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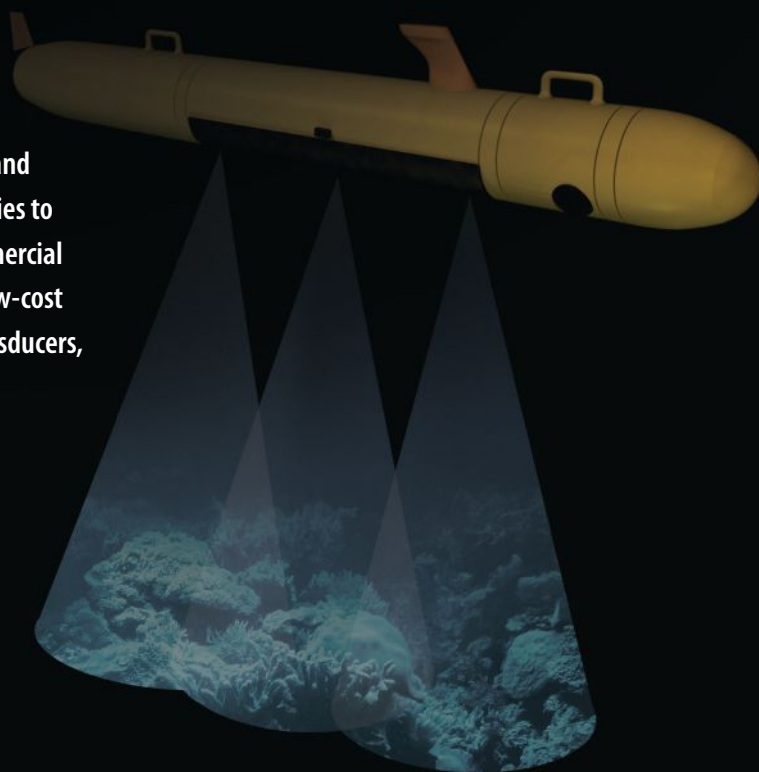
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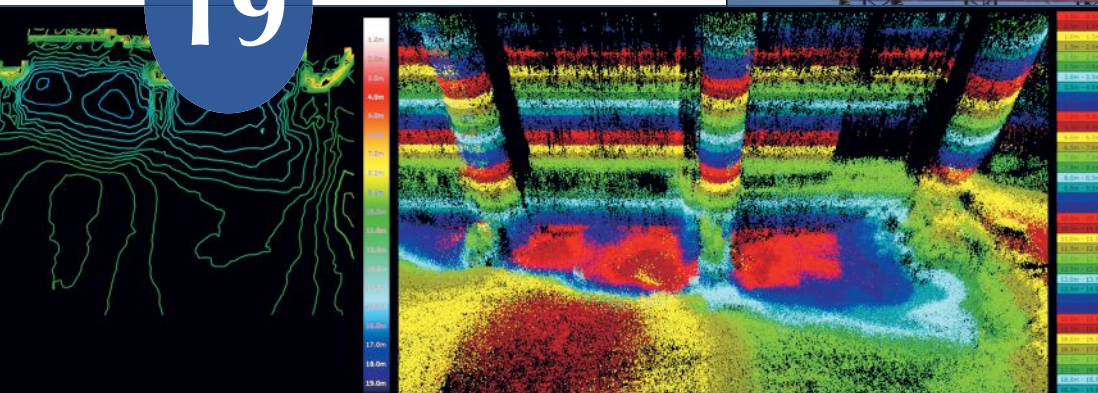
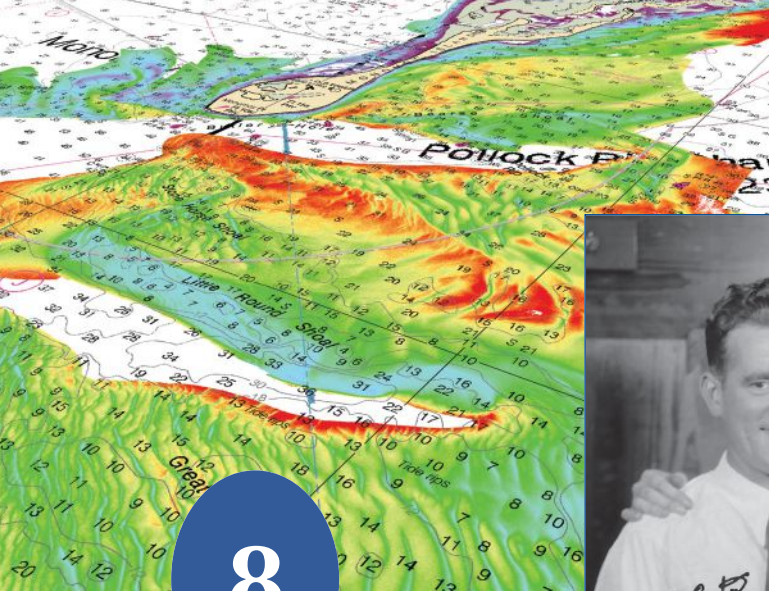
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COVER IMAGE

Imagery of Little Belt, Denmark, using Teledyne RESON SeaBat T50-R dual-head sonar integrated with Teledyne INS Type-30 and Teledyne PDS software, with Google Earth background. Data were captured in July 2020 during Teledyne Marine's semi-annual off-site R&D test campaign.

NEXT MONTH

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)) Report Shows Singapore as Maritime ‘Start-Up Magnet.’ A new study sponsored by Inmarsat offers a comprehensive overview of Singapore’s vibrant maritime start-up sector. The Trade 2.0 Singapore Maritime Start-up and Innovation Ecosystem Report, published through the Inmarsat Research Programme, is the second country-specific study of start-ups and their impact on maritime digitalization. It builds on a global Trade 2.0 report launched in 2019 and the Japan Trade 2.0 report published in April 2020. Once more, the report is authored by Leonardo Zangrando, founder of Startup Wharf, and Nick Chubb, managing director of maritime innovation consultancy Thetius. With one-quarter of the world’s goods passing through the Singapore Strait each year, the report identifies the island city-state as “the start-up magnet.” Singapore’s maritime IT market is forecast to generate US\$2.4 billion in 2021 and reach US\$4.8 billion by 2030. Two Singaporean accelerators are driving innovation for the shipping and offshore sectors. One is Pier 71, founded by the Maritime and Port Authority and NUS Enterprise, which has matched start-ups with backers including BP, Wilhelmsen, Pacific International Lines, Ocean Network Express, Cargotec, Wärtsilä, Vopak and Bernhard Schulte Shipmanagement. The other is the Techstars/Eastern Pacific Shipping MaritimeTech Accelerator that has provided a home to 18 emerging technology companies. The Trade 2.0 Singapore Maritime Startup and Innovation Ecosystem Report captures some rising start-up stars, with several showing how a start-up approach can bring or adapt solutions quickly to markets. To download the report, visit: www2.inmarsat.com/trade-2.0-singapore.

)) Funding to Industrialize Osmotic Energy Tech. Sweetch Energy, a European company that pioneers advanced nanotechnology and eco-material science to harness osmotic energy, has secured €5.2 million to initiate its industrialization phase and develop a first full-scale prototype. Osmotic energy represents a revolutionary addition to existing renewable energy technologies. Naturally available from the difference in the salt concentration when river freshwater meets seawater, osmotic power provides a nonintermittent and abundant source of clean energy. Unlike wind or solar energies, and similar to hydropower, it can deliver electricity continuously and is easily dispatchable to meet the grid baseload power requirements. Osmotic energy represents an estimated 27,000 TW-hr. liberated every year in deltas and estuaries around the world, which is equivalent to today’s global electricity demand, according to Sweetch Energy. Sweetch Energy’s system combines recent breakthroughs in nanofluidic sciences with low-cost eco-friendly materials to create next-generation membranes, coupled with specifically engineered electrodes and innovative cell designs. The technology can harness osmotic energy with an unprecedented level of cost-efficiency, opening the door to large-scale deployment of osmotic energy as a competitive market solution.

)) Winners of NOIA Safety in Seas Awards. GATE Energy and TechnipFMC are the winners of the 2021 NOIA (National Ocean Industries Association) Safety in Seas Awards competition. GATE Energy is the 2021 NOIA Safety in Seas Culture of Safety Award winner, and TechnipFMC is recognized for the 2021 NOIA Safety in Seas Safety Practice Award. The Culture of Safety Award honors overall organizational immersion in and commitment to safety, which has resulted in remarkable, measurable and sustained safety performance over a prolonged period of time. The Safety Practice Award recognizes specific technologies, approaches, methods or projects with direct and demonstrable impacts on improving safety. Compass Publications Inc., the publisher of *Sea Technology* magazine, established the NOIA Safety in Seas Award in 1978. The catalyst was a submersible accident in 1972 that took the lives of two divers from the Harbor Branch Oceanographic Institution. The tragedy illustrated the ever present threat to life and property as the ocean is explored and its resources are developed. The awards acknowledge the significant contributions made by modern-day pioneers in the ocean frontier.

)) Citizen Science Supports Coral Research via Video Game. Marine ecosystems are undergoing a conservation crisis, with coral reefs in particular facing numerous challenges as a result of climate change. To better understand these environments and the threats they face, researchers collect huge image libraries using 3D imagery collected from divers and snorkelers, as well as 2D images collected from satellites. These approaches provide researchers with huge amounts of data, but to extract value from these libraries requires a method to quickly analyze for patterns or classifications. In a new study in *Frontiers in Marine Science*, researchers at NASA’s Ames Research Center’s Laboratory for Advanced Sensing automated this process through the use of an artificial intelligence (AI) tool called a convolutional neural network (CNN). CNNs, loosely based on biological neurons and brains, are used to analyze images and look for features, such as different coral species on a reef or fish swimming through an underwater scene, as well as where these features are in relation to everything else in the image. Vast amounts of 3D coral reef imagery need to be classified to visualize how coral reef ecosystems are faring over time. CNNs require lots of training data to function correctly, so it was vital to build a large database to train the CNN on how to classify these complex 3D images of reefs. Researchers used a video game called NeMO-Net (<http://nemonet.info>) to harness the power of citizen scientists to generate training data sets. As players explore virtual underwater worlds, they can learn about and classify coral species, and their classification labels are then used to train NeMO-Net’s CNN. To date, the game has reached over 300 million people in less than a year since its release. **ST**

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The Pursuit of a Complete Map of the Ocean Floor

Now in its fourth year, The Nippon Foundation-GEBCO Seabed 2030 Project is the accelerator in the initiative to deliver the definitive and complete map of the world's ocean. When Seabed 2030 was launched by Yohei Sasakawa, chairman of The Nippon Foundation, at the UN Ocean Conference in 2017, only 6 percent of the world's ocean floor had been mapped to an adequate resolution. Today, that figure stands at 19 percent—just under a fifth of the world's entire seabed.

Seabed 2030 is a collaboration between The Nippon Foundation, Japan's largest private philanthropic organization, and the General Bathymetric Chart of the Oceans (GEBCO). GEBCO, operating under the auspices of the International Hydrographic Organization and the Intergovernmental Oceanographic Commission of UNESCO, has more than a century of experience in ocean-floor mapping and is the only intergovernmental organization with a mandate to map the entire ocean floor. The project's mission is to compile all existing bathymetric data into the freely available GEBCO digital map and identify areas for which no data exist to inform future mapping expeditions. This ambitious initiative is driven by a strong motivation to empower the world to make policy decisions, use the ocean sustainably and undertake scientific research based on detailed bathymetric information of the Earth's seafloor.

It is clear—especially while acknowledging that the ocean covers more than 70 percent of the Earth's surface—that there is an increasingly urgent need for a complete bathymetric map. A complete map will enable us to tackle pressing challenges of our time, including globalization and how it has led to exponential growth in ocean business. Such valuable data will support our efforts to ensure marine resources are used sustainably and that coastal communities are protected. Underwater topography is also fundamental to the circulation of ocean currents and associated effects on climate change, weather systems, tides, and tsunami wave propagation. Seabed mapping is vital for the security, safety and economic health not only of nation states but, most importantly, for the benefit of humanity. To this end, Seabed 2030 supports the UN's Sustainable Development Goal 14: to "conserve and sustainably use the oceans, seas and marine resources for sustainable development."

Crucial to the success of Seabed 2030 are its valuable partnerships with organizations, across all sectors of society, which play a key role in the pursuit of bathymetric data. Since its launch, the effort to complete the map of the world's ocean has gathered significant momentum, and Seabed 2030 has formed over 150 partnerships to date. The project actively continues to seek further collaborations. Seabed 2030 comprises four Regional Centers and a Global Center. The Regional Centers are responsible for championing mapping activities, assembling and compiling bathymetric information, and collaborating with existing mapping initiatives in their regions. These cover the Southern Ocean, the Arctic and North Pacific Oceans, the Atlantic and Indian Oceans, and the South and West Pacific Ocean. The Regional Centers feed data products into the Global Center, which is responsible for producing and delivering centralized GEBCO products, such as bathymetric grids.

The race is on to map the remaining 80 percent of the ocean as Seabed 2030 enters its final decade, coinciding with the UN Decade of Ocean Science, which recognizes Seabed 2030 as an important initiative. On January 1, 2021, the Schmidt Ocean Institute—a Seabed 2030 partner—collected the first public seafloor data of the new year and the UN Decade. This is a testament to how the project intends to use the time left to produce the definitive map of the seabed. **ST**

AI Expands Reach of SDB

Machine Learning, ICESat-2 Enhance Satellite-Derived Bathymetry

By Kyle Goodrich • Ross Smith

Satellite-derived bathymetry (SDB) technology has been improved and applied more substantially in the past three years than in the previous two decades, primarily due to increasingly accessible machine learning algorithms, scalable computing power, a multitude of satellites orbiting the Earth, and a new source of validation data. Today, SDB is applicable in water conditions and geographic areas once considered entirely unsuitable for the technology.

Credit for these recent advancements must also be attributed to funding by the U.S. government. In 2018, the National Science Foundation (NSF) awarded a Small Business Innovation Research (SBIR) grant to TCarta Marine of Denver, Colorado, to initiate Project Trident (Sea

Technology, June 2020). Its goal was to leverage machine learning to expand SDB beyond clear, calm waters into more dynamic, turbid coastal environments.

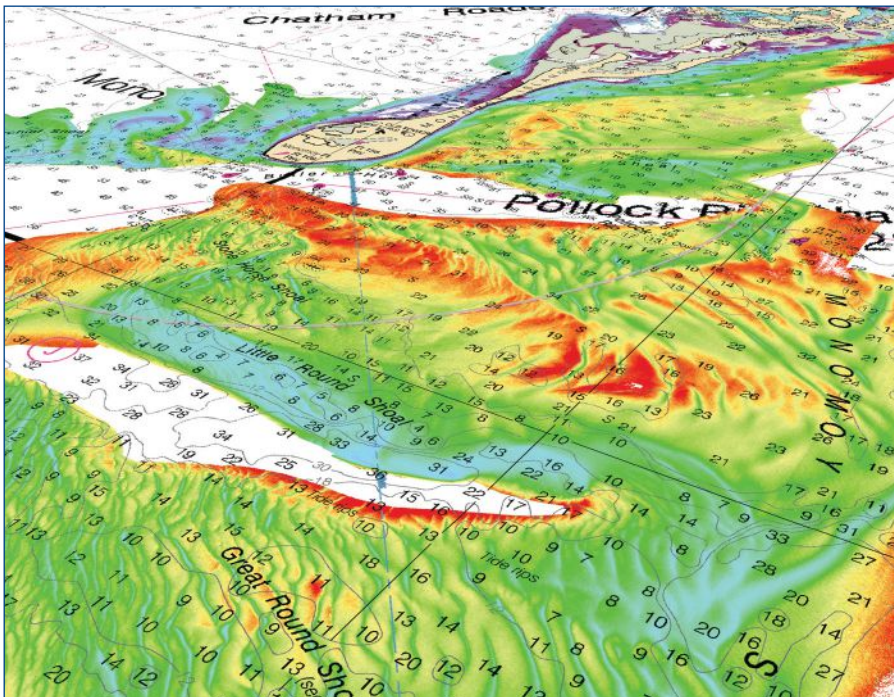
As several key components of the research came to fruition, TCarta set its sights on Alaska. SDB had rarely been applied successfully in this state due to a combination of factors, of which water clarity is just one. NOAA awarded SBIR grants to TCarta in 2020 and 2021 to adapt and modernize SDB techniques and incorporate new sensor capabilities for Alaska and the Arctic region.

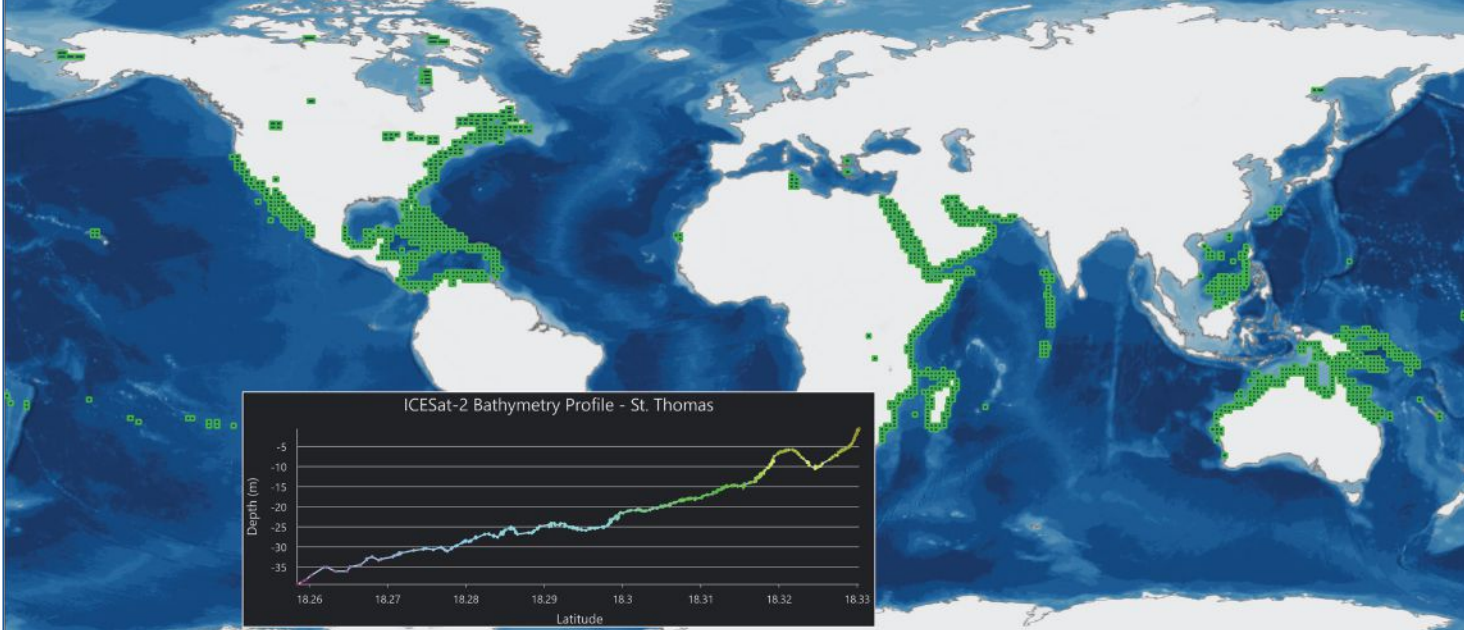
This article describes the latest progress from Project Trident and the current state of play for SDB in northern latitudes.

What is SDB?

SDB technology extracts water depth measurements from satellite imagery at lower cost and with fewer restrictions than ship-borne sonar or airborne LiDAR. SDB algorithms are applied to what is called “multispectral” optical satellite imagery. Multispectral means the onboard sensor measures natural energy reflectance from features on the Earth’s surface in many wavelengths, usually visible red, green and blue, as well as near infrared.

Seafloor sand waves offshore Monomoy Island, Cape Cod, shown in a 2-m resolution bathymetric surface produced from WorldView imagery and validated using ICESat-2 space-based laser bathymetry.





SDB is now a commercial technology, and TCarta routinely generates SDB products with bathymetric point values spaced less than a meter apart on the seafloor to depths of 20 m, depending on water clarity and turbidity. In extremely clear water, measurements down to 30 m are reliably produced. The accuracy of these data sets is typically 10 to 20 percent of water depth.

Enhancing SDB with ML and ICESat-2

SDB processing of multispectral imagery has primarily involved application of two algorithms: Band Ratio and Radiative Transfer. Both are mathematical calculations that rely on visible light passing through the water column and reflecting off the seafloor. The drawback, of course, has always been the fact that light doesn't penetrate murky, sediment-loaded waters in many dynamic coastal environments.

With the NSF-funded Project Trident, TCarta saw supervised machine learning (ML) as a solution to this problem on many fronts. Explained simply, supervised ML uses verified training data to teach the computer to recognize similar features or patterns in other comparable data sets. It is important to note that the current ML renaissance has been made possible by widespread and affordable availability of the massive computing power required to run the iterative ML algorithms in reasonable periods of time.

The underlying premise of Project Trident was that coastal zones known for their cloudy, turbid waters traditionally deemed unsuitable for SDB likely experience at least a few days of water clarity each year. It was simply a matter of collecting satellite imagery, or finding imagery already acquired, on those rare days.

This is where imagery from the European Sentinel-2 satellite came into play. This satellite collects imagery constantly, building an archive of hundreds of images for each spot on the Earth's surface since its 2015 launch. More importantly, the data are available globally for free.

TCarta technicians created ML-based software to automatically search the Sentinel-2 archive and select those coastal images with water quality appropriate for SDB.

Global status of space-based laser bathymetry extraction using an automated deep-learning model. To date, 55,399 ICESat-2 ground tracks have been processed, comprising an estimated 35 percent of the archive. Inset image displays a typical seafloor elevation profile extracted from ICESat-2 ATL03 data.

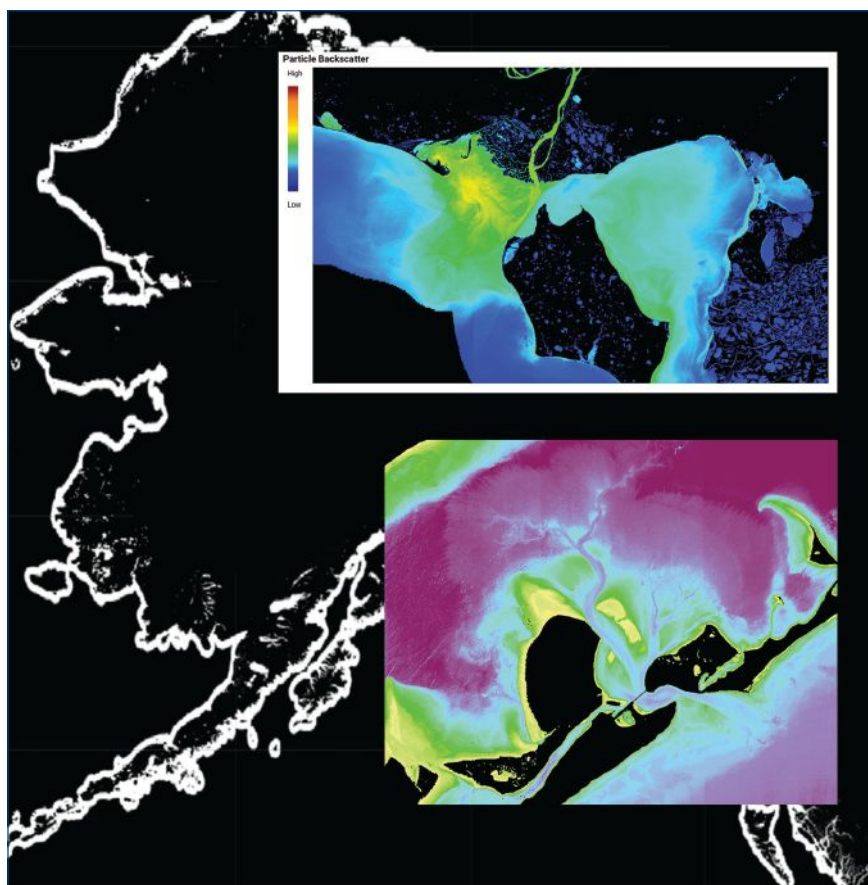
The same filtering could be accomplished with the naked eye but would literally have taken years compared to what ML can do in minutes in the cloud or on a computer equipped with an AI-capable graphics processing unit (GPU).

The automated ML image filtering was a success and, in many cases, returned not one, but dozens or even hundreds of suitably clear images. With the capability to analyze the full archive of available imagery, TCarta's technicians found a substantial advantage when the ML method was scaled to use not just one good image, but to identify suitable individual pixels within multiple images that could be used for SDB processing. These filtering techniques are referred to as pixel-wise and image-wise.

TCarta remote sensing scientists also worked on enhancing the SDB process itself. The team customized a common ML-based decision tree algorithm called Random Forest and adapted it for extraction of water depths from the multispectral images. Random Forest thus became an SDB calculation complementary to Band Ratio and Radiative Transfer.

The Colorado firm then upended the entire SDB workflow. Rather than apply one algorithm to a single satellite image, they created composite images of the best pixels. Then they leveraged the power of cloud computing to process multiple SDB algorithms on every suitable pixel selected by the filtering. This meant dozens of water depth calculations were typically made for each point on the seafloor that was visible in the imagery.

Highly accurate bathymetric values were then determined by combining the results of the multiple calculations. While initially developed and deployed on Sentinel 2 imagery, these same techniques and methods can be applied to any optical imaging satellites.



The 32,000 mi. of the Alaskan shoreline are turbid and highly dynamic (top inset) and pose both a surveying challenge and an opportunity for SDB through precise planning and deployment of multiple space-based surveying approaches (bottom inset).

extracted from Sentinel-2 and ICESat-2 data. G-SDB data sets contain bathymetric measurements from 0 to 20 m generally and up to depths of 30 m, depending on water clarity, at 10-m resolution. The depth values for every 10-m pixel are the combined result of numerous measurements, resulting in accuracy within 10 percent of depth or less. G-SDB will be

available globally for all oceans and seas, as well as large freshwater lakes where water conditions permit.

Applying the results of Project Trident, the Office of Coast Survey at NOAA contracted TCarta to deploy the technology to produce 2-m resolution SDB using WorldView imagery for two historically difficult areas of Western Lake Michigan and around Cape Cod and Nantucket Sound, where natural forces alter the underwater terrain faster than traditional bathymetric surveys can be completed. SDB is being considered as a fast and inexpensive alternative for such coastal zones.

Fine-Tuning SDB for Alaska

Mapping Alaska's coastal waters became a priority for NOAA in December 2019 with the issuance of a Presidential Memorandum that resulted in the development of the Alaska Coastal Mapping Strategy and cites SDB as a key technology for surveying the 32,000 mi. of Alaskan shoreline.

In 2020, NOAA awarded an SBIR grant to TCarta to research and deploy multiple SDB techniques and approaches for Alaska. The Arctic region was considered almost impossible for SDB implementation due to a multitude of factors. Coastal waters there are extremely dynamic, carrying excessive sediment loads, not to mention sea ice, nearly year-round. Additionally, months of darkness and frequent cloud cover thwart image collection by optical satellites.

The goals of the NOAA Phase Two grant is to determine how best to deploy SDB techniques in Alaska and investigate whether the ML algorithms and pixel-wise fil-

Enter ICESat-2

An addition to the SDB workflow came with the 2018 launch of the NASA ICESat-2 (Ice Cloud & land Elevation) satellite carrying a laser altimeter, or LiDAR, designed for measuring the thickness of sea ice, glaciers and tree canopies. The ICESat-2 data proved extremely adept at determining elevation points for the seafloor at 0.7-m intervals with centimeter-level accuracy to depths of 30 m.

Although not applicable for broad-area mapping due to the large gaps between measurement lines, the free data were ideal as a ground truth data set for Project Trident. Scalable and global extraction and application of these data may be the single most important SDB technology breakthrough of the research.

TCarta integrated the satellite LiDAR data into its SDB workflow in two important ways. First, ICESat-2 bathymetric measurements were employed as training data sets for the ML-based Random Forest algorithm. Then after the elevation extraction processing was complete, the team used ICESat-2 points to validate the accuracy of overall SDB calculations, reducing uncertainty in derived water depth values.

As a result of Project Trident, TCarta has generated bathymetric maps for coastlines where water conditions had traditionally thwarted SDB application. These areas include the Korean Peninsula, Greenland, Arctic Canada and New England in the U.S. The depth and accuracy of these locations can now equal those that SDB has previously delivered in clear, calm water.

The research culminated in the launch of a new Global Satellite-Derived Bathymetry (G-SDB) product

tering techniques can be refined for use with higher-resolution commercial imaging satellites in Arctic waters. Even more ambitious, TCarta scientists hope to create composite bathymetric surfaces composed of the best combined pixels from multiple different satellite sensors.

In the first phase of the research, the project is focused on determining when is the optimal time to capture imagery for the most accurate SDB surfaces and comparison of accuracy across multiple optical satellite sensors.

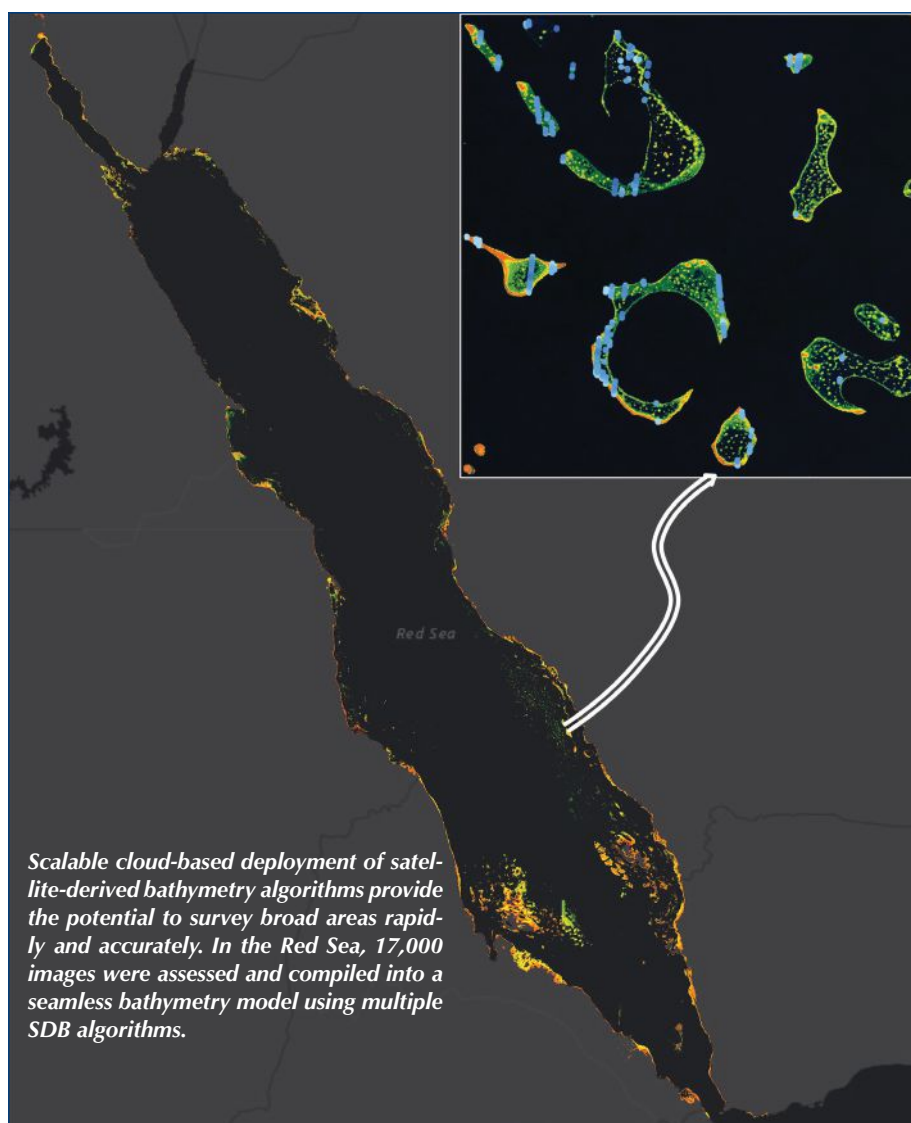
Timing of imagery collection with the tidal phases is paramount in Alaska due to the significant range and because the best images for use in SDB are captured in sync with incoming tides. This is preferable because the maximum tidal zone is exposed and the water is shallow farther out, allowing SDB to measure depths at a greater distance from the shore. The incoming tide typically has better clarity because it brings in clearer ocean water and carries less sediment runoff from the land.

The second phase of the Alaska research is to determine when—or if—optical imagery suitable for SDB processing has been or will be acquired for coastal Alaska. Between the tidal and environmental conditions, TCarta knows the likely collection window is so small that it will not find a treasure trove of hundreds, or even dozens, of appropriate images in existing archives.

To increase the chances of obtaining the necessary high-quality imagery, TCarta is once again applying its ML-based search capabilities to review images and individual pixels acquired by high-resolution optical satellite programs: MAXAR's WorldView and Planet's SkySat, most notably. They are also beginning to incorporate hyperspectral imagery—covering broader wavelengths—from Satellogic, a new provider in commercial remote sensing.

The remote sensing scientists realize they may end up with a combination of SDB-worthy images and pixels from multiple sensors to process together to calculate water depth in small coastal areas.

With this in mind, TCarta had developed a process to assimilate radiometric response to compensate for sensor differences among the various satellite systems. This will enable the ML filtering algorithms to make apples-to-apples comparisons among Planet, Satellogic and World-



View pixels, for example. Assimilation will also be required when SDB processing is applied to stacks of pixels from multiple different satellites.

TCarta is confident that it will make significant headway in determining which satellite sensors, or combinations thereof, have the greatest potential for capturing SDB-quality data. Moreover, the researchers also expect to have begun piecing together a predictive schedule of when the image acquisitions should occur for specific parts of the Alaskan coast. Optimism is tempered by the possibility that suitable images will never be acquired for some areas due to extreme conditions.

Where applicable images—or pixels—are acquired, however, TCarta plans to begin processing them in the refined Project Trident SDB workflow by summer 2022. Again, optimism is modest with expectations suggesting that SDB, if it is successful at all, may produce results in depths of only 8 to 12 m and limited to 3 to 5 m in some locations.

Areas will remain where clear water conditions never exist. But these data and information results will have a high degree of confidence and will represent an improvement over what is available now for many coastal zones.

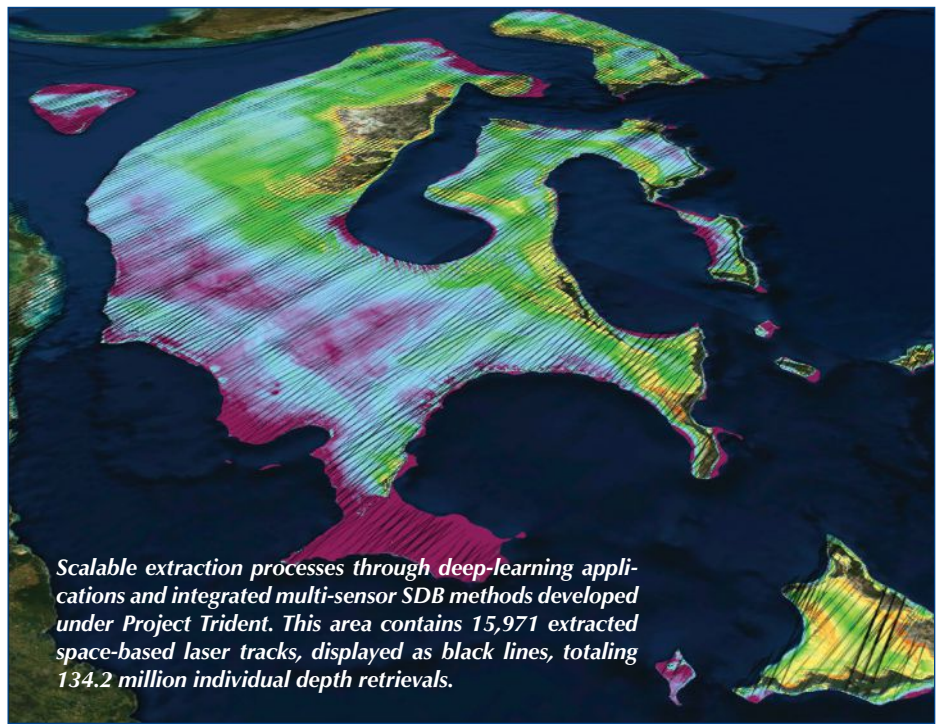
A secondary, yet important outcome of the Alaska research is that by using information from multiple satellites, TCarta will be able to predict when and where coastal water clarity is best in the state on a daily basis. The Colorado firm has plans for a web portal for accessing these insights in support of NOAA's hydrographic surveying operations so the agency can better plan where to deploy LiDAR mapping aircraft in the region. LiDAR, like SDB, depends on clear water for highly accurate subsurface data collection.

There is no one best solution for surveying coastal water, particularly remote and dynamic areas like Alaska, but by combining the recent advancements in SDB technology with the new and next-generation space-based sensors along with machine learning and cloud computation, there is great potential for SDB to address in part the challenge of

surveying coastal waters in Arctic conditions.

Through both the broad and automated approach to global SDB that TCarta developed under Proj-

ect Trident and the precision collection and combination of sensors for Alaskan waters, TCarta has developed and deployed a multitude of next-generation approaches to satellite-derived bathymetry that address the global need for coastal bathymetry. **ST**




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Kyle Goodrich is the president and founder of TCarta Marine and has a 19-year career in geospatial services. Since founding TCarta in 2008, he has led numerous geospatial product research and development plans, including the development and commercialization of satellite-derived bathymetry, stereo photogrammetric bathymetry, a global aggregation and assimilation of multi-source bathymetry data and global vector shoreline. As principal investigator in TCarta's National Science Foundation Small Business Innovation Research Phase Two Project Trident, Goodrich is leading the commercialization of the technology arising from the grant research.

Ross Smith began his geospatial career in 2011 as an infantry sergeant, leading Company Operations Intelligence Support Team operations in support of Operation Enduring Freedom XI-XII. Now serving as TCarta's technical project manager, Smith leads technical research and development of new marine geoprocessing and remote sensing technologies under TCarta's National Science Foundation Small Business Innovation Research program and NASA's ICESat-2 Applied Users Program. Smith is also a United States Geospatial Intelligence Foundation member and certified geospatial intelligence professional.

AUVs Making Real-Time Decisions

The Solution to Object Detection Challenges for Autonomous Vehicles

By Dr. Arjuna Balasuriya • Anya Wintner • Karen Pfautz

You're a marine roboticist, white-knuckling the edge of your seat on a boat in choppy waters, staring intently at the waterproof laptop you had to tape down to keep it from sliding off the table. You're tracking a small, uncrewed drone as it maneuvers ahead, far below you, hopefully gathering data that will clear the area so it's safe for you to explore. After hours of waiting, your heart leaps as the nose of the vehicle breaks the surface. It's brought on board and wired up to your laptop...and your heart sinks as the inconclusive data filter in. The drone will need a second, more targeted pass to identify the potential problem objects it's spotted.

Until very recently, this was a common story for those using AUVs. Initially, AUVs could only collect raw data,

which had to be manually reviewed, georegistered and analyzed by scientists once the vehicle reached the surface. That is, AUVs could only “play fetch” with data; problematic, considering the cost of launching secondary missions. Not only does it cost more money, it takes longer, and it's riskier—making it easier for a covert operation to be detected, or risking damage to equipment and jeopardizing crew needing to operate longer in rough seas.

An Onboard Solution

Moving the industry forward calls for smart, real-time automated target recognition (ATR) that can overcome these challenges. There's progress on this front: AutoTRap





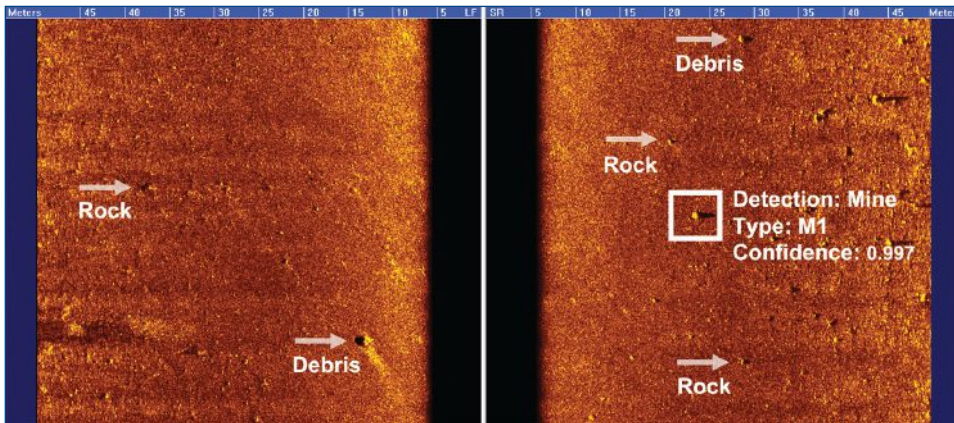
Barriers to Underwater Object Detection

The problems encountered by AUVs attempting to correctly detect and classify underwater objects have made it difficult to realize their potential. The biggest challenge is the data itself. The nature of water as a medium means that acoustic imaging (sonar) is often the only viable option. Unfortunately, sonar data are visually noisy, and targets and nontargets can look virtually identical to an untrained eye.

The information shown in sonar data can also be, simply, wrong. Sound is a pressure wave, and water is an imperfect medium that moves and varies in density, temperature and salinity. Any one of these shifts can bend sound waves, causing a target's actual location to appear in an entirely different place on a sonar image.

AutoTrap Onboard helps

AUVs overcome these challenges; it accurately interprets noisy sonar imagery and generates machine-readable reports for detected objects that include type/class, relative and absolute location, and spatial extent. These reports enable downstream autonomy systems to respond in real time, letting them navigate around an obstacle, or retask for a closer look at an interesting object. Its advanced recognition and computation abilities will increase mission efficiency and provide instant gains for teams recovering lost shipping containers, inspecting underwater pipelines, and accurately mapping the seafloor.



(Top) Charles River Analytics has been developing the innovations behind AutoTrap Onboard under U.S. Navy contracts since 2005, recently partnering with Teledyne to test and deploy it on Teledyne's market-leading line of AUVs. AutoTrap Onboard is now extensible to other platforms. (Bottom) Sonar data reveal the difficulty of performing object detection—rocks and natural features of the seafloor look almost indistinguishable from manmade objects to the naked eye.

Onboard delivers real-time, actionable information on an AUV's embedded hardware. As soon as it identifies an object of interest in the stream of incoming sensor imagery, AutoTrap sends a message to the "brains" of the AUV—the autonomy software it uses to make decisions, like rerouting for a closer look at an interesting (or suspicious) object. On an AUV equipped with an acoustic communications transmitter, AutoTrap can communicate interesting object detections in real time to a surface ship or to other AUVs working the area.

"The manual waterfall processing of sonar data is a real killer of efficiency in mission time," explained Karen Harper, president of Charles River Analytics. "Drones have to be deployed and recovered, and the data downloaded and processed. All that manual processing means it can be hours or even days between missions. Adding AutoTrap Onboard to an AUV allows it all to happen in real time and lets customers leverage one deployment to execute multiple steps of the search-detect-classify-reacquire chain. For our U.S. Navy customers using this tech to find targets, it turns three days of missions into one night."

Lost Shipping Containers

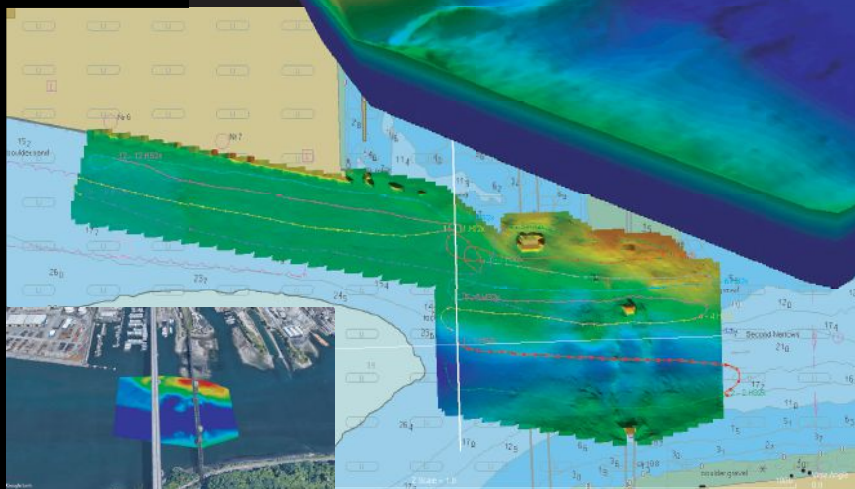
According to the World Shipping Council, an average of 1,582 containers are lost at sea each year. In addition to lost cargo, these metal behemoths disrupt the ecosystem on the seafloor, are dangerous to small vessels when they float just below the surface, and sometimes contain hazardous waste that further disrupts the failing balance in our oceans.

This makes recovery missions extremely important, but retrieving containers takes a significant amount of time and money, with no guarantee they'll be found. The autonomous decision making enabled by AutoTrap Onboard could make a major difference in this process.

Pipeline Inspection

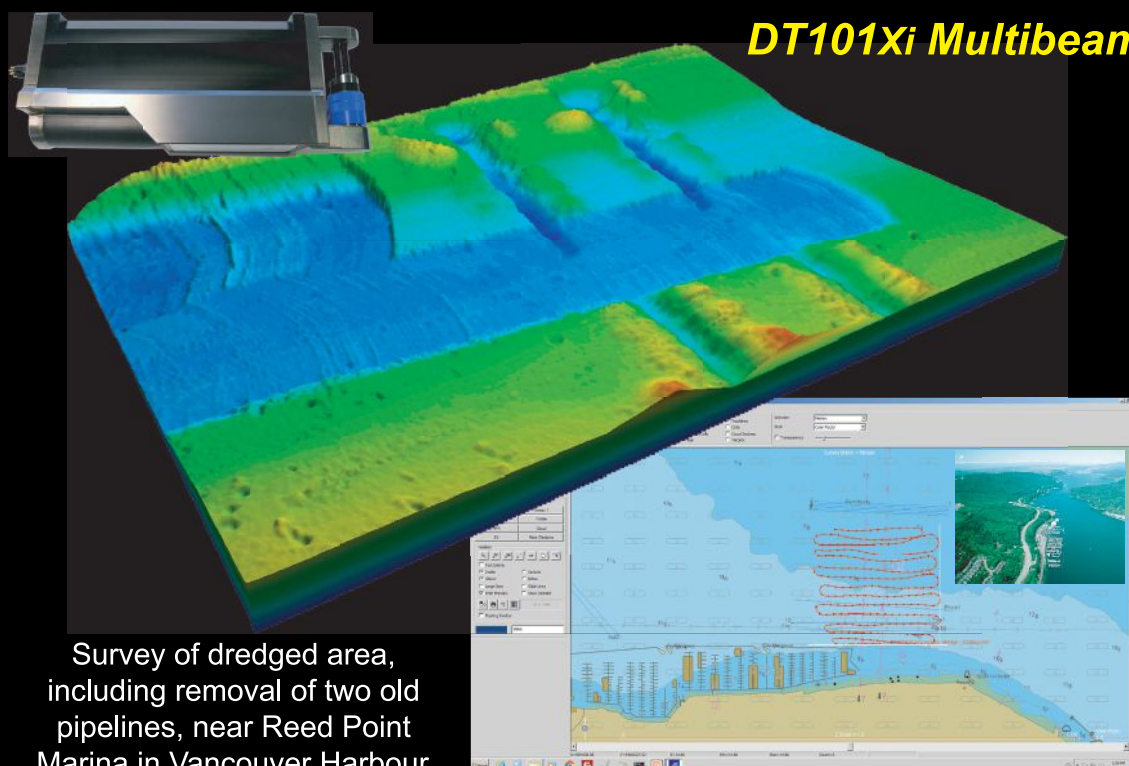
Oil and gas are delivered through an extensive network of pipelines stretching thousands of miles across the seafloor. Subsea pipelines are vulnerable to a variety of damage, with corrosion and collision (vessel, anchor and trawl nets) among the most common. Since these pipelines typically carry hazardous substances, leaks can be extremely harmful to the seafloor and surround-

DT102Xi Multibeam

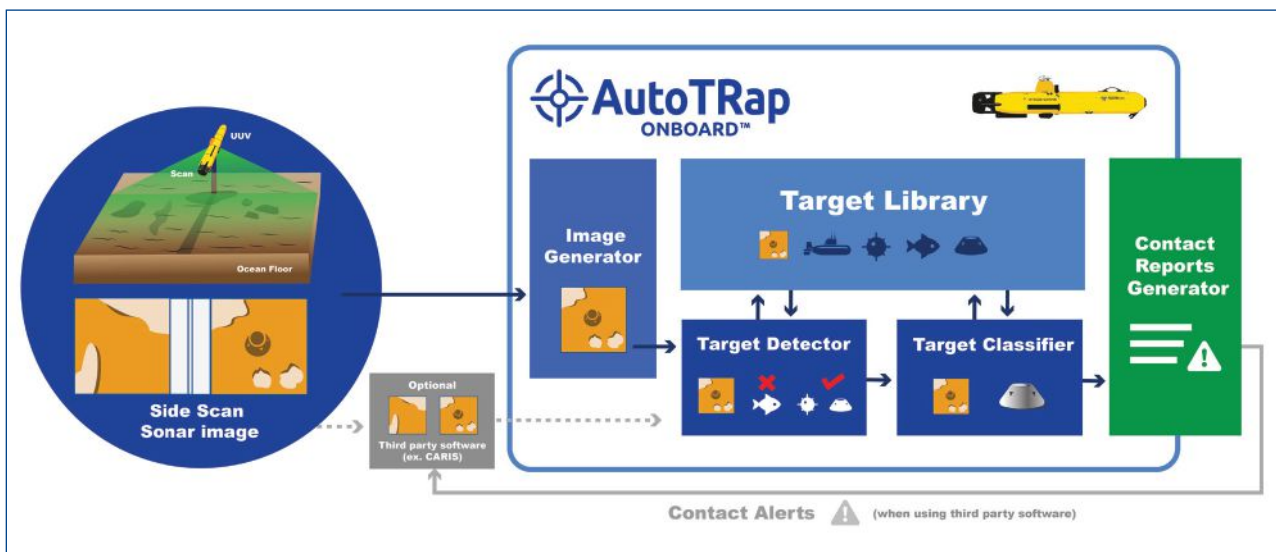


Survey of
Second Narrows in
Vancouver Harbour,
including bridge
footings and rock
covered cables

DT101Xi Multibeam



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



AutoTRap Onboard's target detector and target classifier locate and recognize objects of interest in real time; no more need to perform the time-consuming and error-prone task of manually analyzing sonar data. Real-time contact alerts provide an object's type, confidence of detection and position to any downstream system, such as the vehicle's navigation, control or mapping software.

ing wildlife. To catch issues, subsea pipelines require frequent monitoring. With thousands of miles to traverse at depths up to 9,500 ft., this is a job for AUVs, not humans. AutoTRap Onboard's improved detection capabilities will make the inspection process far more efficient; an AUV no longer needs to surface and have its data read by experts. Instead, AutoTRap Onboard can pass a target location to navigation software, which directs the AUV for a closer inspection with different sensor modalities. It can also send image snippets of interesting objects to the surface for operators to review while it continues to survey the pipeline. With such a large network of pipes on the seafloor and the frequency with which they are checked, this increase in efficiency will be invaluable.

Seafloor Mapping

Comprehensively mapping the seafloor has become critical as changes to the environment bring our oceans closer to environmental failure. The United Nations' 14th Sustainable Development Goal emphasizes the need for improved ocean management. In 2017, the United Nations Ocean Conference estimated that only 6 percent of the seafloor was properly mapped.

That number has since risen to 20 percent, driven by a massive and international collaborative effort. A full map of the seafloor will support safe navigation in the deep ocean, enabling scientific missions on resource management and habitat research. AutoTRap Onboard can greatly improve scientists' ability to accurately and safely generate deep-sea maps, bringing us closer to a

full understanding of our oceans and how to keep them functioning.

The Innovation: Deep Learning And Military De-Noising Tech

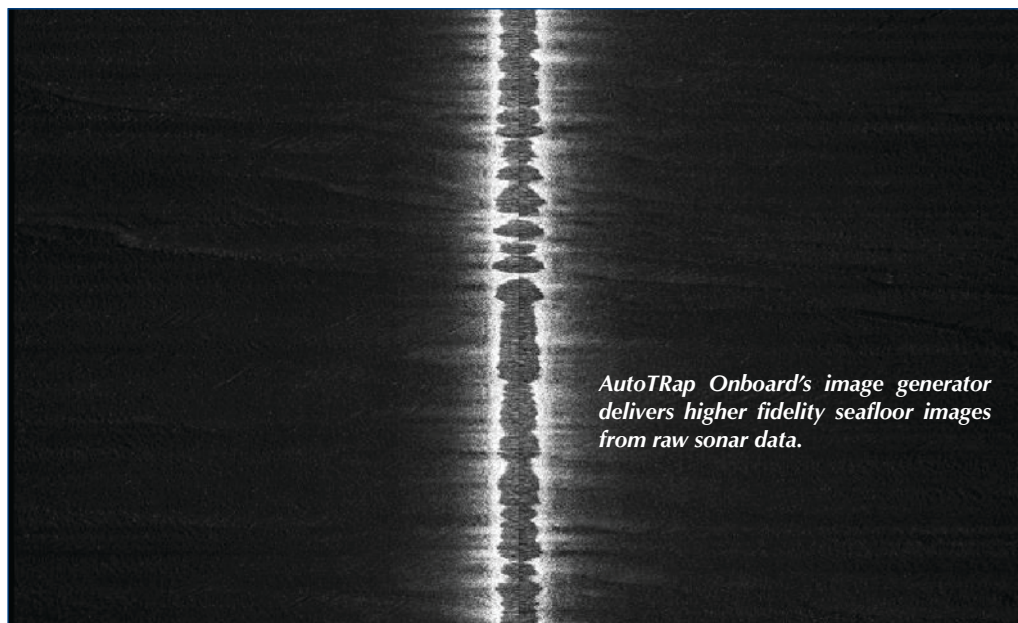
AutoTRap Onboard applies recent advances in deep-learning object detection to locate and classify objects in sonar data. It also incorporates shadow-based classification to delineate objects.

For example, an object to the AUV's side shows up as a shiny reflection, representing a strong signal. Similar to light, a sound wave does not actually go through the object; rather, it reflects, creating a "sound shadow." The length of this shadow correlates to the height of the object. Data-driven deep-learning methods can also pull detailed geometric characteristics from these sonar shadows and use them for object classification.

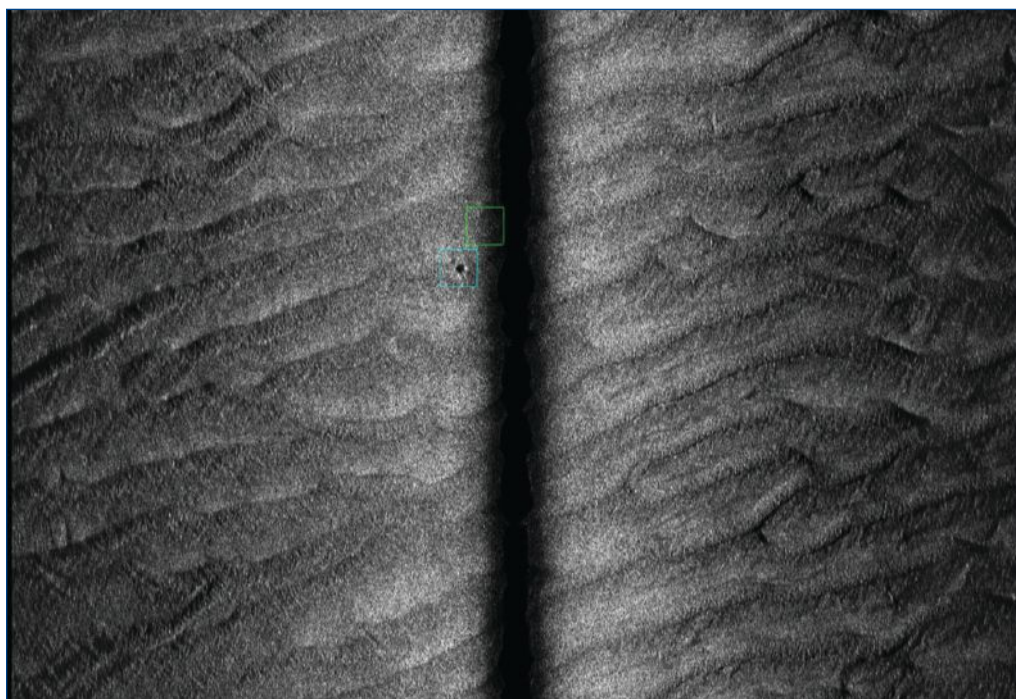
To support a wide range of potential targets and customers—the U.S. Navy looking for targets, the shipping industry looking for lost shipping containers, oil and gas stakeholders needing intact pipelines to transport their product, police searching for submerged human forms, etc.—Charles River Analytics provides services to train AutoTRap Onboard on new targets using data provided by the customer. These data are added to the target library, then machine learning and convolutional neural networks are used to train the target detector and classifier. AutoTRap Onboard's architecture is designed to accommodate different imaging sensors, including side scan, synthetic aperture and new types of forward-looking sonar.

The latest version of AutoTRap Onboard also includes algorithms developed by Charles River Analytics for the U.S. military that directly generate much clearer sonar pictures from the raw data than those generated by the current leading software.

AutoTRap Onboard's accurate detection in the challenging underwater environment supports real-time autonomous behavior for faster, more efficient and less costly mission operations. Without real-time object detection, the AUV just "plays fetch"—collecting sonar



AutoTRap Onboard's image generator delivers higher fidelity seafloor images from raw sonar data.



data and returning them to the surface for analysis. Enhanced autonomy and real-time detection mean that the AUV's navigation and control software can now make more effective decisions on its own. An AUV with AutoTRap Onboard can reroute from its original mission for a closer look at an object it detected, increasing the accuracy of detection on a single deployment.

AutoTRap Onboard reduces mission cost and time because the AUV can accomplish more complex mission goals in a single deployment. Mission resilience increases, especially in unfavorable environmental conditions such as rough seas, when deploying an AUV multiple times can be challenging. By reducing the number of launch and recovery cycles, teams can save power and search a wider area, moving the surface ship out of a storm's path, for example, knowing that the AUV will

safely navigate deep below the surface turbulence to a new meetup point.

Latest Results

AutoTRap Onboard has run multiple tests with Teledyne Gavia, with exciting results. Version 1.0 was released last year and tested in Boston Harbor and off the coast of Iceland. Results included a 90 percent detection rate on truncated conical objects on a rocky volcanic seafloor, but with more false positives than the team wanted to see.

To enhance performance, Version 1.1 starts with the sonar data coming into the system, bypassing data streams where the data are altered by third-party software designed to optimize the data for other AUV functions. Instead, it applies Charles River's own processing algo-

rhythms to the raw data feed, optimizing the image for target detection. It also has an expanded data set from testing in the North Sea, Mediterranean and Boston Harbor. Having diverse geography in the data set on which AutoTRap Onboard's neural networks are trained is important because operating environments vary greatly; the Mediterranean is largely sand with clear water, while the Icelandic coast is littered with rocks very similar to target objects, all sitting in murky water filled with particulate.

Between the additions to the training data set and direct access to the raw data, we expect false positive rates to go down significantly. More testing was planned for May, weather permitting, with yet another test launch planned for September, which will occur off the coast of Portugal.

What's Next?

AutoTRap Onboard represents a big step forward in AUV and ATR development, but of course, the question arises: What's next?

In addition to AutoTRap's immediate applications, the field of ATR is nearing what many consider science fiction. In 10 years, there could be a hivemind of AUVs chatting back and forth as they carefully grid their way across the seafloor.

A low battery would no longer be a reason to return to the surface; instead, a vehicle could head toward a deep thermal vent to recharge on its own, for example.

Swarm and recharge technologies are already being

researched by different teams within Charles River Analytics.

As it stands, AutoTRap Onboard is a game-changer for true and assured autonomy. With a smarter AUV that can reroute on its own, plus send updates and receive guidance without surfacing, teams will be confident that their vehicle can get the job done and reap the benefits of increased efficiency and lower cost of underwater missions. **ST**

Dr. Arjuna Balasuriya has served as chief scientist on anti-submarine warfare and mine countermeasures research cruises and has published more than 100 papers on sensing and automation. As a senior scientist at Charles River Analytics, he oversees R&D efforts related to marine robotics and ocean acoustic sensing.

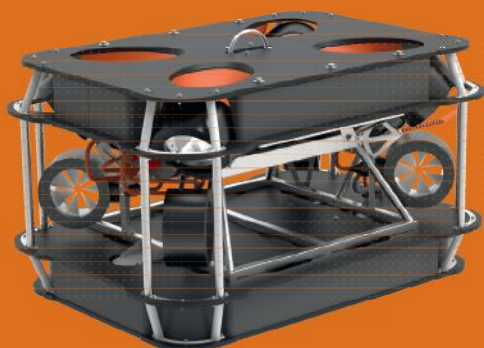


Anya Wintner is a science writer at Charles River Analytics.

Karen Pfautz manages marketing and content services for Charles River Analytics.



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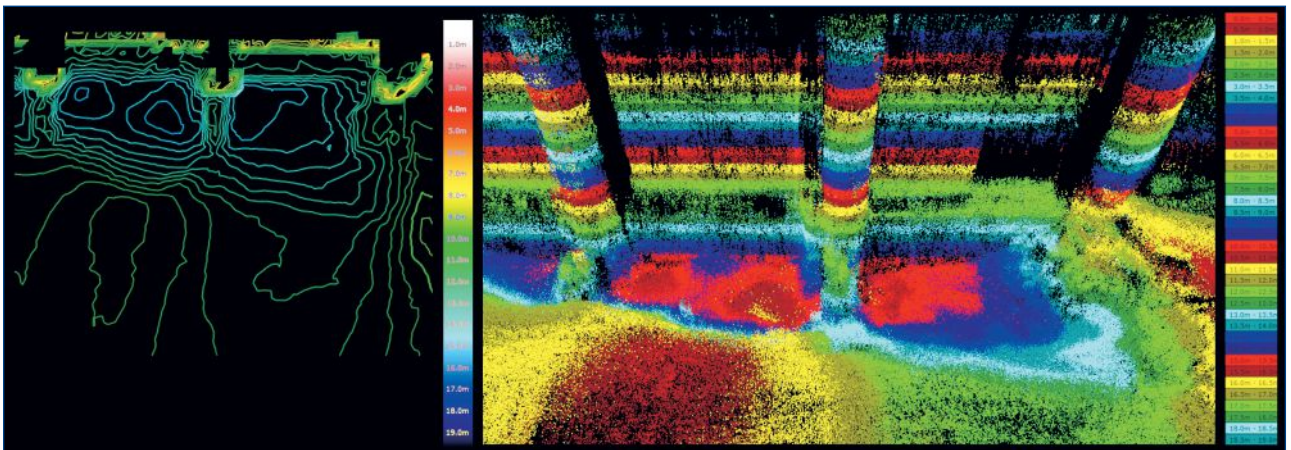
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PMBES Enables Efficient Survey

Multibeam-Like Echosounder for Full Coverage of Rivers, Reservoirs

By Dr. Ephraim Friedli • Francisco J. Gutiérrez



The division of Hydro & Biomass of the Axpo Group in Baden, Switzerland, deals with a wide range of water bodies, such as shallow rivers and deep reservoirs in the mountains. One similarity is that all of them require monitoring for many reasons, including: to judge the integrity of structures within the water bodies, determine sedimentation and erosion, and calculate the volume of the reservoir. By deploying echosounders, one can gather valuable information and address these tasks.

In the past, this work was carried out with single-beam echosounders. Depending on the task, a dense grid of profiles at a defined spacing was acquired, with the drawbacks of a long acquisition time or having no information about the surface adjacent to the measured profiles. By deploying a phase-measuring bathymetric echosounder (PMBES), with its multibeam-like features, one can overcome this and collect detailed, full-coverage information about the bottom's surface and, thus, get a clearer picture of the processes that are happening.

This article describes the tools and methodology used to undertake such a wide range of tasks. Additionally, we discuss the challenges and results of two surveys per-

250-kHz PMBES data collected during the GeoSwath 4 system and software training at a river dam, immediately after the survey, online filters only.

formed with the same PMBES system in two radically different water bodies: a shallow river (less than 15 m deep) and a deep Alpine reservoir (more than 100 m deep).

Tools and Methodology

The main instrumentation used in this work was a 250-kHz PMBES GeoSwath 4R, manufactured by Geo-Acoustics Ltd. (Great Yarmouth, U.K.), integrated with an inertial navigation system (INS) Seapath 130 and MRU H, manufactured by Kongsberg Seatex AS (Trondheim, Norway), and a MiniSVS sound velocity sensor, manufactured by Valeport Ltd. (Totnes, U.K.). Real-time kinematics (RTK) accuracy heights were used as tide and sound velocity profiles (SVP) were taken along the survey to account and compensate for refraction in the water column.



In the first instance, the methodology consists of pre-survey checks (installation-noise debugging and RTK accuracy checking) and the optimization of the PMBES parameters. This all aims to maximize quality and efficiency before proceeding with the survey.

A key element in this methodology is the application of online filters to the raw bathymetry data during the survey, producing virtually clean data immediately after the survey. The subproduct at this stage is a set of clean point clouds that can be used to produce a digital terrain model (DTM) and acoustic imagery of the survey area.

Setup, Deployment and Configuration

Although comprising the same instrumentation, the setup is flexible, as it must be adapted to a wide range of opportunity survey vessels, which sometimes have to be airlifted to the survey site.

The setup inside the boat consists of a flat, rigid, wooden platform, on which the pole that holds the PMBES and

the GNSS-antennas is mounted, as well as metal rods to stabilize the system and prevent pole oscillations in the port-starboard axis of the boat. Two tensioned straps lock the pole in place in the fore-aft axis and prevent vibrations. The remaining equipment is set up in waterproof boxes within the boat. The correction signal for the RTK-GNSS solution can be obtained in two ways, either directly from a national geopotential service (e.g., SWI-POS in Switzerland) or by a mobile reference station set up on a known point. As receiving a correction signal from a national service usually requires a GSM network, which is not always available at remote locations, both correction methods are equally useful.

Pre- and Post-Survey Accuracy Checks

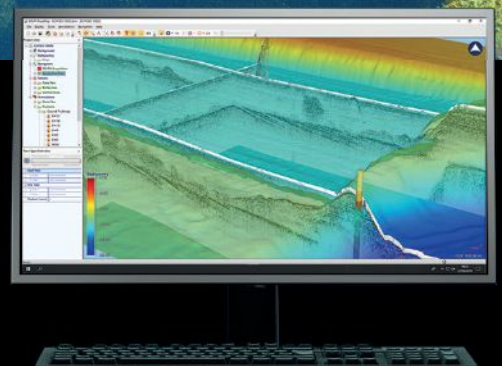
Before the survey starts, the accuracy of the recorded RTK-GNSS height is validated by comparing it to the height of the water level measured with an external geodetic GNSS receiver. In addition to this, a second in-

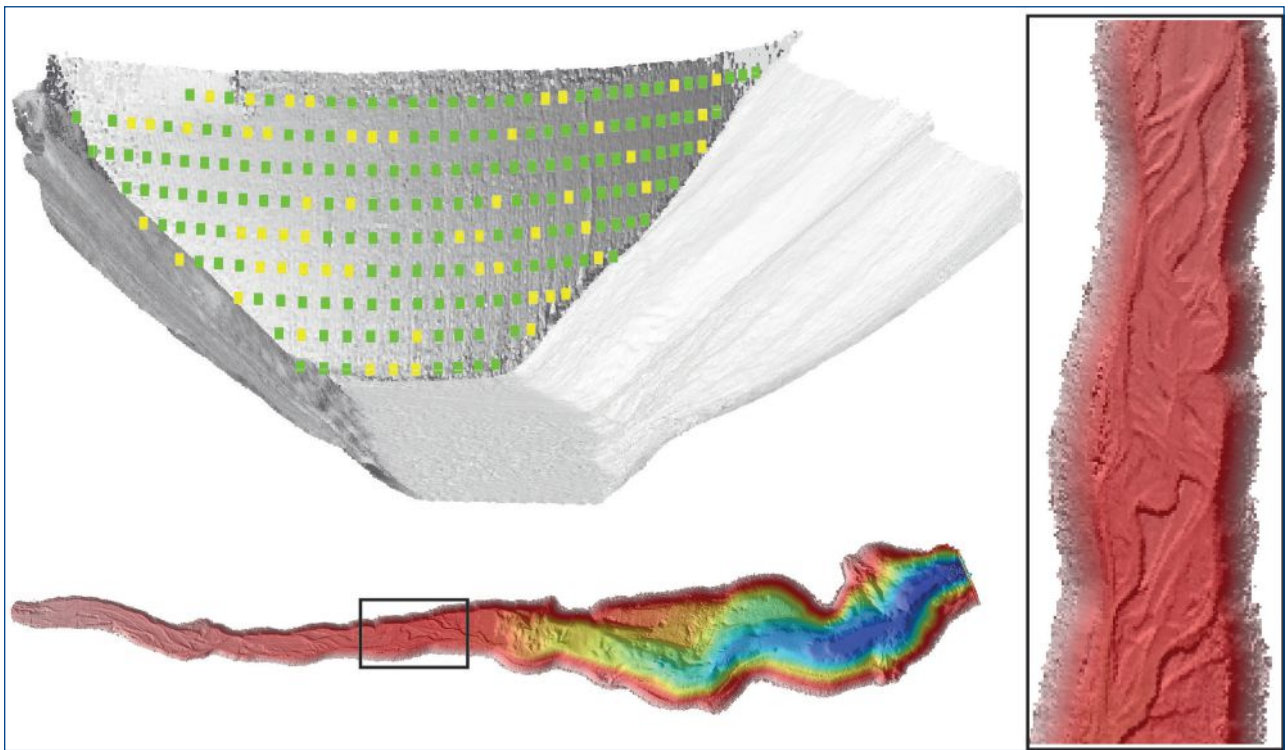
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250-kHz PMBES data of a 1.8-km-long reservoir (bottom) and detail of the original riverbed (right). Top: dam wall bathymetry and separation w.r.t. original CAD model (yellow < 30 cm; green < 20 cm).

dependent measurement of the water level height, with centimetric accuracy, is provided by the company managing the reservoir.

Once the system is deployed, the next step is to characterize and optimize the noise baseline by identifying and removing, or at least minimizing, any sources of acoustic and electrical noise. That produces an optimal signal-to-noise-ratio PMBES measurement.

Finally, a short survey inspecting a significant area should be done to decide on the optimal operation settings: acoustic source level, range resolution, receiver gain and swath width. At this point, the system is ready for an efficient, high-quality survey.

Data Processing Workflow

GeoSwath 4 PMBES uses the proprietary software GS4 for configuration, survey planning, online filtering, data logging, data processing, gridding and mosaicing. It is an all-in-one suite that is used through the first part of the workflow.

As mentioned before, a key approach for an efficient process includes the use of online filters during data acquisition. The aim is twofold: on one side, data outliers are flagged as unaccepted in real time, which produces virtually clean raw data; on the other side, it allows the

surveyor to produce preliminary digital terrain models and evaluate the quality of the acquired data quickly in the field.

Once in the office, the real-time processed data are reprocessed in GS4, hands-off, to incorporate RTK tide and SVP corrections.

At the end of that stage, the data are imported into a second piece of software, AutoClean, manufactured by BeamworX (Utrecht, Netherlands), for more detailed quality control and further filtering if necessary. This software allows a systematic and reproducible approach to the final accepted point cloud, which is vital in monitoring applications.

The GNU General Public Licensed software CloudCompare is used for rendering. The software allows the rendering of vertical structures (dam wall), as well as the river or reservoir basins, producing excellent results.

The final step in the workflow relies on the use of Autodesk AutoCAD to extract sections that are compared to prior measurements and to calculate volumes, e.g., sediment volume for dredging or water volume for reservoir management.

Shallow-Water Example

A typical example in shallow waters is the surveying of river dams and the adjacent areas. Monitoring the transport of materials and siltation is a routine task. The deployment of a PMBES allows the analysis of these effects in more detail, removing the need for interpolation between profiles, as is the case when using a single-beam echosounding system.

As well as the riverbed, monitoring the river floor directly in front and behind the dam wall is essential. With a PMBES, it is possible to identify and quantify the scouring that tends to occur at the foot of the dam wall due

to the strong currents, without the need to send down a diver.

The PMBES system was used to survey a hydroelectric dam on the Rhein River at the border between Switzerland and Germany in September 2020. Compared with a single-beam system, the data acquired by the PMBES showed an accuracy greater than 5 cm at a depth of 10 m.

Deepwater Example

Examples of deepwater applications are encountered at Axpo's Alpine reservoirs with depths of up to 150 m. Reservoirs are monitored to calculate sedimentation rates and storage volumes and to determine actions required for maintenance. In addition to the volume calculation, the level of detail in the data allows observations of where sedimentation occurs and how the material is transported. It is even possible to identify parts of the old riverbed at the bottom of the lake in great detail.

In October 2020, we conducted a survey with a max depth of 120 m. Comparisons with prior single-beam measurements show good agreement, with deviations below 20 cm at depths of 100 m and greater, where sedimentation has occurred, which confirms the accuracy of the measurements.

Although the reconstruction of the dam wall is not the primary objective, it can be obtained almost completely with the PMBES system, which exceeds the expected maximum range of a 250-kHz system. A comparison with an existing CAD model from the wall showed deviations below 20 cm orthogonally to the wall for most of the parts, even at the very bottom of the wall.

Survey Challenges

Due to the wide range of possible applications and deployment options, several challenges are encountered.

Sometimes, the shoreline and the shallowest areas with sand and gravel banks are of interest. The challenges here are mainly due to acoustic multipath and interference: three interfaces (i.e., air, water and floor) of very different acoustic impedance, very close to each other and concurring.

In other cases, mapping critical structures at the foot of a dam at 100-m water depth is required, which is only possible if the integration of all the system elements is faultless and the system is well calibrated.

Mapping the deeper areas, mostly consisting of non-compact fine sediments, is also a challenge as the returned echo signal is extremely weak, stressing the system beyond the specification on many occasions.

Thus, each case requires careful planning and precise configuration. As an example, when corners or a wall have to be surveyed in a dam or harbor, it is advisable to map them at different distances and angles to have enough redundancy and maximize the quality of the data. This also helps to break the symmetry and solve the phase ambiguity in situations where acoustic signals arrive at the same time from two or more different positions at the same distance.

In some locations, poor satellite visibility complicates

the acquisition, as this results in poor position accuracy. In such cases, checking the satellite almanac helps to find the time slots with the best satellite constellation to acquire data.

Conclusion

In this article, it was demonstrated that a single 250-kHz PMBES can be used to cover a wide range of survey tasks: it was successfully deployed in a deepwater reservoir, where the lake bottom was mapped at high density, as well as in a shallow river. Comparisons with prior single-beam measurements and existing CAD data showed good agreement, better than 5 cm at 10-m depth in the river and better than 20 cm at 100-m depth in the deepest parts of the Alpine lake.

Deploying PMBES allows monitoring of the sedimentation processes occurring at the bottom of water bodies in good detail, and even tracking of material transport.

The methodology presented in this article is also valid for other environments and applications, like harbor mapping and monitoring.

A fundamental piece in the workflow is the application of online filters during data collection. Future work will try and incorporate the acoustic backscatter to the workflow, which will provide further information about the type of sediments lying on the bottom of rivers and lakes.

Acknowledgments

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References

For a list of references, contact Ephraim Friedli at ephraim.friedli@axpo.com and Francisco J. Gutiérrez at francisco.gutierrez@geoacoustics.com. **ST**

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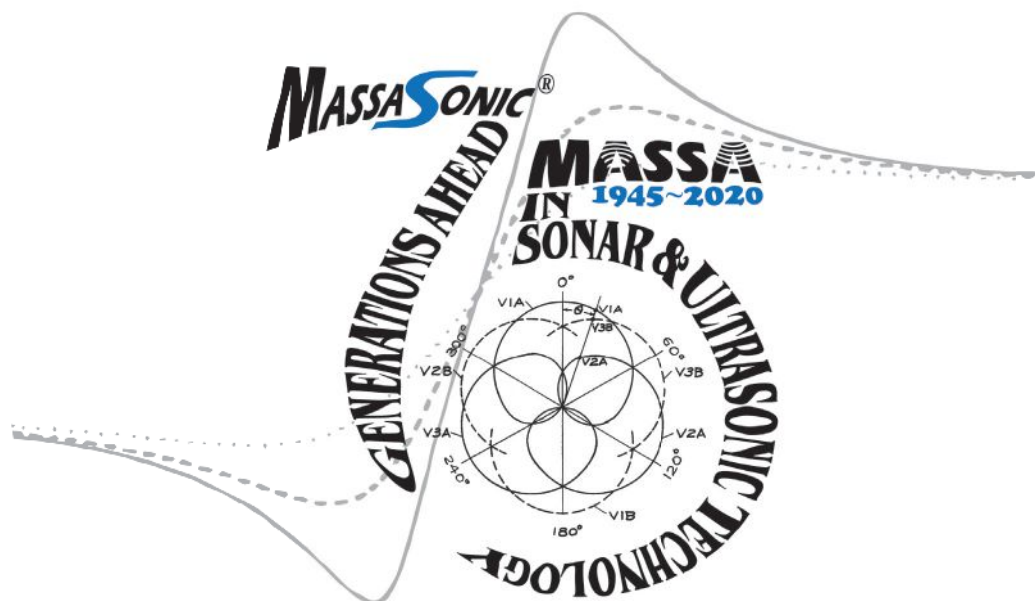
Francisco J. Gutiérrez has an M.S. in physics and is a product specialist for the GeoSwath, PuSAR and TOPAS systems of GeoAcoustics Ltd., where he has also worked as a product manager. He was previously a technologist for the Spanish Research Council, an associate professor of electronics and a field application engineer for Texas Instruments Ltd.



Massa Products Corp.

More Than 75 Years Making History in Electroacoustics

By Dawn F. Massa Stancavish



Massa Products Corp., founded in 1945 by industry pioneer Frank Massa, who was dubbed “the father of modern sonar transducers” by *Sea Technology* in 1985, is a third-generation family business that continues to break the barriers of what’s possible with sound. This father-daughter run business is driven with a fierce innovative spirit. The company has roots at the dawn of the electroacoustics industry.

The Founder

The story of Frank Massa embodies the American Dream. He is the mind behind revolutionizing the sound industry and developing the sonar transducers that helped the Allies win WWII. Frank was the first-born son of Italian immigrants, and he learned English by going to school in Boston. His grandmother saved a jar of dimes so that he might one day go to college.

Frank did go to college: He attended MIT on a full academic scholarship. He graduated from MIT at the top

of his class as a Swope fellow and went on to earn his M.S. in electrical engineering at MIT. After graduating, he eventually rose to become the head of government sound at Victor Talking Machine/RCA Victor/RCA, and director of engineering at Brush Development.

His early career efforts spearheaded the electroacoustics industry, which greatly impacted the sound and recording industry, sonar, and ultrasonics. He co-authored the first-ever acoustic engineering textbook, “Applied Acoustics” (Massa & Olson 1934). His patents and inventions include those for numerous microphones, loudspeakers, amplifiers and ultrasonic cleaners. At Brush Development, he led efforts to modernize and produce the sonar transducers that were essential in the Allied victory in WWII.

After Frank’s storied early career, he continued to follow his passions by creating a company where he would have the freedom to design and produce quality acoustic products.



The RCA days: John Preston (Engineering Model Shop) with Harry Olson and Frank Massa, the co-authors of "Applied Acoustics."

Evolution

The Massa story encompasses science, adventure, romance, loss, gain, failure, learning, reciprocity, family and, of course, success.

My grandparents fell in love over science and met at work at Victor Talking Machine. My grandmother typed the manuscript for "Applied Acoustics" and all my grandfather's patents. In 1945, they founded Massa Labs together, where Frank was the engineer and businessman, and Georgiana was the administrative facilitator. They started something remarkable, and they inspired friends, colleagues and family to join them. This is what it means to be entrepreneurial. They founded a business out of pure love: love of what it stood for, love of their work, and love for their family.

Despite the business being rooted in love, twice in Massa's history the business was nearly ruined because of poor management by nonfamily members.

In 1976, my father, Don Massa, and his father, Frank, became frustrated with how management was running Massa Corp. The quality was going down, and management was not aligned with the Massa family. After several fruitless board meetings, the father-and-son duo went out on their own to form Massa Products Corp., with Don as president. From 1976 to 1978, Massa Products Corp. and Massa Corp. were both operating, but Massa Corp. was heading toward bankruptcy, while Massa Products Corp. was thriving with breakthrough inventions and products; one notable example was the automatic bowling scoring system that Don designed and sold to AMF. When Massa Corp. illegally used patents owned by the Massa family,

they sued and won. Massa Products Corp. bought back Massa Corp. in 1978 and returned to the 280 Lincoln Street location, where the company remains.

In the 2010s, Massa found itself in a similar crisis. This time, my father and I faced management that was misaligned with the founding corporate culture. As a family company, we do not take firings lightly—our philosophy is to train people and give them the opportunity to correct their ways before they are let go. But despite multiple efforts, it became painfully clear we had to restructure the company in 2018. The founder's mentality is important at Massa, and management at the time did not agree, which was harming the business internally and externally, so we restructured. I became COO and chief innovation officer, and my father remained the president and CTO. We also brought back Dick Carpenter, a Massa lifer, from semi-retirement to resume his former role as vice president to help correct residual issues. Massa bounced back in a matter of weeks as the culture was realigned with the company's business and innovation strategy.

Steve Woodaman, director of operations and acoustic innovation engineer, stepped up in capability between 2018 and now, and has proven to be a rising talent at Massa. Much of the day-to-day at the company is now run by him and me. Our team assesses new opportunities from both technical and business perspectives and is able to provide innovative solutions for customers.

Latest Developments

As the company faced its 75th anniversary in 2020, it also had to contend with the COVID-19 global pandem-



(Left) Frank and Georgiana Massa at MIT. (Right) Donald P. Massa, Dawn F. Massa Stancavish and Steve M. Woodaman in front of a plaque honoring the company's founder, Frank Massa, at the Hingham, Massachusetts, facility.

ic. In addition to the pandemic, Massa faced the largest backlog in its history. Even though the world nearly came to a halt, Massa remained open at its facility in Hingham, Massachusetts, as an “essential business” under both the government’s “manufacturing” and “defense industrial base” categories. Staying safely open was imperative for the existing business and government contracts. Although it is a small business, Massa is able to work on a large amount of government programs at different levels (prime and sub) while simultaneously working on industrial/commercial programs. Massa’s fight was not just to remain open for itself; it was fighting to stay open to keep our country safe during lockdown. Massa supplies most of the sonar transducers used on the bow of *Virginia*-class and other submarines.

To successfully remain open during times of national and international crisis, it takes a lot of extra effort, planning and quick implementation of policy. Leadership goes into hyperdrive to make decisions in the best interest of the business and its employees. Massa, as a family company, considers employees members of the “extended Massa family,” therefore, the situation was

managed with heightened care and urgency to provide personal protective equipment, sanitizers, and a safe and clean environment to work. Fears were eased because the company acted quickly and conquered the challenges presented. Employees were grateful to have a job, relieved to be able to come into work, and proud that their work was essential to the U.S. Navy. Massa, operating with over 95 percent of employees reporting to the facility since September 2020, has maintained a record of zero on-site COVID-19 transmissions. Massa employs more than 70 people.

Passion Drives Innovation

Today, Massa is soaring to new heights and diving to new depths with new technology, business and stories that are sure to resonate. In so doing, it has not abandoned its history, knowledge or intellectual property; rather, it has grown by continuing to learn and remain passionate about its work.

Any business that has been around for over 75 years has its ups and downs, and people come and go, but Massa is unique as a third-generation family business;



Harold "Doc" Edgerton visiting with Frank and Don Massa at Massa Products Corp. in Hingham. (Left) Harold "Doc" Edgerton on board after the Stellwagen Bank whale study excursion.



only 12 percent of family businesses survive into the third generation. In addition, Massa also has the rare qualities of being a small business and an American manufacturer. According to the U.S. Census, in 2019, the number of small businesses dropped to 28.8 million from 30.2 million; only 254,941 of these are U.S. manufacturing companies.

We have stayed in business through a storied history of innovation.

For example, the legendary engineer Harold "Doc" Edgerton was a lifelong friend to Frank Massa (having been in the same class at MIT) and a close friend of the Massa family. In the 1980s, Edgerton was on Massa's board of directors and highly involved with whale research. Doc spoke to Don Massa about Massa's portable sonar and wondered if it could be used to find whales and to learn more about their behavior in the sea. Don, who had worked in his early days as an engineer at the Coast Guard Oceanographic Unit and later at Woods Hole Oceanographic Institution, was keen on the idea and leaped at the opportunity.

Edgerton first obtained a grant from National Geographic to use the sonar system at Stellwagen Bank to locate and learn about whales. *Sea Technology's* 1985 article "Massa Leads by Doing the Impossible" describes that effort in depth (www.massa.com/wp-content/up

[loads/2017/08/Sea_Technology_November_1985.pdf](http://www.massa.com/wp-content/uploads/2017/08/Sea_Technology_November_1985.pdf)). The article was read by Hilary Maybaum, then a graduate student at the University of Hawaii. She contacted Massa to see if there was interest in using the sonar to study the mating patterns of humpback whales in Maui. Edgerton thought that would be fantastic, so he got another grant from National Geographic for this purpose. I was only a young child when I had the chance to go to Maui to study whales with the Massa team, University of Hawaii researchers and Edgerton. It's an experience that has stayed with me. I got to swim with the whales up close. I was able to see how the team recorded beautiful whale songs and hear them played on the boat. The thesis paper that Maybaum wrote from the research she conducted on that trip became the first published paper on how whales respond to sonar.

Today, I continue to help drive this innovative passion internally and externally. As COO and chief innovation officer since September 2018, I have seen the company grow over 60 percent, with increased productivity, sales, product development and community outreach. I believe growth in business can coincide with environmental stewardship. All the groups in the oceanographic community share commonalities, and through positive working relationships, a balance can be achieved between industry and conservation. Massa is a longstanding example of how industry can use technology to enhance business while protecting and learning about marine life and habitats. **ST**

Dawn F. Massa Stancavish is the COO, chief innovation officer and director of Massa Products Corp. She is the third generation of the Massa family at the company. She holds a master's degree in psychology from Fairleigh Dickinson University, with a focus on systems dynamics; has a certificate in finance from Harvard Business School; and is a U.S. patent holder and artist. She serves on NOAA's Stellwagen Bank National Marine Sanctuary Advisory Council and the board of trustees for South Shore Conservatory.

Offshore Weather Awareness

Advanced Weather Sensing Assists Wind Farm Development Vessels

By Mikko Nikkanen

With the demand for renewable energy growing at an increasingly rapid rate, wind energy has the potential to deliver a significant amount of clean energy to meet the power needs of cities throughout the world. With available real estate for traditional land-based wind farms dwindling, offshore wind farm development is advancing around the globe.

Solely within the United States, the National Renewable Energy Laboratory (NREL) estimates that the technical resource potential for offshore wind is more than 2,000 GW of capacity—or 7,200 TW-hr. per year of generation. As deployment in new markets around the world gains momentum, industry experts anticipate offshore installations will account for 20 percent of total wind energy installations by 2025, with acceleration in the United States and key European markets, as well as large ca-

capacity becoming operational in budding markets such as France, South Korea and Vietnam, driving the escalation.

As new installations occupy space in nearshore environments at an increasing rate, the offshore wind industry is moving farther away from coastlines, into deeper waters and harsher environments.

New Environments, New Challenges

As the industry moves farther out to sea, the development of offshore wind farms faces several operational challenges that go well beyond wind resource assessment.

First, in order to capture the abundant wind resources available offshore, turbine blades are growing larger and reaching unprecedented heights—as high as 200 m above sea level—to produce more electricity. The ability



Offshore wind turbine at a wind farm under construction off the English Coast, North Sea. (Credit: DJ Mattaar/Shutterstock)



components and installs them.

While the smaller turbines of decades past posed no real challenges to existing fleets of WTIVs, as turbine sizes substantially grow, so too does the need for larger crane capacities and lifting height on such vessels. Despite the global shortage, these specialized vessels remain critical in not only the initial construction phase of projects but also to maintaining and periodically replacing equipment and, eventually, for the decommissioning phase.

WTIVs must also contend with the elements. In order to maximize the value of an offshore wind farm, project locations are determined by whether there is a high probability of strong winds on a daily basis. If there were not a high probability of strong winds at a particular location, that site would obviously not be selected for an offshore project. So, while strong winds are necessary for the success of offshore wind farms, wind is a major cause of challenges to WTIV operations—costing millions in downtime and repairs. Strong winds have the potential to seriously delay installation operations and prolong construction times, which can have an incredibly expensive impact on a project's bottom line. Wind hazards could also endanger crew safety.

to accurately assess wind characteristics for larger areas and taller turbines is challenging with traditional meteorological masts, which are often either impossible or prohibitively expensive to deploy and maintain during the prospecting phase. Not only do met masts struggle to measure up to the full height of modern offshore turbines without mathematical extrapolation, but increased turbine sizes mean met masts cannot aggregate accurate wind data while staying within a cost-effective budget.

Complicating matters further, the transportation, installation, maintenance and service of wind turbines becomes much more difficult in deeper waters, distant from ports and at the ever-increasing altitudes turbines are now reaching. Even though offshore wind resources are more abundant, more powerful and more consistent than their land-based counterparts, meteorological and oceanic conditions are considerably less forgiving the farther removed from shore a project is located.

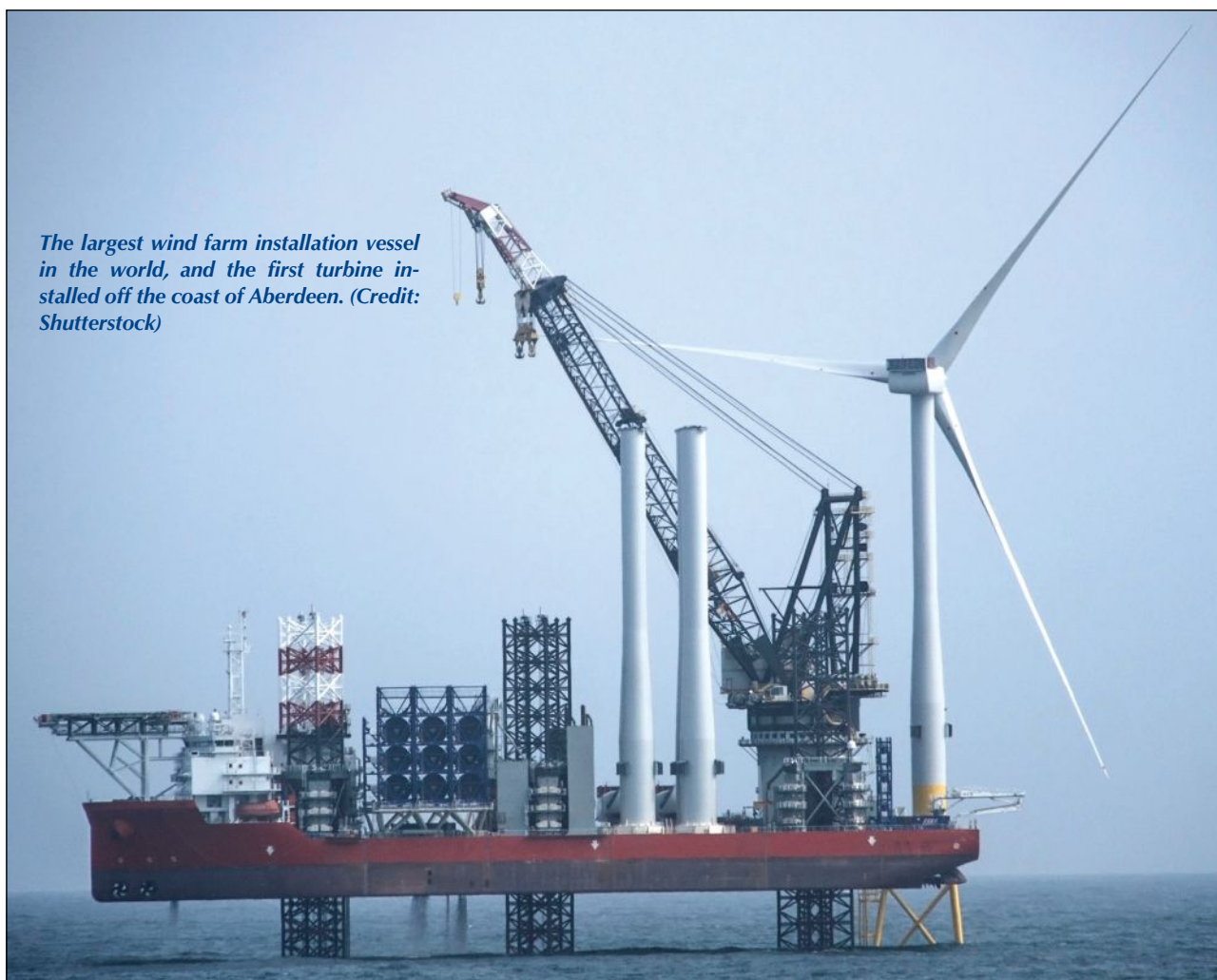
Furthermore, due to the immense demand for offshore wind, there are not enough wind turbine installation vessels (WTIVs) to support this burgeoning market. These massive vessels are large enough to carry the pieces needed to build turbines more than 150 m tall, with blades that extend roughly 100 m and components tens of meters tall, from the port to the installation site. Once they reach the site, these WTIVs are equipped with legs that reach down to the seafloor to steady the vessel and lift it up out of the water so it can serve as a stable platform. From there, a crane on the platform lifts the turbine

components and installs them.

Since the cost of renting a WTIV can range from \$200,000 to \$300,000 per day—and building a new vessel for this application comes with an enormous price tag of up to \$500 million—it's critical to know the wind, wave and other meteorological conditions at any given moment to determine whether it's safe to have a crane lifting turbine components or a helicopter transporting maintenance crews and/or replacement components to the wind plant site. Depending on the weather, the installation of each individual turbine can take up to five days. As a result, minimizing downtime is essential. If an install takes longer than expected, the extra cost of hundreds of thousands of dollars each day is often untenable.

Beyond wind, other environmental factors can have an impact on wind turbine installation. Waves can destabilize platforms, whether that platform is semisubmersible or uses tension legs fixed to the seabed, and most installation vessels have constraints for significant wave height. Additionally, a recent study published in the "International Journal of Naval Architecture and Ocean Engineering" revealed that wind turbine installation faces a myriad of other delay factors. In South Korean waters, for example, the study found delay factors such as precipitation, temperatures below -10° C, and limited visibility as a result of rain, fog or snow can have a significant impact on the duration of construction. Harsh environmental

The largest wind farm installation vessel in the world, and the first turbine installed off the coast of Aberdeen. (Credit: Shutterstock)



conditions are not unique to the sites analyzed in the study, which is why it is crucial that decision makers are equipped with the localized meteorological and forecast information they need to minimize these threats.

Fortunately, precautions to minimize damage and downtime can be taken by utilizing the latest innovations in advanced weather sensing technologies.

Optimizing Operations with Offshore Weather Awareness

Advanced weather sensing technologies can help ameliorate many of the challenges currently being faced by WTIVs during the construction of an offshore wind farm. These solutions include wind LiDAR technologies that enable wind measurements to detect hazardous wind gusts that can impact offshore operations, helideck monitoring systems (HMSs) that provide accurate information on the prevailing weather and helideck motion to ensure effective flight planning and safe landings on the WTIVs during offshore installations, and sensor networks that detect thunderstorms to deliver reliable storm and lightning information to optimize and secure offshore operations. It's crucial for project owners to tie these modern weather sensing technologies together into a comprehensive solution by leveraging software platforms that allow the myriad meteorological technologies to

communicate with one another in order to deliver robust and accurate weather data to improve operational and safety decisions.

With reliable, easy-to-deploy wind LiDAR, companies can create a holistic view of how winds are developing on top of the WTIV—up to 200 m into the atmosphere. A highly refined and mature technology, vertical-profiling wind LiDAR provides unmatched wind measurement capabilities for simplifying offshore operations and maximizing operational continuity while maintaining overall safety. Such instruments can be positioned almost anywhere on the vessel and cover the rotor sweep of even the largest offshore turbines. Commonly used during craning and mounting operations, LiDAR helps ensure the accurate placement and installation of turbines on an offshore site because the wind direction can vary at different altitudes. In addition, future forecasting of operation lengths becomes easier as wind data are collected during the construction phase and can later be evaluated.

By vertically measuring wind speed and direction, modern LiDAR can ensure safety and situational awareness, as well as the right timing for cranes to lift the turbine components. With near-real-time data, a wind LiDAR can be used to inform transportation movements, for example, helicopter lifts and craning around site.

Thus, any helicopter movements around site can be conducted more efficiently and allow operators to work with a higher level of certainty within safety windows for these operations. With offshore wind development accelerating, LiDAR is a timely—and increasingly vital—innovation for consistent, reliable and accurate wind information.

When wind LiDAR is combined with other sensors and solutions, such as an HMS with integrated wave monitoring, a full range of meteorological and oceanographic conditions can be monitored, and any impacts can be quickly quantified to optimize operations, minimize idle time spent at sea and ensure the safety of the on-site crew.

Typically required according to CAP 437: Standards for offshore helicopter landing areas, HMSs help to ensure effective flight planning and safe landings on the WTIVs during offshore installations by leveraging sensors to monitor the wind, visibility, barometric pressure, cloud height, temperature, humidity and wave height. Much like offshore loading, supply vessel loading/unloading and crane operations, helicopter traffic control also requires accurate weather and sea state information on a 24/7 basis.

Advanced HMSs are often equipped with software that includes a real-time data display, reporting tools and critical alarms to enable operators to make more informed decisions during critical weather situations. With accurate weather and motion data, HMSs help decision mak-

ers avoid frustrating—and costly—flight interruptions.

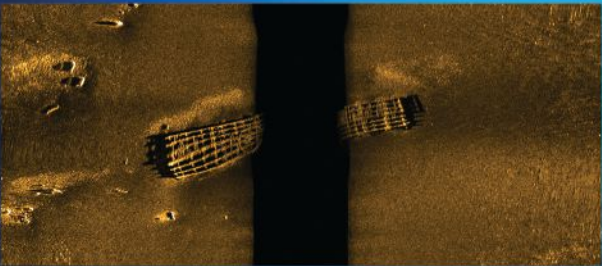
By detecting thunderstorms in real time, tracking their trajectory and intensity, and supporting hazardous weather warnings—even outside the range of weather radar—a global lightning detection sensor network delivers accurate and dependable lightning information for warning applications. These networks are key in ensuring the safety of WTIV operations, where lightning is a significant concern in the transport of helicopters and personnel to and from offshore installations. With reliable and trustworthy lightning data, offshore wind project operators are able to balance operational efficiency with employee and public safety anywhere in the world. Because people and operations depend on accurate lightning detection, early warnings allow decision makers to better anticipate a lightning threat before it reaches the offshore site and helps keep workers safe while reducing the duration of safety shutdowns. Additionally, the comprehensive, actionable data such networks provide can also be used to support local forecast and meteorological applications.

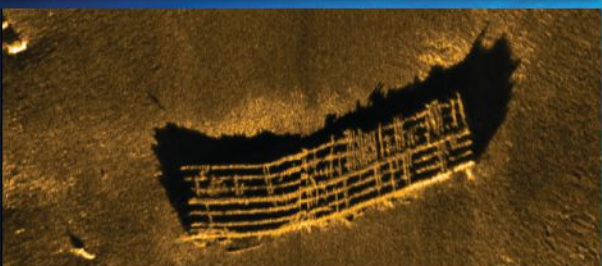
Wind LiDAR, HMS and lightning detection data are vital for: alerting WTIVs before sudden winds, inclement wave and weather conditions, or thunderstorms impact operations, which allows time for crews to secure cranes and position vessels for safety as early as possible; creating a safer environment by better understanding vessel behavior during heavy wind gusts, intense wave activity and dangerous meteorological conditions, such as thunderstorms and lightning events; and making improve-



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“When wind LiDAR is combined with other sensors and solutions, such as an HMS with integrated wave monitoring, a full range of meteorological and oceanographic conditions can be monitored”

ments in planning and updating protocols in offshore environments, which will increase safety and decrease damage and downtime—ultimately saving money in the long term.

Vaisala (www.vaisala.com) provides multiple industry partners with various LiDAR solutions mentioned above, including WindCube Offshore, WindCube Nacelle and WindCube Scan. In addition, hundreds of HMSs carrying Vaisala's meteorological equipment and real-time and historical lightning data, via the Global Lightning Detection Network GLD360, are currently meeting the needs of oil rigs, wind farms and other offshore wind projects around the world.

Conclusion

As the offshore wind industry continues to move into harsher environments with increasingly challenging weather conditions, new approaches are required to uphold safety and performance while minimizing damage, downtime and liability. With a one-week rental of a WTIV ranging from \$1.4 million to \$2.1 million, it is vital for uptime and operations to go as smoothly as possible. Strong winds, high waves, lightning and other meteorological phenomena can potentially put a halt to operations, creating a significant financial burden; damage to the vessel, the crane, the vessel's cargo; or, worst of all, putting personnel in harm's way.

Ensuring the safety of your employees and assets is critical, and monitoring the meteorological conditions that impact your daily functions with wind LiDAR, HMS and lightning detection sensor networks is the ideal way to make offshore weather awareness possible and make the operations most cost efficient. Having comprehensive and proven technologies on your side is priceless as every offshore wind construction site and operation faces different environmental conditions. Once your WTIV is on the way, you need to know the local conditions at your site and which parameters need to be measured and tracked to ensure the safety of your people while maximizing the continuity of your operation. **ST**

Mikko Nikkanen is the head of maritime at Vaisala, a global leader in weather, environmental and industrial measurement, where he brings more than 20 years of global experience in leadership, business development and solution creation in various industries and application areas.



international

Elbit Acquires Sparton

Elbit Systems Ltd.'s U.S. subsidiary, Elbit Systems of America LLC, has completed the acquisition of Sparton Corp. from an affiliate of Cerberus Capital Management L.P. for a purchase price of \$380 million.

Headquartered in De Leon Springs, Florida, Sparton is a premier developer, producer and supplier of systems supporting undersea warfare for the U.S. Navy and allied military forces.

Wavespec Goes Private

Wavespec is now under new ownership as a private entity. Wavespec, a provider of technical services, engineering and solutions to the gas processing, liquefied gas, renewable and marine industries, is now operating its U.S., U.K., Netherlands and Singapore-based offices under a new umbrella, Wavespec Holding BV.

Wavespec's previous owner was Braemar Shipping Services PLC. The new Wavespec Holding is backed by Cosmos SICAV Plc, an investment fund managed by Abalone Asset Management Ltd., committed to invest aggressively in the energy transition.

Safety Procedures for CO₂ Transport

DNV has published new procedures to provide the

required safety level in transporting CO₂ by pipelines and strengthen the development of carbon capture and storage (CCS) projects. This follows the outcome of the CO2SafeArrest joint industry project (JIP) between Energy Pipelines CRC (Australia) and DNV. The work has been supported by the Norwegian funding body CLIMIT and the Australian Commonwealth Government under the Carbon Capture & Storage Research Development and Demonstration Fund.

The need to transport CO₂ is expected to increase significantly as part of the widespread view that CCS is a viable means to reduce CO₂ emissions. Reliable transport from where it is captured to a storage site is therefore of utmost importance.

Maritime Security Guidance

The shipping industry continues to face threats such as piracy, kidnapping and terrorism. Ship operators need to stay alert to security risks and recognize that threats are continually evolving and demand constant vigilance.

To assist the shipping community in preparing for these challenges, the International Chamber of Shipping has launched the first edition of "Maritime Security: A Comprehensive Guide for Shipowners, Seafarers and Administrations." It sets out the security threats faced by the shipping industry today; the statutory requirements that ships, shipping companies and port facilities must meet; and provides guidance on how to conduct a thorough threat assessment for a voyage.

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A model ship security plan is also provided, along with guidance on how to complete it in accordance with statutory requirements.

Alpha Ori Technologies Secures Funding

Maritime digital solutions provider Alpha Ori Technologies (AOT) has closed a \$6 million investment round. The round was jointly led by shipowners Hafnia and BW LPG. Mikael Skov, CEO of Hafnia, has joined the Alpha Ori Technologies' board of directors.

With a diverse range that includes SMARTShip, SMARTVoyager, ShipPalm and VIO, AOT is transforming the multitrillion-dollar maritime industry by replacing disjointed analog systems with smart digital enterprises.

IRClass Authorized for Remote Survey

Panama Maritime Authority has authorized Indian Register of Shipping (IRClass), an international ship classification society, to conduct specific surveys through remote inspection techniques.

As pandemic-induced travel restrictions continue, IRClass can ensure that ships continue to stay compliant with various IMO conventions and sail with valid certificates. IRClass has developed the necessary remote survey guidelines, released earlier this year, and a dedicated facility with the requisite IT infrastructure has been put in place at its head office in Mumbai.

Arcturus Marine Systems Sold After 34 Years

California-based Arcturus Marine Systems, known in the marine market as ABT-TRAC, has been sold by company founder and president D'Milo Hallerberg to businessman Roger Fellows after 34 years.

Hallerberg founded the company in 1986 and built it to become a leader in design and manufacture of bow and stern thrusters, roll fin stabilizers, and onboard hydraulic systems for yachts. ABT-TRAC, based in Rohnert Park, California, employs 47 people.

Fellows also owns Western Marine Electronics Co., known as WESMAR and based in the Seattle area.

Deep Ocean Engineering Patent Approved

Deep Ocean Engineering's patent for its disruptor tool has been approved by the United States Patent and Trademark Office. The disruptor, invented by John D. Bergman, is used for eliminating underwater explosives and comes as an optional attachment for all of Deep Ocean Engineering's ROV models.

Puget LNG Joins SEA-LNG

Puget LNG is the latest LNG supplier to join the growing cross-industry coalition SEA-LNG. This strengthens SEA-LNG's membership base on the North American west coast and underlines the increasing accessibility of LNG as a marine fuel around the world.

The investment made by Puget LNG in its quay-side facility in the Port of Tacoma recognizes that LNG is commercially competitive now and offers financial risk mitigation to shipowners choosing this lower-carbon marine fuel. The facility will have a shared function, provid-

ing LNG for Puget LNG's commercial customers, as well as providing necessary domestic supply backup for Puget Sound Energy's customers.

Kraken Business Updates

Kraken Robotics Inc. has entered into a nonbinding letter of intent in connection with the proposed acquisition of PanGeo Subsea Inc. from Cahill Innovation Inc., a member of the Cahill Group of Companies, and Argentum Asset Management AS.

PanGeo is a private Canadian services company specializing in high-resolution 3D acoustic imaging solutions for the subseabed. This proposed acquisition would accelerate Kraken's transformation to a robotics/data-as-a-service model by increasing recurring service revenue and providing increased exposure to the nondefense market, including the offshore renewable energy market.

Kraken has also acquired 13 Robotics Ltda of Brazil (13R), specializing in autonomous underwater inspection for offshore oil and gas and renewable energy.

Svitzer Americas Moves to Panama

The Panama Design Center (PDC) has welcomed new residents as Svitzer Americas opened its new regional headquarters in Panama City as part of the company's ambition to move even closer to its customers and operations and further strengthen its position in the region.

PDC also houses other entities of the Maersk Group, including Sealand Americas, APM Terminals, Hamburg-Sud, Twill and Maersk Liner Operations Clusters.

Port Canaveral to Host Commercial Vessels

The Hapag-Lloyd container ship *Al Bahia* has arrived at Port Canaveral to begin the required conversion process to reflag the vessel in the U.S. The *Al Bahia* will be renamed the *Delaware Express* and is the first of five Hapag-Lloyd container vessels scheduled to undergo the U.S. reflagging process in Port Canaveral over the next several months. Once the U.S. reflagging process is complete, each vessel will be included in the federal Maritime Security Program and made available for use when necessary by the U.S. government while it continues to operate commercially in international trade.

Compensation for Suez Canal Blockage

Egyptian authorities have seized the massive cargo ship that blocked the Suez Canal for almost a week earlier this year. An Egyptian court ordered the vessel's Japanese owner, Shoen Kisen Kaisha, to pay \$900 million in compensation as a result of losses inflicted when the Panamanian-flagged *Ever Given* prevented marine traffic from transiting through the vital global trade waterway.

Bollinger Acquires Gulf Island Fabrication

Bollinger Shipyards has acquired Gulf Island Fabrication Inc.'s shipyard facilities.

Gulf Island had been building the towing, salvage and rescue ships (T-ATS) for the U.S. Navy and *Regional*-class research vessels for the National Science Foundation and Oregon State University. **ST**

US Offshore Wind Report

ABS has published a report evaluating the U.S. offshore wind industry's readiness to deliver the 40 GW of offshore wind capacity the International Energy Agency estimates will be installed by 2040.

The "ABS Offshore Wind Report, Positioning for U.S. Expansion: U.S. Ports and Vessels Innovation" is a landmark document assessing U.S. port infrastructure, availability of specialist support tonnage, and emerging industry trends and challenges for the growing U.S. offshore wind market.

The report also highlights ABS's leading role in supporting the U.S. offshore wind industry through the development and application of class rules and safety requirements, including classing the first Jones Act-compliant wind turbine installation vessel and service operation vessel.

The report is available at: tinyurl.com/yurk2cu5.

TechnipFMC Teams with Magnora on Offshore Wind

TechnipFMC has entered into an agreement with Magnora ASA to jointly pursue floating offshore wind project development opportunities under the name Magnora Offshore Wind.

Magnora holds a strategic position within the renewable energy sector as an owner in offshore wind, onshore wind and solar development projects, and is a key enabler in solar energy technologies.

When combined with TechnipFMC's unique technologies, experience delivering integrated EPCI projects and its novel Deep Purple initiative to integrate wind and wave energy with offshore green hydrogen storage, this partnership will enable Magnora Offshore Wind to realize significant opportunities in the growing offshore floating wind market.

Magnora Offshore Wind has already commenced operations and started work on an application for the first round of seabed leasing

through the Scottish government's ScotWind Leasing program. In addition, Magnora Offshore Wind will participate in the first offshore wind application round in Norway, which opens in 2021, and will also consider entering new markets.

Fugro to Survey for Danish Energy Island

Energinet has awarded Fugro a marine site characterization contract for the Danish Energy Island project in the North Sea. The contract is part of Energinet's preliminary studies to build the world's first "hub and spoke" energy scheme: an energy island 80 km off the Danish coast that will act as a transmission center for hundreds of surrounding wind turbines.

Fugro will perform geophysical and unexploded ordnance (UXO) magnetometry surveys, which will be used to prepare an integrated geological and geotechnical soil model on which wind farm developers will base future tenders.

The fieldwork will run from May to November 2021, resuming in February and March 2022, and will comprise two phases: phase one will deliver the geophysical surveys, including seabed sampling and soil data down to at least 100 m below the seabed; phase two will be the UXO magnetometry survey, using Fugro's dedicated Geowing solution. Fugro's survey and offshore wind consultancy teams will use the acquired geodata to provide a reliable derisked site interpretation.

Hempel Coatings for Orbital O2 Tidal Turbine

Hempel has provided coatings to protect the Orbital O2 tidal energy turbine, the world's most powerful tidal turbine. Hempel's ambition is to become the leading global coatings solution provider for the global renewable energy segment.

O2 is set to operate at the European Marine Energy Centre (EMEC) in the Orkney Islands, Scotland, where tidal currents can reach over 4 m/s, making them some of the strongest

in the world. To harness this energy, Orbital's O2 comprises two 1-MW turbines, which together create a 600 m² rotor area and can generate 2 MW of clean, predictable energy. O2 is capable of supplying enough energy to power around 2,000 U.K. homes.

TDI-Brooks Surveys For MarWin

TDI-Brooks International Inc. has deployed two of its oceanographic research vessels to the U.S. East Coast to support US Wind's MarWin offshore wind project off the coast of Maryland. TDI-Brooks engaged in the seabed geophysical surveys to better understand the geological issues that may exist with project development to ensure safe and long-term operations and performance of the facilities.

The MarWin project is expected to produce approximately 270 MW of power. The project is expected to come online in 2024.

Magallanes Renovables' Tidal Platform Back at EMEC

The European Marine Energy Centre (EMEC) has welcomed Spanish tidal energy developer Magallanes Renovables back to its tidal test site at the Fall of Warness in Orkney, Scotland, for the successful reinstallation of Magallanes' second-generation 2-MW tidal platform ATIR.

The Magallanes team worked in collaboration with Orkney-based marine service provider Leask Marine, along with the Orkney Harbour Authority tug *Thor*, to install the platform in an operation lasting 8 hr. The ATIR will be connected to the national electricity grid.

Hammer Spread for Italy's First Offshore Wind Farm

MENCK, an Acteon brand, has signed a contract with Dutch marine contractor Van Oord to deliver the hammer spread for the installation of the Taranto offshore wind farm, Italy's first. The installation of 10 monopiles, each supporting a 3-MW turbine, will begin in the third quarter of 2021 and is expected to take 16 days. **ST**

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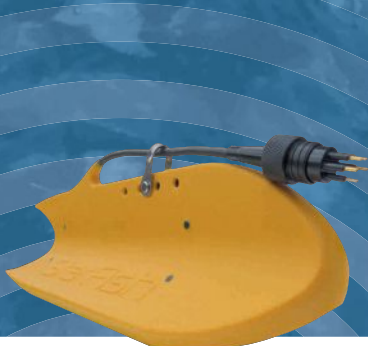
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Sub-Bottom Profilers



Two new pole-mount sub-bottom profilers have been added to the family of 3400 sub-bottom profiling systems. The ultralightweight shallow-water and lightweight shallow-water over-the-side pole-mount 3400-OTS systems use flat multi-channel hydrophone arrays to generate high-resolution images of the sub-bottom stratigraphy in oceans, lakes and rivers. EdgeTech.

Compact Antenna

Intelsat's FlexMaritime service now offers a 45-cm antenna, v45C, for broadband connectivity performance and affordability to leisure, fishing and light-commercial vessels around the world. Intellian Ltd.

Pressure Logger

RBRquartz³ Q|plus meets the demands for high-accuracy, long-term measurements of sea level, tidal and wave dynamics by coastal oceanographers worldwide. It has an integrated Paroscientific Digiquartz pressure sensor for best-in-class initial accuracy, resolution and low-drift performance. RBR Ltd.

Emissions Advisory

Carbon emissions advisory services will help clients navigate changing legislation, source high-quality emissions offsets, and structure and execute carbon offset projects or transactions. The new service is a response to the growing number of requests for shipowners and operators to offset their direct greenhouse gas (GHG) emissions through voluntary carbon standards. IFCHOR and ClearBlue Markets.

Filterless BWMS

EcoOne is a revolutionary new ballast water management system (BWMS) that eliminates the filter. CIO2 treatment technology works effectively as a single-pass treatment under all operating conditions, with no neutralization or retreatment prior to discharge. Ecochlor Inc.

Offshore Wind Vessel



Strat Cat 27 (SC27) caters to the increasing demands from the offshore wind industry and offers enhanced vessel capabilities with a reduced environmental footprint and hybrid drive options. The SC27 is an evolution of the Strat Cat 26. To cater to the different operating areas around the world, several options are available for the propulsion system, deck cranes, active fender system, ride control, etc. Strategic Marine (S) Pte Ltd.

Field-Ready Connectors

Fischer UltiMate 80, a field-ready NATO STANAG 4695-compatible connector, offers unparalleled functionality and ruggedness in comparison with similar harsh-environment quick-release connectors. The standard Fischer UltiMate connector is now available in size 15 with various pin layouts of up to 27 signal and power contacts. Fischer Connectors SA.

Small-Class UUV

The REMUS 300 is open architecture and can dive to depths of 305 m (1,000 ft.). It has endurance options up to 30 hr. Huntington Ingalls Industries Inc.

Automated Fish Counting

This system is designed for tuna farming and utilizes image rec-

ognition technology to count the number of fish. Under optimal conditions, it has succeeded in automatically counting tuna with an accuracy of more than 98%. Yanmar Marine Systems Co. Ltd.

Bio-Rope

Several products, including AmSteel-Blue, AmSteel-X, Saturn-12, EverSteel-X and Turbo-RC, now come with the option of sustainable, bio-sourced fiber made from climate-neutral feedstock through sustainable forestry. This option will enable customers to reduce their carbon footprint. Samson Rope Technologies.

Connectivity Device



The Remote Monitoring Unit (RMU) allows products without internal telemetry hardware to transfer data and communicate with an overarching control and monitoring or asset management system. The RMU can receive data from a connected lantern (and power supply) and transfer to a high-level control and monitoring system such as Star2M using its satcom interface via Iridium. Star2M Pty Ltd.

ROV Motors

New-generation thrusters for Mariscope ROVs are brushless, and they feature robust materials, magnetic coupling and electronic protection, as well as smaller size and increased power. Mariscope Meerestechnik.

Vessel Security Assessment

A comprehensive pentest methodology quickly and cost-effectively assesses the security posture of a vessel even while it is underway. RASP (Rapid Attack Simulation PenTest) provides a deep dive into an IT infrastructure's critical security measures to test and expose deficiencies and recommends fixes. EPSCO-Ra.

Imagery in All Conditions

FLIR M364C combines two cutting-edge imaging systems in a single, robust, pan-and-tilt marine camera housing to produce highly detailed thermal and visible imagery. The result is increased situational awareness and safer navigation via increased object identification capability in any lighting conditions, from total darkness to full sunlight. FLIR Systems Inc.

Data Analytics

Via the Spire Bridge portal, customers can now access Spire Analytics to monitor data usage and get support, documentation and product updates to activate and operationalize data. This tool allows customers to graph, report and visualize data. It can also filter searches by ship type, voyage, density map and more. Spire Global Inc.

Boat Monitoring, Control System

Smart Skipper comprises Smart Mate devices and the Smart Skipper app. Tablets and smartphones

connect to the Smart Mate device's Bluetooth 5.0 mesh network. Blue Guard Innovations.

Multi-Sensor System

OceanObserver is now on Slocum Glider autonomous vehicles. It is an intelligent passive-acoustic, multi-sensor system capable of in-situ, near-real-time underwater sound detection and measurements. JASCO Applied Sciences and Teledyne Webb Research.

Multibeam Sonar

WASSP S3r embeds the Ellipse-D, the new miniature RTK dual-antenna INS from SBG Systems. S3r can survey an area up to 10 times faster than a single-beam sounder. Furuno ENL Group and SBG Systems S.A.S.

Wave Buoy

CB-25-SVS measures wave height, period and direction using the SVS-603 wave sensor for drifting, tethering or mooring applications. NexSens Technology Inc. and SeaView Systems Inc. **ST**

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Framework to Protect Ocean

An international team of 26 authors, including six at UC Santa Barbara, has published a study in *Nature* offering a combined solution to several of humanity's most pressing challenges. It is the most comprehensive assessment to date of where strict ocean protection can contribute to a more abundant supply of healthy seafood and provide a cheap, natural solution to address climate change, and to protecting embattled species and habitats.

The researchers identified specific areas of the ocean that could provide multiple benefits if protected. Safeguarding these regions would protect nearly 80 percent of marine species, increase fishing catches by more than 8 million metric tons and prevent the release of more than 1 billion tons of carbon dioxide by protecting the seafloor from bottom trawling, a widespread yet destructive fishing practice.

The study does not provide a single map for ocean conservation, but it offers a first-in-kind framework for countries to decide which areas to protect depending on their national priorities.

The analysis supports the claim that 30 percent is the minimum amount of ocean that the world must protect in order to provide multiple benefits to humanity.

Testing Hydrogen Fuel Cell

Yanmar Holdings Co. Ltd. and its subsidiary Yanmar Power Technology Co. Ltd. have conducted a field demonstration test for the maritime fuel cell system in Oita, Japan.

The International Maritime Organization has announced a strategy to reduce greenhouse gas emissions to zero by the end of this century.

With marine environmental regulations tightening worldwide, in December 2020, the Japanese Ministry of Economy, Trade and Industry formulated its "Green Growth Strategy towards 2050 Carbon Neutrality," which highlights the development of energy and power sources that reduce impact on the environment, including those for vessels powered by carbon-free fuels such as hydrogen and ammonia.

Yanmar was among the first companies to comply with environmental regulations with its development of dual-fuel marine engines. Looking to the future of powertrain technology, Yanmar has developed a maritime fuel cell system that incorporates hydrogen fuel cell modules from Toyota's MIRAI automobile. The system was installed into Yanmar's EX38A FC pleasure boat for field testing.

The boat is the first to officially comply with the safety guidelines for hydrogen fuel cell vessels formulated by the Ministry of Land, Infrastructure, Transport and Tourism in Japan.

Yanmar has plans to scale the maritime fuel cell system by connecting multiple units. The system is planned to be deployed to larger vessels by 2025.

Warm Water Important For Cold-Water Fish

Warm river habitats appear to play a larger than expected role supporting the survival of cold-water fish, such as salmon and trout, a new Oregon State University-led study found.

The research has important implications for fish conservation strategies. A common goal among scientists and policy makers is to identify and prioritize habitat for cold-water fish that remains suitably cool during the summer, especially as the climate warms.

This implicitly devalues areas that are seasonally warm, even if they are suitable for fish most of the year, said Jonny Armstrong, lead author of the paper and an ecologist at Oregon State. He called this a “potentially severe blind spot for climate change adaptation.”

Two New NOAA Coastal Forecast Models

NOAA has two new coastal condition forecast models that will enhance critical decision making for mariners along the West Coast and Northern Gulf of Mexico. The models provide continuous quality controlled data on water levels, currents, water temperature and salinity out to 72 hr.

Forecasts from both models are used by commercial and recreational mariners, fishermen, emergency managers, search and rescue responders, and National Weather Service marine weather forecasters. These two new models join a network that now totals 15 such models in coastal waters around the U.S. The models—located in critical ports, harbors, estuaries, Great Lakes and coastal waters—are part of a larger national backbone of real-time data, tidal predictions, tide and lakes datums, and operational modeling that enables users to make the best decisions for their needs.

DuPont, Waterise Collaborate On Subsea Desalination

DuPont has entered into a collaboration with Waterise to provide seawater reverse osmosis membranes and expertise to the company's subsea desalination plants.

Subsea reverse osmosis (RO) desalination presents a sustainable and more economical new way to turn seawater to freshwater.

As subsea desalination leverages the natural hydrostatic pressure found at the depths of the sea to run the reverse osmosis, it reduces the energy requirements of conventional RO desalination by 40 percent. It also requires 80 percent less coastal land than land-based plants, presenting a viable option for communities with limited space.

From an environmental perspective, subsea desalination requires lower amounts of pretreatment chemicals and eliminates the discharge of concentrated brine into coastal waters.

Waterise's desalination units reside on the seafloor and will use DuPont's FilmTec seawater membranes. DuPont and Waterise will share knowledge and expertise, as well as collaborate on research and development toward the mission to advance subsea desalination operations and performance. **ST**

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JW Fishers Side Scan Sonar Locates Submerged Truck

The James River is a tributary of the Missouri River. It is roughly 710 mi. long and spans over 20,000 sq. mi. of North and South Dakota, with more than 70 percent of the river's drainage occurring in South Dakota. River conditions during normal years include both still water and flooding on the James River and its tributaries. Water easily breaches the low banks, and these floods tend to cover a significant portion of the floodplain. When the river is still, water quality drops and it becomes difficult to see more than a few feet underwater.

The Beadle County Office of Emergency Management (OEM) is responsible for disaster preparation, response, recovery and mitigation. The office is Beadle County's liaison to the South Dakota Office of Emergency Management. One tool

in their possession is a JW Fishers' side scan sonar system. This system is invaluable for locating drowning victims, missing evidence, dumped cars or ships lost underwater. It becomes especially useful when waters are murky or turbid. The sonar equipment paints a picture of the riverway bottom and allows for identification of objects in a way that increases team safety.

The JW Fishers side scan sonar was used to pinpoint the location of a 2014 Dodge pickup that was driven into the James River. The pickup's orientation was clearly shown to be on its side. Once the pickup was identified, dive team members deployed a J-hook from a Zodiac boat to snag the truck so it could be pulled to shore.

Training Partnership

Kongsberg Digital (KDI) has signed a partnership agreement with

the University of South-Eastern Norway (USN) to develop cloud-based simulation exercises for the international maritime education market. This is KDI's first commercial agreement with an external partner and will enable USN to develop its cloud-based training products and distribute them globally via KDI's digital platform, K-Sim Connect.

The aims of the partnership complement both the cloud-based maritime simulation initiative supported by Innovation Norway, which has the aim of addressing the global need for easily accessible, high-quality, simulation-based training solutions for teaching and practicing navigation, and the COAST (Centre of Excellence in Maritime Simulator Training and Assessment) project, for which USN is the host institution.

Satellite Life Extension

Oslo-based Telenor Satellite, which delivers connectivity solutions for all maritime segments operating throughout the EMEA (Europe,



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Middle East and Africa) and North Atlantic regions, has announced the successful docking of Northrop Grumman's MEV-2 (Mission Extension Vehicle) with its THOR 10-02 satellite. This represents the start of a new era for satellite communications, paving the way for a different approach to satellite servicing and life-extension possibilities.

The THOR 10-02 satellite, jointly owned with Intelsat (Intelsat IS-10-02), was first launched in 2004 and remains in excellent condition, continuing to carry thousands of vital communication links to vessels navigating across busy shipping lanes and operating in remote off-shore fields, as well as delivering connectivity for broadcasting and land-based services in remote locations. The prospect of preserving the operation of these links made it an obvious choice for this pioneering technology, and the companies are the first commercial satellite operators to perform on-orbit servicing of an active satellite in geosynchronous orbit.

The MEV-2 satellite docked directly onto the communications satellite, effectively providing the space equivalent of a jetpack and thus extending the operational life of THOR 10-02/IS-10-02. The MEV-2 has now taken control of both the orbit and pointing of the satellite and will continue to do so until the satellite is eventually retired in approximately five years.

BV Certifies Hybrid Ship

Bureau Veritas (BV) has certified and classed Singapore's first hybrid-powered ship. Built, owned and operated by Singapore-based Penguin Shipyard International, a subsidiary of Penguin International Ltd., *Penguin Tenaga* is a 15-m, 12-passenger aluminum pilot boat capable of entirely running in electric mode at 5 kt. for more than 30 min., and in conventional diesel mode can reach a maximum speed of 24 kt.

The vessel design is based on the same hull form as two of Penguin's existing monohull pilot boats that are currently operating for Shell Eastern Petroleum in Singapore.

Penguin Tenaga is classed under BV with the notation Electric Hybrid and Zero Emission (ZE) mode.

Digitizing Navigation And Compliance

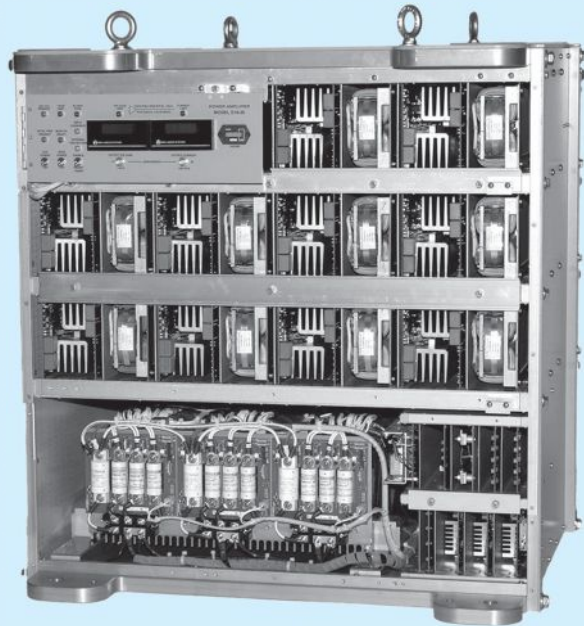
Inmarsat and OneOcean have partnered on the digitalization of navigation and compliance in the maritime industry. The multi-phase agreement, which will see OneOcean become an Inmarsat certified

application provider, aims to leverage Inmarsat's technology platform and OneOcean's digital solutions to transform the way voyage planning software is deployed, updated and integrated between ship and shore.

The agreement will enable OneOcean software to be deployed over Inmarsat's high-speed Fleet Connect dedicated bandwidth service, which is completely separate from crew and business traffic. **ST**

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Comanche ROV Sea Trials For Arctic Research

Forum Energy Technologies' light work-class ROV, Comanche 38, has successfully completed sea trials with Amundsen Science (Université Laval, Canada).

The ROV was sold to the scientific research organization last year and will support exploration of Arctic and sub-Arctic seafloor ecosystems. The vehicle was installed on board the Canadian research ice-breaker vessel, CCGS *Amundsen*.

The ROV's deployment procedures and versatile capacity trials included undertaking video surveys, high-resolution still photography of benthic habitats, collection of coral and other benthic fauna samples, and sediment sampling using precisely positioned sediment push cores.

Seafloor Observatory Installed In Conception Bay

The Fisheries and Marine Institute of Memorial University and the University of Victoria's Ocean Networks Canada (ONC) have installed a seafloor observatory in Conception Bay to enable real-time monitoring of oceanographic conditions and marine life.

Equipped with specialized instrumentation, the \$750,000 observatory monitors currents, waves, water temperature, salinity and underwater sounds. It also features a high-resolution camera developed by SubC Imaging of Newfoundland and Labrador to collect time-lapse video of nearby flora and fauna.

Located 4 km north of the Marine Institute's (MI) Holyrood marine base, the observatory sits in 85 m of water and sends real-time data via a seafloor, fiber-optic cable. The observatory is expandable and will also serve as a development, testing and demonstration facility for subsea instrumentation operating in harsh environments.

The cabled observatory was designed and built by ONC. ONC monitors the west and east coasts of Canada and the Arctic to contin-

uously deliver data in real time for scientific research that helps communities, governments and industry make informed decisions. MI is an associate member of the ocean observation network.

Warming Climate Favors Invasive Blue Catfish

A new study by researchers at the Virginia Institute of Marine Science (VIMS) suggests that continued warming of Atlantic coastal waters may enhance the spread of invasive blue catfish in the Chesapeake Bay and other estuaries along the U.S. East Coast.

The research, by Dr. Vaskar Nepal and Dr. Mary Fabrizio of VIMS, appeared in *PLOS ONE* and builds on an earlier study by the two authors showing that blue catfish can better tolerate salinity spikes than most freshwater fishes, and thus may be able to expand their range downstream into mainstem Chesapeake waters, and from there into new bay tributaries and even Delaware Bay.

"Blue cats" were introduced to tidal freshwater stretches of the James, York and Rappahannock Rivers during the 1970s and 1980s to enhance recreational fisheries. They feed on vegetation, mollusks and fishes, often out-competing native species.

East Coast estuaries are warmer and typically saltier during summer; colder and fresher during winter and spring. Their heat and salt content can also vary on shorter time scales during rainy spells, drought, heat waves or cold snaps.

The research results show that warmer water temperature has a positive effect on the biology of blue catfish under salinity conditions often encountered in estuarine waters. Warmer, fresher waters—as projected by climate models of the bay due to increased trapping of heat and enhanced precipitation—would appear to favor the spread and establishment of blue cats.

"Given these findings, state and regional management agencies

should pay close attention to habitats at these salinities, especially in areas that provide nursery habitat for native species of conservation concern," Nepal said.

Early Earth May Have Had Bigger Ocean

A vast global ocean may have covered early Earth during the early Archean eon, 4 to 3.2 billion years ago, a side effect of having a hotter mantle than today, according to new research. The findings challenge earlier assumptions that the size of the Earth's global ocean has remained constant over time and offer clues to how its size may have changed throughout geologic time.

Most of Earth's surface water exists in the oceans. But there is a second reservoir of water deep in Earth's interior, in the form of hydrogen and oxygen attached to minerals in the mantle.

A new study in *AGU Advances* estimates how much water the mantle potentially could hold today and how much water it could have stored in the past. Since early Earth was hotter than it is today, its mantle may have contained less water because mantle minerals hold onto less water at higher temperatures.

If early Earth had a larger ocean than today, that could have altered the composition of the early atmosphere and reduced how much sunlight was reflected back into space. These factors would have affected the climate and the habitat that supported the first life on Earth.

Ranger 2 USBL to Support RV *Atlantis*, Alvin Submersible

Sonardyne's Ranger 2 ultrashort baseline (USBL) underwater tracking technology will provide improved support to oceanographic work from the RV *Atlantis*, including science expeditions in the manned submersible Alvin.

The latest Ranger 2 provides greater precision, speed and range tracking and replaces the existing Ranger 1 system for the ship. Upgrades include a new AvTrak tracking and telemetry instrument for Alvin to support the increased depth rating from 4,500 to 6,500 m. **ST**

meetings

Note: The coronavirus (COVID-19) pandemic could affect event dates. Check event websites for the latest updates.

AUGUST

August 16-19—AUVSI XPONENTIAL, Atlanta, Georgia. www.xponential.org.

August 16-19—Offshore Technology Conference, Houston, Texas. www.otcnet.org.

August 17-18—CLEAN PACIFIC, Renton, Washington. www.cleanpacific.org.

August 23-27—World Water Week, Virtual. www.worldwaterweek.org.

August 30-September 2—Oceans In Action, Gulfport, Mississippi. www.mtsociety.org/oceans-in-action.

August 31-September 2—MAST Europe, Toulon, France. <https://mastconfex.com/europe2021>.

August 31-September 2—Subsea Tieback, Galveston, Texas. OffshoreEvents@endeavorb2b.com or www.subseatiebackforum.com.

SEPTEMBER

September 7-10—SPE Offshore Europe, Aberdeen, Scotland. +44 (0) 1224 253807, gillian.george@bigpartnership.co.uk or www.offshore-europe.co.uk.

September 13-17—London International Shipping Week, London, England. +44 1296 682104, ljacobs@elabor8.co.uk or <https://londoninternationalshippingweek.com>.

September 19-24—Underwater Minerals Conference, St. Petersburg, Florida. lazevedo@immsoc.org or www.underwaterminerals.org.

September 20-22—Oi Middle East, Abu Dhabi, United Arab Emirates. www.oceanologyinternationalmiddleeast.com.

September 20-23—Global OCEANS 2021 San Diego – Porto, California and Virtual. <https://sandiego21.oceansconference.org/global-oceans-2021-san-diego-porto>.

September 20-24—NMEA/RTCM Conference & Expo, Orlando, Florida. 410-975-9425, enauer@nmea.org or www.expo.nmea.org.

September 21-23—Sea Asia, Singapore. www.sea-asia.com.

September 26-October 1—SEG21, Denver, Colorado. seg.org/AM.

September 29-October 1—Lakebed 2030 Conference, Virtual. 231-995-2500 or marinecenter@nmc.edu.

OCTOBER

October 5-7—Deepwater Operations and Topsides, Platforms & Hulls Conference and Exhibi-

tion, Galveston, Texas. www.offshore-event.com.

October 12-14—Ocean Business, Southampton, U.K. www.oceanbusiness.com.

October 26-27—Offshore Energy, Amsterdam, Netherlands. www.offshore-energy.biz.

NOVEMBER

November 2-5—Aquatech Amsterdam, Amsterdam, Netherlands. +31 (0)6 51815306 or a.koomen@rai.nl.

November 2-5—Europort, Rotterdam, Netherlands. www.europort.nl.

November 15-19—BlueTech Week, Virtual. www.tmablue-tech.org/bluetech-week.

November 16-17—Subsea Asia, Kuala Lumpur, Malaysia. www.subseauk.com/11668/subsea-asia-2021.

November 16-18—CLEAN GULF, San Antonio, Texas. cdavie@accessintel.com or www.cleangulf.org.

November 24-25—Marine Renewables Canada, Halifax, Canada. <https://marinerenewables.ca/marine-renewables-canada-2021-annual-conference-november-24-25-2021>.

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



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contracts

Danfoss Editron, Nordborg, Denmark, has been chosen to provide the drive train system powering Singapore's first plug-in parallel hybrid-electric fast-launch vessel. Sea Forrest Power Solutions Pte Ltd.

Wärtsilä, Helsinki, Finland, has signed an optimized maintenance agreement to evaluate Wärtsilä's Expert Insight predictive maintenance service as part of a pilot program that could lead to fleet-wide implementation. Nippon Yusen Kaisha (NYK) and Monohakobi Technology Institute (MTI).

Nicola Offshore GmbH, Hamburg, Germany, has signed a commercial partnership agreement with the goal of sharing knowledge and resources to unlock new efficiencies for acquiring marine data using multibeam echosounders, subsea gliders and ocean monitoring instruments. Cyprus Subsea Consulting and Services C.S.C.S. Ltd.

Damen Shipyards Group, Gorinchem, Netherlands, has announced a partnership, named "DP Lease," for the financing of green shipping projects. DP Lease will provide flexible, long-term lease financing solutions to solve the finance gap created by additional capital expenditure requirements associated with the purchase of environmentally advanced vessels. DP Lease aims to support decarbonization of the maritime industry. Purus Marine.

Next Geosolutions, London, U.K., with the support of CoNISMa (National Inter-University Consortium for Marine Sciences), which will perform environmental survey tasks, has been awarded the survey works for the west section of power cables of the Tyrrhenian Link project (the Italian national transmission grid for high and extra-high voltage power). Terna.

Norsepower Oy Ltd., Helsinki, Finland, has signed a framework agreement to deliver project management, delivery and installation supervision to support installation, servicing and warranty of Rotor Sails. Offshore Technology Development (OTD), Keppel Offshore & Marine.

DEME's French subsidiary SDI, Lambersart, France, has received an EPCI contract for the export cable that will connect the Leucate floating offshore wind farm to the power grid, in a consortium with JDR Cables. Réseau de Transport d'Électricité.

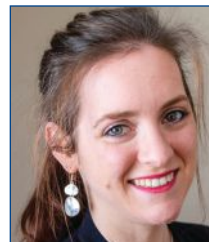
VIKING Life-Saving Equipment, Esbjerg, Denmark, will deploy HydroPen container firefighting innovation on 85 vessels. CMA CGM Group.

TechnipFMC, London, U.K., has received a notice to proceed for a subsea production system contract for the Barossa project, located 300 km north of Darwin, Australia, at 130-m water depth. The contract covers the supply

of subsea trees and associated control systems, manifolds and wellheads, as well as installation and commissioning support, which will help to extend the life of the existing Darwin LNG facility. Santos Ltd. **ST**

people

OneOcean has appointed **Adam Pang** as chief commercial officer. He has an extensive background in disruptive technology and holds specialist knowledge in complex software-as-a-service (SaaS) solutions. With over 20 years of experience in high-growth B2B environments, he has built commercial teams at scale using modern data-driven insights and the latest tech stack available for sales, marketing and customer success.



ROSEN (UK) has promoted senior corrosion engineer, and chair of the Young Pipeline Professional Europe, **Marguerite Forde** to integrity solutions specialist and sales manager, focusing on the U.K. and Ireland. The role will play an integral part in growing the business's integrity service offering both on and offshore.

Forde has a decade of corrosion engineering experience and has worked for ROSEN (previously MACAW Engineering) since 2011.

Sea Machines Robotics has hired **Moran David** as chief commercial officer, reporting to the company's CEO, **Michael G. Johnson**. He is responsible for global sales and marketing of Sea Machines' advanced technology to the builders and operators of the world's commercial and defense fleets.

MacArtney UK has appointed **Kevin Murray** as head of sales. He will work closely with Managing Director **Phil Middleton** in the strategic leadership of sales activity within the business and will contribute toward ambitious plans for growth.

Tanner A. Johnson, a former legislative director for Sen. Mary Landrieu (D-La.), has joined Van Ness Feldman LLP's Washington, D.C., office as a policy adviser. Johnson brings decades of experience in the areas of coastal restoration and resiliency, federal energy policy, environmental restoration and climate change, as well as federal and NGO grant processes to the firm.

Swathe Services has appointed **Kerry Beckwith** as business development manager. She will also provide consultancy to sister company Unmanned Survey Solutions. **ST**

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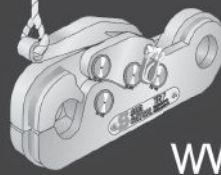
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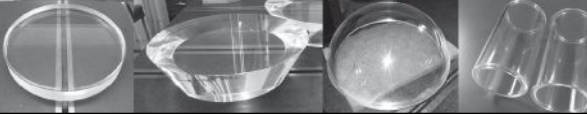
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Dr. Francisco de los Santos serves as the chief information and innovation officer for the Algeciras Port Authority, where he works to help bring to reality the Algeciras Logistics Innovation Cluster. He holds an M.S. in civil engineering, an executive master in telecom management and IT, a Ph.D. in port engineering, and an executive M.B.A. from the IESE Business School at the University of Navarra.



In order to manage the port call process successfully, ensuring smooth interaction among all parties is paramount.

There are many actors at play: the terminal, pilots, port authority, maritime authority, stevedores, shipping lines and others. Coordinating so many parties has, in the past, been rather haphazard.

Over the last decade, huge technological advances have made a significant impact in improving port call efficiency with respect to coordination.

Now, technology provides us with more data and different ways to be more effective in the coordination of the various actors involved in port calls. This is not only the case in so far as operational processes go, but also in terms of the exchange of data, our ability to check important information, the reduction of idle time, reduction of waiting times, and an increase in situational awareness, resulting in the safer management of large vessels entering or departing a port.

As well as increasing the operational efficiency of the port call process, we have also recently found new means to improve port-to-port connection within the global maritime logistic chain and are gradually improving further upon that goal. In these ways, innovative technological tools are helping us to avoid or reduce emissions.

The challenge that we currently face is that there are numerous legacy processes to look at anew and many actors from whom we need to seek consensus in order to coordinate the whole ecosystem of ports.

The first step in achieving that aim was to develop a common language, with the standardization of data and a common view of the business process, agreed upon by all stakeholders. That was essential before we could then begin to apply technology to the standardized process.

We have come a long way in the past 10 years in areas such as real-time communications and algorithms that allow us to more accurately forecast arrivals or departures. Today, technology of this sort allows us to be far more synchronized, coordinated, safer and efficient than we were even just a few years ago.

In recent years, as part of the Algeciras BrainPort 2020 program, we have collaborated with around 40 start-ups and tech companies, with one of the most significant collaborations being with the digital solutions provider PortXchange. The open innovation program that we are pursuing focuses on encouraging start-ups to collaborate and co-create the next-generation Algeciras Port.

The port is located in Andalusia, Spain, and was recognized with the ESPO (the European Sea Ports Organisation) Award in 2020.

The collaboration between the Port of Algeciras and PortXchange is helping us make huge gains in efficiency. With the user-friendly PortXchange technology platform and the company's guidance in its adoption, we are no longer operating on the basis of opinions and conjecture at the port. Instead, by making verified data accessible to each of the various actors involved, we are empowered to make more informed and strategic port call decisions. Thus,

vessels' idle and waiting times can be dramatically reduced.

One of our key objectives at Algeciras Port is to eliminate waste in operations. Our intention is that idle and waiting time on arrival and departure should tend to zero. To that end, we envisage that the collaboration with PortXchange and the implementation of the tech platform in our port community—offering a real democratization of data—can not only help to lower waiting and idle time but also support better utilization of port assets and minimize CO₂ and NOx emissions.

It is too soon to cite figures evidencing the success of the recent initiatives we have put in place at Algeciras Port, but we can clearly see a qualitative impact: All signs are positive, and we are confident of a good return on investment.

For example, regarding our goal to reduce idle and waiting times for vessels calling at our port and to improve these numbers year by year, we are monitoring the idle time on arrival and departure per port call and have observed clear improvements in the container sector.

At the Port of Algeciras, we are not pursuing a philosophy of innovation and collaboration with forward-thinking start-ups because it is fashionable to modernize. We do it because we believe this is the surest route to stay competitive in the sector, to differentiate our offering in terms of the quality of service, and to do so in a sustainable manner.

But we do possess other, more altruistic motivations as well. It is imperative that we continue to seek inventive answers to the problems that have long beset shipping—not least, inefficiencies in the port call process. Above and beyond improving our bottom lines, our goal must be to leave a better planet for our children and future generations. With effort, cooperation and the right mindset and technology, that goal is possible. **ST**

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