina

An 8-acre marina, ONE°15 Brooklyn Marina, was built at the mouth of the East River, between Piers 4 and 5 at Brooklyn Bridge Park in New York. It is the first construction of its kind on the N.Y. Harbor in more than 50 years and cost more than \$28 million. ONE°15 is located between former shipping piers and is situated between two rivers and the Atlantic Ocean. The marina has wave attenuators comprised of deep-draft steel barges to reduce incoming waves. **ST**

Ocean Engineering

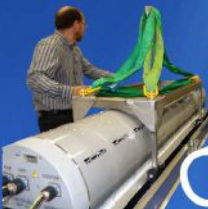


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marinerenewables

Lease Extension for EMEC Fall of Warness Tidal Site

Crown Estate Scotland has granted an extension to the European Marine Energy Centre's (EMEC) lease for the Fall of Warness tidal energy test site in Orkney until 2040. The extension will support the long-term ambitions and demonstration plans of EMEC's clients.

EMEC's Fall of Warness site offers developers of tidal energy technologies eight grid-connected test berths ranging from 12 to 50 m in depth.

Fugro Work Extension For Dutch Wind Farm

Fugro has been awarded a further substantial marine site characterization project off the Dutch Coast. This is the largest geotechnical site characterization program tendered by the Netherlands Enterprise Agency and will be performed in the Hollandse Kust (west) Wind Farm Zone.

Other contracts executed by Fugro in the various zones of Hollandse Kust and Borssele wind energy developments since 2015 include geophysical and geotechnical data acquisition and metocean monitoring.

The target start date was in April. The geotechnical program will continue until September and comprises a seabed investigation and borehole drilling. Fugro will also deliver laboratory testing and an integrated geological/geotechnical soil model for future developers of the wind farm to prepare their bids.

The fieldwork will utilize Fugro vessels and SEACALF MkIV system for seabed cone penetration testing.

The Hollandse Kust (west) Wind Farm Zone has a total capacity of 1,400 MW.

Auxiliary Wind Power

Norsepower Oy Ltd.'s Rotor Sail Solution has received the first-ever

type approval design certificate granted to an auxiliary wind propulsion system on board a commercial ship. The type approval from DNV GL was issued in February after a design assessment of Norsepower's 30-by-5-m Rotor Sail. The landmark certification means that vessels operating the Rotor Sail Solution are technically capable of safely navigating "all operational and environmental situations."

Success for Alpha's First Year in Australia

One year after entering the Australian wind energy market, Alpha Offshore Service has successfully completed its first 10 projects in the area. Alpha expanded into the Australian market in February last year to support new and existing clients with operations in West Australia, South Australia and New South Wales. These campaigns have implemented wind turbine blade upgrades and carried out main component exchanges for a development that required the upgrade

NORBIT SUBSEA

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ULTRA COMPACT

The advertisement features a large, colorful 3D multibeam sonar scan of a seabed, showing a prominent, elongated, and textured underwater feature. The scan is color-coded, with blue representing deeper areas and yellow/orange representing shallower, more elevated areas. In the bottom right corner, there is an image of an open black equipment case with the 'NORBIT' logo on the lid. Inside the case, various electronic components, cables, and a small white device are visible. The background of the entire advertisement is black.

of 26 gears. Australia's Clean Energy Council reported that 14.7 GW worth of large-scale wind and solar projects were either under construction or had reached financial closure by the end of 2018.

GreenSteam to Contribute to Maritime Zero Emissions

GreenSteam has joined Denmark's Green Ship of the Future (GSF). GreenSteam's ma-

chine-learning platform can make sense of the complex factors that impact vessel performance, help to build accurate performance models for a vessel, and highlight where inefficiencies lie. This technology will help support GSF's goal to explore the road toward zero-emission maritime transportation.

GreenSteam's machine-learning Discover service will be used as part of the GSF 2019 Retrofit project

to investigate the effects fuel-saving technologies have on vessel performance. The Discover service, which can be applied to all vessel types, will be used to build an accurate performance model of the project vessel and identify a wide range of opportunities to improve efficiency.

Discover will also highlight any changes to the vessel performance created by the introduction of the different technologies to the ship and remove "noise" by understanding external factors such as hull fouling, sea state and weather conditions.

Report Details Lessons From Minas Passage

Nova Scotia's efforts to explore the energy potential in the Minas Passage will benefit from the new report "Lessons Learned: Marine Operations in the Minas Passage," which documents the critical information learned from working in the challenging conditions among the world's most powerful tides.

Commissioned by the Offshore Energy Research Association through the Nova Scotia Department of Energy and Mines, the report enables marine operators, research scientists, vessel owners and the public to review lessons drawn from dealing with situations such as sensor platform deployments and recoveries, mooring trials, turbine operations, and diving and ROV activities.

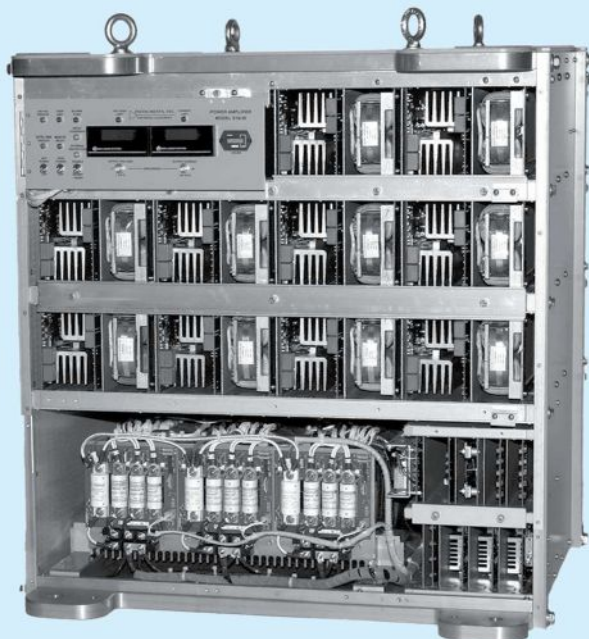
The report also looks at how the local supply chain has been involved in tidal energy activities.

Opening of Arkona Wind Farm in Germany

The Arkona offshore wind farm in the Baltic Sea in Mukran on the German island of Rügen is officially open. Arkona is operated by the Germany company E.ON in collaboration with Equinor. It has the capacity to supply renewable energy to 400,000 German homes. The wind farm started supplying power to the German national grid in September 2018, and its 60 wind turbines, each producing 6 MW, reached peak production in 2019. The farm's capacity is 385 MW. **ST**

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Teledyne Supports Nekton Seychelles Expedition

Teledyne Marine worked with the Nekton Deep Ocean Exploration as an official subsea technology partner through value-in-kind contribution of equipment, technology and support for Nekton's Seychelles expedition in March. The expedition was a major global scientific collaboration that aims to create a step-change in knowledge of the Indian Ocean and catalyze its sustainable governance.

The Seychelles covers an exclusive economic zone of 1.4 million sq. km.

The expedition was carried out in specific areas within the plateaus of designated outer islands with depths of up to 500 m.

Teledyne Marine provided: Teledyne RESON T50-P SeaBat multibeam echosounder; Teledyne RD Instruments ADCP Workhorse; two Teledyne software packages during and after the expedition; Teledyne PDS acquisition software and Teledyne CARIS HIPS and SIPS for post-processing of the hydrographic data; Teledyne Bowtech HD cameras and LED lights mounted on the manned submersibles and ROVs; and Teledyne SeaBotix ROV LBV300-5 Mini fitted with Teledyne BlueView high-resolution forward-looking sonar systems M900-2250.

Kongsberg Application Enables BV's First DP Digital Survey

Kongsberg Maritime, Bureau Veritas (BV) and BOURBON have announced the successful testing of a new solution for DP (dynamic positioning) system performance and redundancy audits—a first in the maritime industry.

Developed by Kongsberg Maritime in collaboration with BOURBON and BV's DP experts, the DP Digital Survey application runs on an industrial data management system that ensures unprecedented data consistency for the verification of installed systems. It acquires information directly from the DP sys-

tem and delivers it to auditors via a secure cloud infrastructure, allowing compulsory surveys to be conducted remotely.

The DP Digital Survey application offers a distinct advantage for vessel owners utilizing the remote survey tool to collect a comprehensive quantity of test execution and completion evidence.

MBES Hydrographic System For Island of Corsica

MacArtney France has delivered a portable multibeam echosounder (MBES) hydrographic system, designed for small vessels, to the French government organization Collectivité de Corse, in Corsica, France.

The Collectivité de Corse represents the interests of the community of Corsica, a Mediterranean island off the south coast of France. Large parts of the island are designated as the Parc Naturel Régional de Corse, not only to protect the natural landscape but the local population and cultural heritage of the region, too.

With 1,000 km of coastline, the island attracts many tourists and cruise ships, creating the need for an MBES hydrographic system small and versatile enough to be portable by road across the island to Corsica's many harbors.

The purpose of the MBES hydrographic system is to ensure visiting vessels can securely navigate the harbors of the island, monitor the seabed to control the quality of dredging, identify obstructions on the seafloor, and verify underwater installations.

MacArtney France worked with partners Kongsberg, Valeport and SBG Systems on this project.

The scope of supply included: Kongsberg Mesotech M3 sonar; Subsea SBG NavSight inertial navigation system; Valeport miniSVS; 4G modem for receiving RTK corrections; HYPACK software for acquisition and processing; pole for deployment; and on-site installation and training.

New Gyros as Pilot Aid for Largest Construction Vessel

Silicon Sensing Systems Ltd.'s latest inertial measurement technology has been used in AD Navigation AS's new pilot's aid, the ADX XR, to successfully guide the *Pioneering Spirit*, the world's largest construction vessel, into Maasvlakte in the Port of Rotterdam.

In the trials, precise movement data from Silicon Sensing's CRH02 all-silicon gyros allowed the ADX XR to deliver a highly accurate and detailed 3- to 5-min. ship course prediction to the pilot.

CRH02 is a compact, low-noise, single-axis gyroscope that performs similar to a fiber-optic gyro, but is more rugged, with a lower size and weight.

Following this successful performance, AD Navigation has placed a production order for CRH02 gyros with Silicon Sensing.

Sonardyne's SPRINT-Nav 700 For NOC's Under-ice AUV

The U.K. National Oceanography Centre (NOC) has selected high-performance hybrid navigation technology from Sonardyne International Ltd. for the next generation of its Autosub AUV, targeted for under-ice operations.

The NOC, based in Southampton, will incorporate Sonardyne's highest performing SPRINT-Nav inertial navigation system (INS) into the new 2,000-m depth-rated Autosub, which is being specifically developed for carrying high-performance sensors on the most demanding research missions under polar ice, hence its name Autosub-2KUI (A2KUI).

SPRINT-Nav combines Sonardyne's SPRINT INS sensor, Syrinx 600-kHz DVL and a high-accuracy intelligent pressure sensor into a single housing, making it one of the smallest combined inertial navigation instruments on the market.

The SPRINT-Nav 700, selected by the NOC, is equipped with the highest-performance available sensors, including Honeywell ring laser gyros and accelerometers, and has a conservative quoted accuracy of 0.04 percent 2dRMS. **ST**

productdevelopment

For more information on any of these products, visit our website at www.sea-technology.com/products

Stainless Steel Connectors

TrustLink (MS) series includes stainless steel power and signal connectivity solutions in three shell sizes ranging from four to 37 electrical contacts with male or female insert options within the same metal shell housing. MacArtney A/S.

UAV Inertial Navigation System

Quanta UAV is a low-power INS/GNSS that provides both real-time and post-processing. It has settings for two levels of accuracy and comes with a free year of Qinertia PPK software. SBG Systems S.A.S.

Upgraded Optical Sensors

Hyperion Turbidity is a standalone sensor with nephelometer and OBS readings with a minimum detection level of 0.03 NTU (nephelometer) that can measure turbidity up

to 6,000 NTU (OBS). The SWIFT-plus fluorometer measures chlorophyll-a, fluorescein, rhodamine or phycocyanin. Valeport Ltd.

Relative Positioning System

3D Recon delivers high-resolution, geospatially correct, 3D models of what is imaged subsea. It navigates in real time while building a 3D model, with precise navigation to 3 m, 2 m, 5 cm or 1 cm of any defined feature on a structure. Zupt LLC.

Multi-Range Pressure Calibrator

HPC50 offers scaling, percent error and flow calculations, as well as internal and external pressure modules in a single handheld unit. It works in pressures from vacuum to 15,000 psi with accuracy up to 0.035%. Ametek STC.

Unified Network Connection

Designed for Asian seas, Fusion-IP-LITE allows automatic switching between cellular and satcom networks to ensure consistent, stable connectivity with speeds of up to 40 mbps. The system offers automatic WAN switching, an email service, core firewalling, eNOAD and file management and synchronization. NSSGlobal Ltd.

Multipurpose USV Platform



Sounder USV System uses the K-MATE ASV control system, capable of following survey patterns, autonomously following AUVs, or tracking a mothership with autonomous, supervised and direct control options. It can be equipped with a wide selection of Simrad sensors. Kongsberg Maritime A/S.

Satellite Voice, Data Comms

Orion Edge+ offers flexible data plans for offshore support vessels, tugs and oil and gas contractors. It is powered by Thuraya's Orion IP broadband and Seastar circuit-switched voice terminal, along with consumption monitoring tools and controlled welfare applications. IEC Telecom Group.

Mirrorless Camera Housing

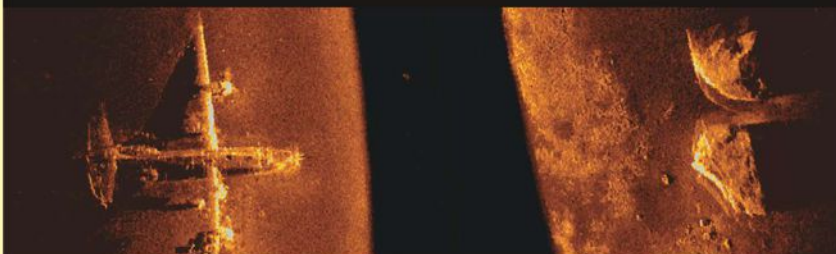
The FA6400 housing is specifically designed for the Sony a6400 mirrorless camera. It features an ergonomic design offering access to essential camera functions, with professional standards of functionality and durability. Fantasea Line.

Shallow Profiling Vehicle

Pawler collects and transmits sensor data from the surface to 500 m of the water column, traveling the mooring wire using wave-actuated motion. It was originally developed by NOAA's Pacific Marine Environ-

SONARWIZ7

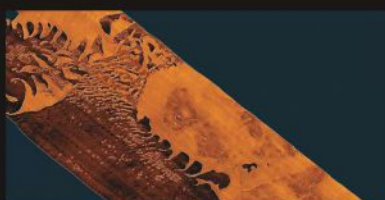
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mental Lab, with deployments including NASA projects to examine the salinity balance in the upper ocean. McLane Research Laboratories Inc.

Wireless Communication Node

LUMA 500ER combines wireless, high-speed and low-latency subsea data transfer. It can beam data at speeds up to 500 kb/s with a 120° angle over 50 m underwater. It has twice the bandwidth and 10 times the range of the previous version. Hydromea SA.

Low-Sulphur Fuel Lubricant

Shell Alexia 40 is a two-stroke engine cylinder oil for use with engines running on 0.5% sulphur content very-low-sulphur fuel oil (VLSFO). It is available for use in Singapore in June 2019 and will be introduced to other main supply ports such as the U.S., China, U.A.E. and the Netherlands before January 2020. Shell Marine Global.

ROV-Dedicated Steering Software



NaviSuite Mobula offers manual steering, video streaming and 3D data fusion, with multiple views with maps, imagery, sonar, laser, camera and other data, as well as a range of forward-looking sonar, multibeam sonar, cable/pipe tracker and LiDAR options. EIVA a/s.

Unmanned Launch & Recovery

The system can launch and recover craft ranging from large, remotely controlled RIBs to autonomous USVs in difficult sea conditions. It can be used with existing davits and has no need for special tools during launching or recovery. H Henriksen AS.

Miniature Accelerometers

Models J356A43/44/45 are small, 0.47-in., ground-isolated, triaxial cube accelerometers with TEDS

(transducer electronic data sheet), ideal for modal and structural analysis, electric automotive NVH and package testing. They are available in three ranges, 50/100/500 g, and greatly reduce signal noise. PCB Piezotronics Inc.

Simulator Training Software



VMAX is a 3D ROV simulation system for training and evaluation of ROV pilot skills such as tether management, manipulator control and tooling operation, has been updated to integrate with the next generation of eROVs. Forum Energy Technologies Inc.

Voyage Planning Platform

My Route Appraisal (MyRA) digital routing service provides vessels and onshore personnel with an automatically proposed ECDIS-ready voyage plan based on a route network, port databases, bathymetry from ENC's, weather forecasts and the ship model. ChartWorld GmbH.

Ultralow-Power Sensors

C-FLUOR submersible probes are single-wavelength in-situ sensors with a response time of less than 0.6 sec., for detecting in vivo chlorophyll, crude oil, dissolved organic material, blue/green algae, fluorescein and rhodamine dyes, optical brighteners and turbidity. Turner Designs Inc.

Fleet Security System

KeyWatcher Fleet software offers flexible booking workflows to balance usage, ensure vehicle availability, report problems, automatically initiate work on vehicles and generate reports. System alerts track unauthorized activity and expired licenses. KeyWatcher Fleet is networkable and offers API support. Morse Watchmans Inc. **ST**



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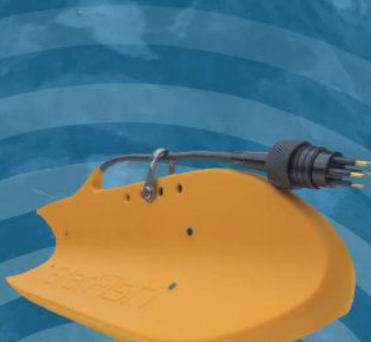
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MVP200 Selected for New Swedish Research Vessel

AML Oceanographic announced that a moving vessel profiler (MVP) is being installed on the Swedish newbuild RV *Svea*, owned by the Swedish University of Agricultural Sciences (SLU). It will be used by the university and the Swedish Meteorological and Hydrological Institute (SMHI) for environmental surveys, from monitoring ocean acidification to assessing fish stock.

The MVP will facilitate understanding of the oceanographic dynamics encountered in the Baltic Sea, such as strong halocline layers and anoxic waters. The MVP's high data density will improve data quality of hydroacoustic measurements and make SMHI's oceanographic models more accurate.

The MVP200 will collect CTD, dissolved oxygen and chlorophyll-a data continuously in real time.

Discovery of WWII-Era USS *Wasp* in Coral Sea

Another historic WWII aircraft carrier has been located thanks to efforts by the crew of Paul Allen's RV *Petrel*. The USS *Wasp* (CV-7) was located 4,200 m below the surface of the Coral Sea.

The *Wasp* played a pivotal role on multiple fronts during WWII. It was sunk on September 15, 1942 by four Japanese torpedoes from the Japanese submarine I-19 while escorting transports of reinforcements to Guadalcanal. Even after the torpedoes set the carrier ablaze, the men aboard showed a reluctance to leave until all remaining crewmates were safe, and only when assured the *Wasp* had been successfully abandoned did Captain Forrest P. Sherman leave the burning ship. One-hundred-and-seventy-six men of the 2,248 aboard perished in the attack.

Corals Around Equator More Bleaching Resilient

In theory, reefs in the warm waters near the equator would be at a higher risk of bleaching than their

more temperate counterparts because warmer waters encourage bleaching. But a new study by scientists at UC Santa Barbara and the Florida Institute of Technology has found, surprisingly, that corals in warmer latitudes appear more resilient to bleaching.

Corals host a symbiotic algae whose photosynthesis provides the animal with extra energy. However, when the coral is under stress, it often expels this colorful algae, revealing its white skeleton underneath in the bleaching process.

Kongsberg to Equip New Belgian RV

Kongsberg Maritime will deliver an integrated suite of subsea technology to a new Belgian research vessel. Already under construction at Freire Shipyard in Vigo, Spain, the advanced new replacement for the RV *Belgica* is due to be handed over to the Belgian Federal Science Policy Office (BELSPO) in October 2020.

Kongsberg Maritime's delivery for the new vessel is based on a substantial integrated subsea package, comprising scientific, hydrographic, geophysical, SSBL and GNSS positioning systems. Kongsberg will also deliver a full sensor integration solution in addition to various third-party systems.

Oil-Eating Bacteria Found In Deepest Ocean Trench

Scientists from the University of East Anglia have discovered a unique oil-eating bacteria in the deepest part of the Earth's oceans, the Marianas Trench, at about 11,000-m depth.

Together with researchers from China and Russia, they undertook the most comprehensive analysis of microbial populations in the Marianas Trench.

The team collected samples of the microbial population at this great depth and found that the proportion of hydrocarbon-degrading bacteria in the trench is the highest on Earth.

These hydrocarbons may help microbes survive the crushing pressure at the bottom of the Marianas Trench. They may also be acting as a food source for other microbes, which may also consume any pollutant hydrocarbons that happen to sink to the ocean floor.

New Deep-Sea Coral Species Found During US Expedition

DNA analysis has confirmed that Woods Hole Oceanographic Institution (WHOI) scientists and their collaborators at OceanX, the University of Connecticut (UConn) and NASA's Jet Propulsion Laboratory (JPL) discovered two new species of deep-sea corals during a September 2018 expedition in the Northeast Canyons and Seamounts National Monument, located about 100 mi. from the Northeast U.S. coast.

Utilizing OceanX's research and exploration vessel *Alucia*, the team explored and surveyed several of the unique deep-sea habitats in the monument, which includes three underwater canyons deeper than the Grand Canyon.

During the two-week expedition, the scientists collected a total of 29 coral samples in Lydonia Canyon at depths between 369 and 903 m using the submarine Nadir. These were the first human-occupied submersible dives in this canyon since 1982 and only the third deep-submergence mission to Lydonia Canyon.

The two likely new species found in Lydonia Canyon are bubblegum corals, not found in any neighboring canyons.

The researchers found at least 24 coral species and are discovering more through genetic analyses. In total, the team collected some 200 samples of corals, sponges and other marine life during the expedition's three submersible dives.

The team also tested a new universal barcode for invertebrates during the expedition.

Barcoding is a technique that uses a specific segment of an organism's DNA to identify different species at the genetic level, rather than by analyzing an organism's physical characteristics. **ST**

people

GreenSteam appointed **Jonas S. Fredriksen** as head of performance management. Fredriksen's background is in ship design consultancy, product innovation and business development as former head of future products at Odense Maritime Technology. He brings knowledge of naval architecture, strategic innovation and performance optimization.



Subsea 7's life-of-field business unit, i-Tech 7, has appointed a new regional director to strengthen the unit in the Asia-Pacific region. **Simon Hird** has more than 40 years of experience in the subsea oil and gas industry and has worked for major contractors in the construction and life-of-field sectors, including UTEC Survey.

BIRNS Inc. hired **Bruce Meredith** as its technical sales manager to be responsible for leading the sales team, overseeing global distributor and dealer networks and managing accounts for deep submergence connectors, cable assemblies and high-performance marine and nuclear lighting systems sales. Meredith worked previously at Custom Bilt Metals, Exceptional Solutions Group and Rapid Rack Industries.

The National Ocean Industries Association's board of directors has elected **Richard Clark** as chairman and **Galen Cobb** as vice chairman for the 2019 to 2020 term. Clark is the president of the Gulf of Mexico Business Unit for Kosmos Energy. Cobb is vice president of industry relations for Halliburton.

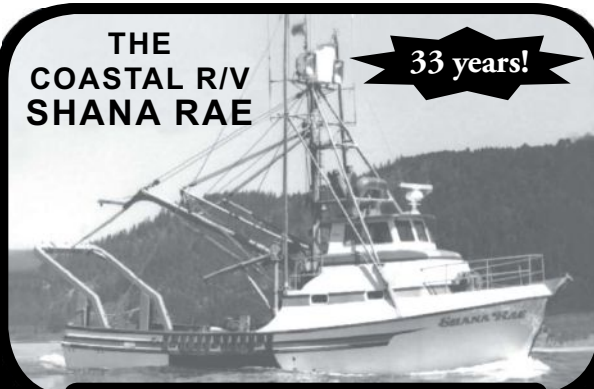
WFS Technologies appointed **Moray Melhuish** to the new role of commercial director. Melhuish was previously business development director at ROVOP, where he helped the business from one to more than 50 ROV systems and from six to more than 200 staff within six years.

Phoenix International promoted **Jon Regh** to area manager of its Houston, Texas, location, where he will be responsible for increasing market share and expanding into new markets. He is a certified project management professional and has worked on major deepwater projects around the world.

Dr. Jackie King is the 2019 Stockholm Water Prize Laureate for her contributions to advancing the scientific understanding of water flows, giving decision makers tools to assess the real costs and benefits of river system development. The prize is awarded by SIWI in cooperation with the Royal Swedish Academy of Sciences. **ST**

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Climate Change Affects Productivity of Fisheries

Fish provide a vital source of protein for more than half the world's population, with more than 56 million people employed by or subsisting on fisheries. But climate change is beginning to disrupt the complex, interconnected systems that underpin this major source of food.

A team of scientists led by Christopher Free, a postdoctoral scholar at UC Santa Barbara's Bren School of Environmental Science & Management, has studied how warming waters may affect the productivity of fisheries. The study looked at historical abundance data for 124 species in 38 regions, which represents roughly one-third of the reported global catch. The researchers compared this data to records of ocean temperature and found that 8 percent of populations were significantly negatively impacted by warming, while 4 percent saw positive impacts.

From 1930 to 2010, the researchers saw the greatest losses in productivity in the Sea of Japan, North Sea, Iberian Coastal, Kuroshio Current and Celtic-Biscay Shelf ecoregions. The greatest gains occurred in the Labrador-Newfoundland region, Baltic Sea, Indian Ocean and Northeastern United States.

New Partner for Kognifai Program

Met Office, the U.K.'s National Meteorological Service, has signed a partner agreement with Kongsberg Digital to offer meteorological and oceanographic data to customers, independent software developers and other users of the Kognifai ecosystem in the maritime market.

Both Met Office and Kongsberg Digital see an increasing demand for services involving environmental data.

Study Reveals Significant Seafood Fraud in US

Oceana has released the results of a new seafood fraud investigation, finding that one in every five

fish tested was mislabeled. The study tested seafood not included under the existing federal traceability program.

Oceana collected more than 400 samples from more than 250 locations in 24 states and the District of Columbia.

Last year, the federal government required traceability for seafood at risk of illegal fishing and seafood fraud. The Seafood Import Monitoring Program currently only applies to 13 types of imported fish and only traces them from the boat to the U.S. border.

The report finds: seafood was more frequently mislabeled at restaurants (26 percent) and smaller markets (24 percent) than at larger chain grocery stores (12 percent); of the species tested, sea bass and snapper had the highest rates of mislabeling (55 and 42 percent, respectively); and seafood substitutes identified include imported seafood sold as regional favorites, vulnerable species sold as more sustainable catch, and seafood sold with generic names like "sea bass" and "catfish" disguising lower-value species or masking health and conservation risks.

Japan Accedes to Ship Recycling Convention

Japan is the 10th country to become a party to the IMO's Hong Kong Convention, which covers the design, construction, operation and maintenance of ships, and preparation for ship recycling in order to facilitate safe and environmentally sound recycling, without compromising the safety and operational efficiency of ships.

Under the treaty, ships are required to carry an inventory of hazardous materials, specific to each ship.

Ship recycling yards are required to provide a ship recycling plan, specific to each individual ship to be recycled, specifying the manner in which each ship will be recycled, depending on its particulars and its inventory.

The Hong Kong Convention will enter into force 24 months after the following conditions are met: not less than 15 states are party; the combined merchant fleets of the parties constitute not less than 40 percent of the gross tonnage of the world's merchant shipping; and the combined maximum annual ship recycling volume of the parties during the preceding 10 years constitutes not less than 3 percent of the gross tonnage of the combined merchant shipping of the parties.

Worldwide Consumer Demand For Healthier Fish

The aquafeed and aquaculture additives market will be worth more than \$215 billion by 2024, according to a new report by Global Market Insights.

An overwhelming increase in lifestyle diseases such as diabetes, obesity and other cardiovascular ailments has prompted consumption of fish among a diverse set of populations in varied geographical regions. Fish are a rich source of omega-3 fatty acid and lean protein.

The consumer demand has boosted the frequency of fish harvesting around the world, and increasing health consciousness is spurring a demand for healthier aquafeed and aquaculture additives.

P8X Metal Detector For Underwater Search

Conventional marine propellers remain the standard propulsion instrument for ocean vessels, small to large boats, and underwater vehicles. The design process for propellers takes a lot of time and money.

When a propeller dislodges from a vessel and falls to the murky seafloor, usually, the operator contracts a diving company to aid in the search, using tools such as JW Fishers' Pulse 8X underwater metal detector. Recently, Marine Diving Service used the Pulse 8X to locate and retrieve an expensive propeller at the bottom of the Hudson River.

Another recent use of the Pulse 8X was by Underwater Resources Inc. in a project to locate embedded rebar in a shallow lagoon basin at a water park. **ST**

contracts

Kongsberg Maritime, Kongsberg, Norway, will deliver a Sounder USV system for a Peruvian fishing company to overhaul operations throughout its 48-vessel fleet. The system combines fishery sonar and a wideband Simrad echosounder for remote operations. TASA.

VT Halter Marine Inc., Pascagoula, Mississippi, is contracted for design and construction of polar security cutter (PSC) class vessels. The initial award supports procurement of long lead-time materials and construction of the first ship, with options for two additional vessels for a total contract value of \$1.9 billion. U.S. Coast Guard, U.S. Navy.

TechnipFMC, London, England, will supply flexible pipes for oil production, gas lift, gas injection and associated accessories to the Lapa Field in Brazil, which will be connected to the FPSO(2) Cidade de Caraguatatuba. Lapa Field Consortium.

Forum Energy Technologies, Houston, Texas, will supply three ultra-compact, 2,000-m-rated, 150-hp Perry XLX-C work-class ROVs to be deployed onto ROV support vessels for recently awarded projects in Brazil. The systems will be manufactured in Yorkshire and delivered this year. DOF Subsea.

Metal Shark, Jeanerette, Louisiana, will build the next generation of fire boats for a Florida fire department: the 50 Defiant X fireboat powered by twin inboard diesel engines that are mated to water jet propulsion units, with a projected top speed of more than 45 kt. Miami-Dade Fire Rescue Department.

Corvus Energy, Bergen, Norway, will supply a 550-kWh energy storage system (ESS) for a new all-electric skimmer workboat with solar panels on board. The ESS will allow the boat to be in full working mode for up to 5 hr. and provide insight for incorporation of ESS into future workboats. Port of Oslo.

ABB AS, Billingstad, Norway, secured an order covering power, automation, propulsion and digital systems for the second ice-going cruise ship to be built for Lindblad Expeditions for cruises to remote polar regions. Designed as a sister ship to *National Geographic Endurance*, the new ship is scheduled for completion in 2021. Ulstein Verft.

Fugro, Singapore, has been awarded a multimillion-dollar contract for an advanced ROV system that operates to 1,000-m depths. The system will be installed as part of the auxiliary submarine rescue vessel *ASR-II's* onboard submarine recovery system. Republic of Korea Navy.

Thordon Bearings, Burlington, Canada, has received a contract to supply six award-winning SeaThig-or shaft seals for retrofit installation to three purpose-built icebreakers: the 5,910-grt CCGS *Pierre Radisson* and sister ships CCGS *Amundsen* and CCGS *Des Groseilliers*. Canadian Coast Guard. **ST**

meetings

JULY

July 10-12—Offshore Energy and Storage Summit, Brest, France. rupp@uwindsor.ca or www.osesso.ciety.com/oses2019.

July 23-25—HydroVision International, Portland, Oregon. 918-831-9560, or www.hydroevent.com.

AUGUST

August 20-21—AUVSI Unmanned Systems, Washington, D.C. 571-858-4364 or ehallberg@auvsi.org.

SEPTEMBER

September 1-6—European Wave and Tidal Energy Conference, Naples, Italy. ewtec2019@ewtec.org or <https://ewtec.org>.

September 3-6—SPE Offshore Europe, Aberdeen, Scotland. www.offshore-europe.co.uk.

September 8-11—SMM Hamburg, Hamburg, Germany. +49-(0)40 3569-2445, nora.ebbinghaus@hamburg-messe.de or www.sm-m-hamburg.com.

September 9-13—London International Shipping Week, London, England. +44 1295 814455, sales@shippinginnovation.com or <http://londoninternationalshippingweek.com>.

September 13—Arctic Day, Washington, D.C. meetings@navalengineers.org or www.ArcticDay.org.

September 16-20—NMEA and RTCM Marine Electronics Conference and Expo, West Palm Beach, Florida. 410-975-9425, mreede@nmea.org or www.expo.nmea.org.

September 16-20—OceanObs'19, Honolulu, Hawaii. 202-448-1245, cyanoff@oceanleadership.org or www.oceanobs19.net.

OCTOBER

October 2-3—OilComm, Houston, Texas. 484-869-2378, dmuirhead@accessintel.com or www.oilcomm.com.

October 3-5—INMEX SMM India, Mumbai, India. nora.ebbinghaus@hamburg-messe.de or www.in-mex-smm-india.com.

October 6-9—Teledyne Marine Technology Workshop, San Diego, California. 508-563-1639, Margo.newcombe@teledyne.com or www.teledynemarine.com/tmtw2019.

October 7-9—Offshore Energy Exhibition & Conference, Amsterdam, Netherlands. +31 10 209 2600, marketing@offshore-energy.biz or www.offshore-energy.biz.

October 8-10—PACIFIC 2019, Sydney, Australia. +61 (0)3 5282 0500, expo@amda.com.au or www.pacificexpo.com.au.

For more industry meetings, visit sea-technology.com/meetings. **ST**

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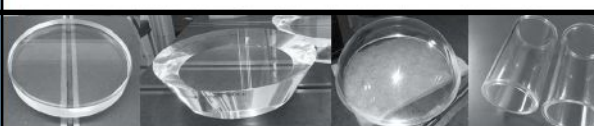


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Viviana Castillo received a B.S. in oceanography from the University of Washington. After a study-abroad program at the Queensland University of



Technology, she started learning about and working with autonomous systems. She currently holds a position at the Applied Physics Laboratory (APL) at the University of Washington as a research scientist/engineer, working with critical ocean technologies.

I moved to Seattle five years ago from eastern Washington. My family migrated from Mexico 22 years ago, fleeing poverty. Once in Washington, my family worked endlessly. I grew up in a single-parent home, raised by my older sister. I was a quiet kid. I read a lot. When I was 11, I told my mom that I was “out of there” right after high school. I decided I would do anything possible to make that happen.

I am the first in my family to attend college. Education was my way out and my way of providing for my family. I, like the many incredibly bright, relentless, inspiring students of color that I have the privilege of calling my classmates and friends at the University of Washington (UW), pushed through the barriers to learn how to navigate a large institution.

The challenge to fit in and feel like I deserved my place in this highly ranked university was nearly impossible to overcome. I didn’t have the support at home that other kids did when it comes to help with homework, applications or advanced classes.

I took charge of my education and enrolled in Running Start my junior year of high school. A counselor dissuaded me, saying classes could be too hard, or I might not have the \$5 to drive daily to the community college. It is encounters like this that deter students of color from challenging themselves fur-

ther. But I stuck it out and graduated with an even better G.P.A. from the community college than my first two years in high school.

I entered the university environment with this drive and work ethic. Undergrad was extremely difficult, from worrying about how I was going to pay for classes to learning how to study and feeling that I deserved to be there. For the first three years of undergrad, I suffered from imposter syndrome; overcommitted, sleeping 3 hr. a night and unable to shake the feeling of not belonging.

I did not get through high school and undergrad at UW on my own. The Advancement via Individual Determination program in high school encouraged me, and the College Assistant Migrant Program my freshman year of college pushed me. It was the small community of people of color at UW that inspired and convinced me that I had indeed earned my seat there and was not alone. It was the many nights at Latinx Student Union meetings where we would discuss our hardships with classes, with our peers and in this country that uplifted me and ultimately brought me to the Applied Physics Laboratory at UW (APL-UW).

I began working at APL-UW in October 2017, two months after finishing my undergraduate degree in oceanography. UW oceanographer Rick Rupan, whom I worked with, suggested I contact Sarah Webster at APL-UW, an independent department at UW that is a Navy-recognized University Affiliated Research Center, one of only five in the U.S. I met with Sarah and Pete Brodsky, autonomous underwater system engineers at APL-UW. They took a chance and offered me a position.

The first three months were grueling because I had little to no experience in the critical technologies of ocean engineering. However, I was able to focus my attention and

give it my all. It was thrilling and rewarding.

On my first day at work, Pete, my boss, showed me around. The first thing I noticed was a pair of old, cut-up denim behind wooden fish cutouts labeled “Donald Trump” and “Hillary Clinton.” There were shot glasses around the room. I eventually learned the shot glasses were for epoxying 3D-printed parts, the fish were for a previous project, and the denim was old pants and jackets cut up into rags.

This scene is partly why I was immediately drawn to APL-UW. I felt I could succeed in this light-hearted, flexible, yet rigorous environment. Without the remarkably bright APL-UW employees, I would not have learned as much as I did in such a short period of time.

In less than a year, I’ve had the opportunity to work with more technologies than I thought possible, including the Linux operating system, the Python programming language to write applications and Matlab to analyze data. I have learned communication protocols such as serial, Ethernet and I2C. I’ve developed interfaces to internal sensors and actuators. I’ve learned how to establish a reliable network time protocol and have worked with submersible Iridium-based remote autonomous locating beacons. I have wired and soldered boards for computers and have worked with high-bandwidth data links using fiber-optic cables, connectors and switches.

In August 2018, I went on a research cruise. It was a chance to live with my co-workers in a challenging, exciting, exhausting and richly rewarding environment. There’s nothing like eight days at sea to stress you out and help you get to know your colleagues and yourself better.

I hope to spend even more time at sea. Now, I know I belong and have earned my place, ready to embrace another challenge. **ST**

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