

SEA TECHNOLOGY®

An aerial photograph of a long bridge spanning a wide river. The bridge has multiple piers and a long, straight deck. In the background, a large, forested hill rises above the riverbank. The trees are mostly green, with some yellow and orange foliage visible on the left side of the hill. The sky is a clear, pale blue.

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**Oceanology International 2020, March 17-19, ExCel London, U.K.

**OCEANS 2020 Singapore, April 6-9, Singapore

MARCH - digital only

Electronic Charting/Vessel Management/

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APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

**AUVSI XPONENTIAL 2020, May 4-7, Boston, MA

**Offshore Technology Conference, May 4-7, Houston, TX

**UDT 2020, May 26-28, Rotterdam, The Netherlands

MAY

Communications, Telemetry, Data Processing

**BlueTech Expo, June 10-11, Washington, DC

**CLEAN PACIFIC 2020, June 9-11, Seattle, WA

JUNE

Seafloor Mapping/Sonar Systems/Vessels

JULY - digital only

Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST

Geophysical Exploration/Seafloor Engineering

**SEG 2020, October 11-16, Houston, TX

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

**Offshore Energy 2020, dates TBD, Amsterdam, The Netherlands

**OCEANS 2020 Gulf Coast, October 19-22, Biloxi, MS

**CLEAN GULF 2020, October 20-22, San Antonio, TX

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

**International Water Conference, November 8-12, San Antonio, TX

NOVEMBER

Undersea Defense/Antisubmarine Warfare

DECEMBER

Diving, Underwater Vehicles & Imaging

**Underwater Intervention 2021, dates TBD, New Orleans, LA

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2020

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CONTENTS

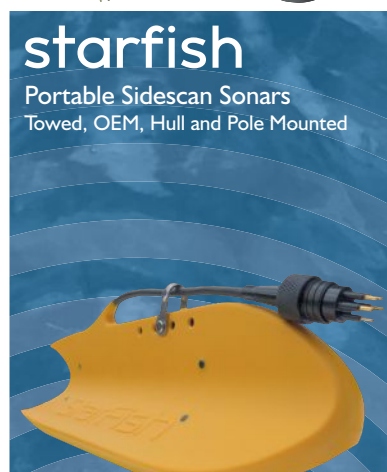
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FEATURES

- 10** **ONE-SOURCE SOLUTION**
Stuart Mason (*Teledyne Marine*), Burns Foster (*Teledyne CARIS*) and Gaspar Lima (*Teledyne Optech*) discuss the advantages of using a single supplier for survey needs.
- 15** **ENVIRONMENTAL TELEMTRY**
Helen Taylor and Matt Trumbo (*In-Situ*) give an overview of new tech advancements that make remote monitoring more affordable.
- 19** **OCEANOLOGY INTERNATIONAL**
—Conference Preview
- 21** **SOUND-SPEED PROFILING**
Jim Gardiner (*Valeport*) explains how simplicity is key in the evolution of profilers.
- 24** **INDUCTIVE-CONDUCTIVITY CELL**
Dr. Mark Halverson, Eric Siegel and Dr. Greg Johnson (*RBR*) offer a primer on high-accuracy CTD technology.



DEPARTMENTS

- | | |
|-------------------------------|---|
| 7 Editorial | 37 Marine Resources |
| 9 Soundings | 38 People |
| 28 International | 39 Contracts/Meetings |
| 30 Product Development | 40 Professional Services Directory |
| 32 Marine Electronics | 41 Soapbox |
| 34 Ocean Research | 42 Advertiser Index |
| 36 Marine Renewables | |

COVER IMAGE

A Teledyne solution of sensors and software (RESON T50 multibeam, Optech M3 laser, PDS and CARIS) were used to survey the West Mission Bay Drive Bridge in San Diego, California, as part of the Teledyne Marine Technology Workshop held in October 2019. See story in this issue.

NEXT MONTH

Unmanned surface vehicles to enhance port, harbor security ... Voice navigation for vessels ... Cutter suction dredge 3D construction software ... Marine lubricants for vessel management ... Project management for Boston Harbor submarine cable.

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Elizabeth Scallon, WeWork Labs, Northern California/Northwest

Accelerating Blue Growth

The Maritime Blue Innovation Accelerator is the first Washington state maritime accelerator and among only a handful that exist in the U.S., established by Washington Maritime Blue, the Port of Seattle and WeWork Labs. The goal is to demonstrate the capabilities, opportunities and leadership our region has to be a global innovation hub for the blue economy.

Eleven promising start-ups were selected for the first cohort of the accelerator, which began January 2020. They were picked from more than 100 applicants.

The chosen start-ups are: Beam Reach, which catalyzes marine research and education about the oceans, bioacoustics and sustainability across the critical habitat of the endangered orcas, from northern California to British Columbia, with a focus on Puget Sound and the Salish Sea to empower future generations to protect our orca population; Discovery Health MD, which offers a suite of services to improve health at every stage of a mariner's career, reduce an employer's risk exposure, and alleviate the fear and anxiety of providing medical care at sea; ecoSpears, which is a clean-tech-solutions company utilizing green, NASA-developed environmental technology for the cost-effective, sustainable and permanent extraction and destruction of persistent environmental toxins; eOceans, which is building data and analytical software to make sure ocean science can keep pace with business, society and ocean change; Equill, which has a digital platform that helps eliminate waste and inefficiencies through technological solutions that directly connect truck owner-operators and shippers by automating the entire process; Net Your Problem, which provides fishing gear recycling services to fishermen and fishing companies then upcycles the gear into raw plastic that's transformed into a variety of new products; oneTank, which markets, sells, assembles, tests and delivers a simple, small, low-consumption and low-cost ballast water treatment system; OneForNeptune, which is changing the food industry with healthy, high-protein snacks made from sustainable seafood products; Pure Watercraft, which develops high-performance electric outboard motors and battery packs to enable a new era of enjoyable, accessible, environmentally friendly boating; SPBES, which provides high-power lithium-ion energy storage to hybridize or electrify heavy industrial equipment; and MER Equipment, which is building a new engine exhaust gas after-treatment system to reduce fuel consumption while also decreasing nitrogen-oxide particulate matter as a lighter, smaller, less costly alternative to diesel engines.

These entrepreneurs will benefit from intensive programming over a four-month period. Start-ups will receive access to the Washington Maritime Blue industry and ocean leaders alongside WeWork Labs' global network of mentors and advisers. This will be a powerful opportunity for local companies to grow and secure funding in a sector where capital is often scarce.

The accelerator will conclude in April 2020 with a formal Showcase Day, when the start-ups will pitch their ideas to a curated audience of investors, mentors, corporate partners and government officials. The Showcase Day will coincide with the annual Maritime Blue Summit that will attract hundreds from around the world.

The Organisation for Economic Co-operation and Development (OECD) predicts the global ocean economy is expected to double to \$3 trillion by 2030. We must employ sustainable solutions and accelerate innovation that addresses current climate and ocean health challenges to enable responsible growth of the blue economy.

The Washington Maritime Blue cluster organization is a strategic alliance formed to accelerate innovation and sustainability, building on one of the most diverse, interdependent and strong maritime and ocean economies in the U.S. With Washington's strengths in technology development, advanced manufacturing and a culture of best practices, our region will be able to grow jobs, protect the environment and support resilient communities. **ST**

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SAAB

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)) Major Step in Undersea Sampling Automation Could Influence Space Exploration. A hybrid ROV developed by Woods Hole Oceanographic Institution (WHOI) has taken the first known automated sample performed by a robotic arm in the ocean. An international team of researchers used one of WHOI's underwater robots, Nereid Under Ice (NUI), to explore Kolumbo volcano, an active submarine volcano off Greece's famed Santorini island. "For a vehicle to take a sample without a pilot driving it was a huge step forward," said Rich Camilli, an associate scientist at WHOI leading the development of automation technology as part of NASA's Planetary Science and Technology from Analog Research (PSTAR) interdisciplinary research program. "One of our goals was to toss out the joystick, and we were able to do just that." Camilli was part of an international team of researchers on an expedition aimed at learning about life in the harsh, chemical-laden environment of Kolumbo and exploring the extent to which scientists can hand over the controls to ocean robots and allow them to explore without human intervention. Slightly smaller than a Smart Car, NUI was equipped with Artificial Intelligence (AI)-based automated planning software that enabled the ROV to decide which sites to visit in the volcano and take samples autonomously. The very first automated sample was of a patch of sediment from Kolumbo's mineral-rich seafloor. This level of automation will be important for NASA as it looks toward developing technologies to explore ocean worlds beyond our solar system. Further work will include training ocean robots to see like ROV pilots using "gaze tracking" technology and building a robust human-language interface so scientists can talk directly to robots without a pilot go-between. There could eventually be a network of cognitive ocean robots with a shared intelligence spanning an entire fleet.

)) 5G to Revolutionize Shipbuilding Business. Verizon's 5G Ultra Wideband service is now live at Newport News Shipbuilding (NNS), a division of Huntington Ingalls Industries (HII) in Newport News, Virginia. HII is America's largest military shipbuilding company, and its Newport News Shipbuilding division turned to Verizon to explore how 5G can enhance the shipbuilding process as part of its digital transformation. With 5G's increased bandwidth and ultralow latency, NNS will be better equipped to meet network connectivity demands and will test new ways its engineers can use augmented and virtual reality (AR/VR) to support everything from architectural design to employee training. The company recently undertook a rapid modernization, transitioning from pen-and-paper designs to tablets and allowing smartphones to be used on premise. As a company that deals with government classified information, the change not only led to increased bandwidth needs but also the need for network reliability and security. With Verizon 5G, network virtualization will lead to a dramatic reduction in service deployment times, allowing for quick security updates. Further, 5G is expected to be able to support up to 1 million connected devices per square kilometer, and its increased throughput and low latency will enable things like autonomous robotics and enhance machine learning and AR/VR solutions to improve the overall speed and quality needed to deliver U.S. warships.

)) Digital Waves Project to Advance Maritime Digitalization. Columbia Shipmanagement Ltd. (CSM) and the Cyprus Marine and Maritime Institute (CMMI) have signed a memorandum of understanding to launch Digital Waves, a comprehensive joint innovation program to explore the digitalization of certain domains of the maritime industry. Digital Waves will have a global perspective and address domains including the sensorization of ships, augmented and virtual reality, the gathering and grooming of data using 5G and edge-cloud technologies, and incorporation of the latest trends in machine learning and cognitive artificial intelligence. These elements will form a holistic program to contribute to significant efficiencies, cost savings and strategic transformation. The program will also analyze the value chain of the maritime sector and investigate potential transformations of the business model. Digital Waves will have three phases. The first phase involves strategic analysis of the main issues faced by maritime industry stakeholders. The second phase will involve real-time testing and implementation in maritime environments. The final phase will be the development of digital products and solutions.

)) Coalition Forms to Focus on Offshore Wind Energy. The international Ocean Renewable Energy Action Coalition has been formed to advance sustainable deployment of ocean-based renewable energy and mitigate the harmful impacts of climate change. Ocean-based renewable energy—such as offshore wind, floating solar, tidal and wave power—could meet nearly 10 percent of the annual greenhouse gas emissions reductions needed by 2050 to keep global temperatures under 1.5° C above pre-industrial levels, according to a report released by the High-Level Panel for a Sustainable Ocean Economy. Most of this climate change mitigation potential is expected to come from offshore wind. Bringing together civil society, intergovernmental institutions and industry, the Action Coalition will represent the offshore wind sector in the global dialogue on climate action. It will be spearheaded by Ørsted and Equinor. The group also includes: CWind, Global Marine Group, JERA, MHI Vestas, Mainstream Renewable Power, Shell, Siemens Gamesa, TenneT and the Crown Estate. The Action Coalition will prepare a vision for 2050, highlighting the actions that industry, financiers and governments can take to sustainably scale-up offshore wind and, thereby, contribute to the UN Sustainable Development Goals and global decarbonization goals. Initial outputs will be announced at the UN Ocean Conference in Lisbon in June 2020. **ST**

One-Source Solution

The Advantages of Using a Single Supplier for Survey Needs

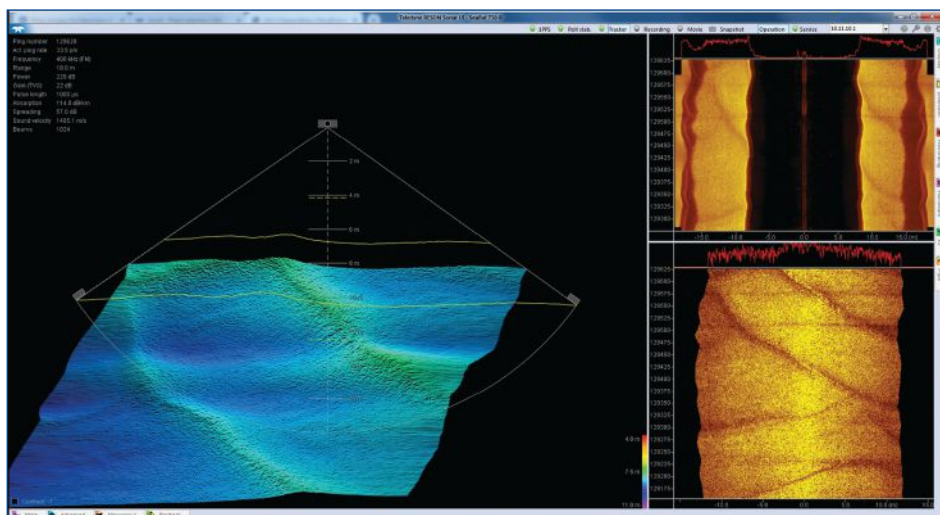
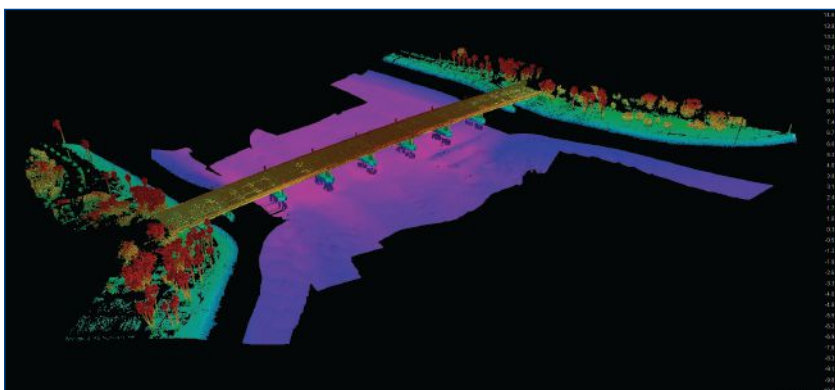
By Stuart Mason • Burns Foster • Gaspar Lima

Near-shore hydrographic surveying can be a challenging task even under the most ideal conditions. Whether a survey is being conducted to determine the safety of navigation, support construction and infrastructure management, or aid scientific research, the survey platforms typically involve multiple sensors operating simultaneously and integrated. Advances in sensor technology mean sensors can operate with incredible coverage and precision, resulting in significant volumes of data collected in even a single pass to maximize the survey efficiency of the platform.

Through the collaboration of several business units under the Teledyne Technologies umbrella, a new integrated solution for the marketplace now exists. This system allows customers to easily collect and process data utilizing world-leading sensors and software with unparalleled efficiency. With this single-source solution, users can achieve high-accuracy data for real-time analysis, providing quick responses with less resource requirements.

(Top) The final data set of the West Mission Bay Drive Bridge survey showcases the combined Teledyne solution, including spatial data from multibeam (Teledyne RESON) and laser scanner (Teledyne Optech). (Bottom) The SeaBat T-series user interface provides real-time visualization, control and pre-analysis.

This solution was recently applied in a combined survey undertaken on the West Mission Bay Drive Bridge, San Diego, California, in tandem with the Teledyne Marine Technology Workshop held nearby in early October 2019. A high-density multibeam sonar sensor was paired with a high-density laser scanning system (LiDAR) in addition to the supporting inertial positioning system and





Installation of Teledyne Technologies solution for the West Mission Bay Drive Bridge survey.



sound-speed sensors. A highly efficient data collection effort can introduce a significant bottleneck as the surveyor must then take the collected data and post-process them into whatever data products are required for the project. As a solution, equipment and workflow was optimized within the Teledyne ecosystem to maximize the potential of the data within the most efficient time possible.

Equipment Selection

Teledyne RESON SeaBat T50 Sonar. SeaBat T50 produces unprecedented clean data, providing faster operational surveys and reduced processing time. The SeaBat T50 is fully frequency agile from 190 to 420 kHz, allowing for improved swath performance and reduced survey time under challenging acoustic conditions, and offers a beam resolution of 0.5° by 1° , with up to 1,024 uniquely beamformed soundings per ping.

The SeaBat T-series has been designed to provide exceptional acoustic performance for high-precision surveys that require minimal data cleaning and post-processing. The aim of the SeaBat T-series is to get the user the required data—cleaner, faster and cheaper.

Built to facilitate a wide range of hydrographic tasks, the SeaBat T-series offers several data management tools. Both the user interface and the sonar are fully user configurable—or the user can select the intelligent Tracker Autopilot—and maintain focus on other tasks at the same time. Data acquisition on the West Mission Bay Drive Bridge was acquired in exactly this mode, the sonar adjusting its operating parameters to the optimum settings, based on an ongoing analysis of the data returned in real time.

Teledyne Optech TLS-M3 LiDAR Scanner. The TLS-M3 from Teledyne Optech is a high-resolution laser scanner

system (2 mm at 100 m), capable of collecting up to 500,000 points per second with survey-grade accuracy (5 mm). It can reach up to 2,000 m and delivers a highly detailed 3D point cloud of all above-the-water features.

The TLS M3 was designed for outdoor applications and includes an internal heat system and a protective marine package for marine applications. It can be installed on a vessel, terrestrial vehicles for mobile operations, or on a tripod or pillar for static and monitoring applications.

The sensor is fully integrated with PDS software from Teledyne RESON. PDS controls the unit, manages the survey parameters, streams the data, synchronizes and displays the 3D point cloud in real time.

Installation

For the collection of the data at West Mission Bay Drive Bridge, the installation of the SeaBat T50 was a normal bathymetric installation, with the unit mounted straight down. The system can steer the acoustic beams if

required, for instance, when looking at bridge support struts or quay walls, but many inspection-specific installations have the option to install the system with a physical tilt to enhance the acoustic return.

Teledyne Optech TLS-M3 laser scanner was installed with the system on the starboard side of the vessel, scanning vertically, as the vessel will provide the horizontal movement. The scanner was mounted on a fixed mobile bracket that holds the instrument on the correct orientation, even on multiple installation projects. This is essential to hold the boresight calibration and speed up the workflow for data collection.

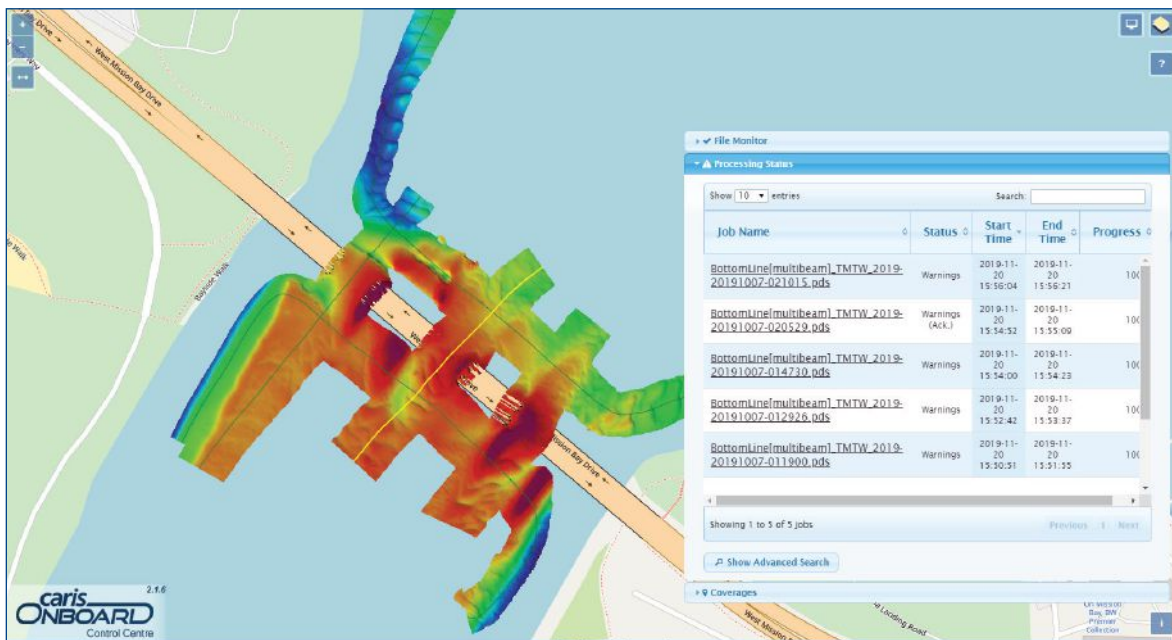
The equipment was co-located as closely as possible with the inertial positioning system to minimize the potential for lever arm error.

Data Acquisition

Teledyne PDS software is designed to efficiently create high-quality, fast results—whether it is for laser and multibeam surveys, single-beam surveys, construction or dredging work.

The acquisition of the Teledyne Optech TLS-M3 laser scanner and the Teledyne RESON SeaBat T50 data was supported via integrated drivers inside Teledyne PDS, enabling the surveyor to control all acquisition components from one piece of software.

Survey progress is shown real time in 2D and 3D views using a color-coded digital terrain model (DTM) and/or historical raw point cloud. Various filter settings can be applied to the multibeam and laser data online, thus providing real-time data processing, which can always be adjusted or tweaked in offline processing later if desired. QC displays reassured the operators that the data were of the desired quality. The 3D editing module combines 3D swath editing, multibeam and laser calibration



Real-time survey process in control center.

With the workflow uploaded, the logging directory of the acquisition software is configured, and monitoring can begin. Once the survey begins, new files created in this location are detected as new data are processed, and a map viewer is provided to track progress on processing status, as well as review coverage and quality check using any generated products.

This real-time capability allows the operator to review the coverage and quality of a data set, as a semi-final product, at a glance during survey operations. As an additional efficiency, the remote connection capability would allow any supervisor (or client) to monitor progress in real time as well.

Once the survey is complete, in addition to the raw logged data products, the user now also has a fully processed CARIS project, ready for final processing and data QC in HIPS and SIPS.

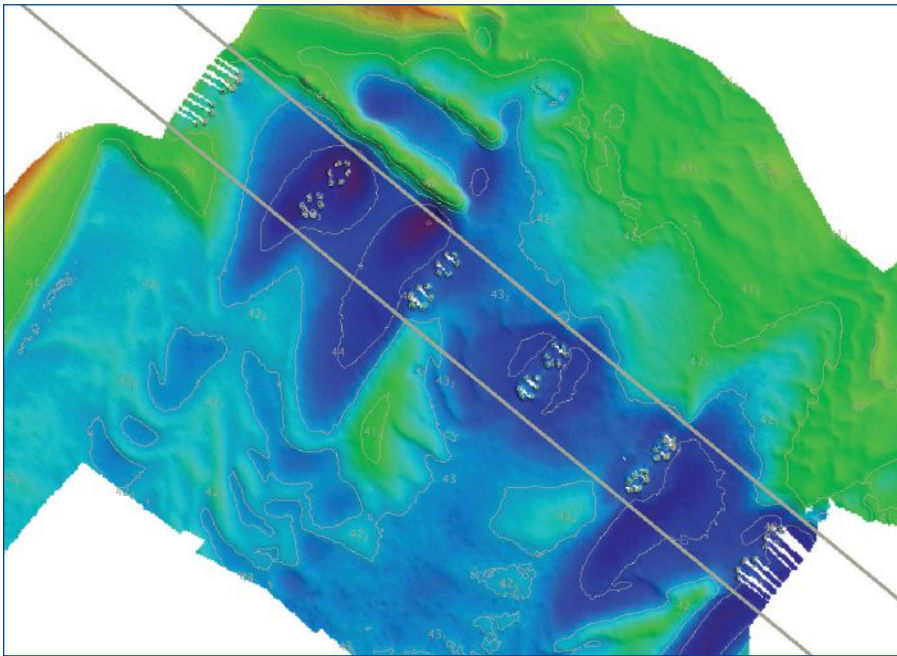
HIPS and SIPS is CARIS's flagship desktop hydrographic data processing product. Backed by over 25 years of hydrographic processing experience, it offers essential capabilities and professional-grade tools that allow users to simultaneously process multibeam, side scan, single-beam and scanning laser data sets. As a Teledyne product, HIPS and SIPS offers optimized and streamlined support for all Teledyne hardware products, including the Seabat T-series multibeam and Optech M3 laser. This allows seamless processing of both sensor products in a single workspace, as well as the generation of combined product deliverables. In this case, the software also allows application of post-processed SBETs and/or corrected tides after the survey is complete, which minimizes the amount of data reconversion and prevents the loss of any previous data edits.

routines, DTM modeling and editing, CUBE modeling, WCD data visualization and SVP editor. Combining all these features into one module saves a lot of time for the data processor.

Processing and Analysis

Teledyne CARIS is a leading provider of marine geospatial software, offering a comprehensive portfolio of products for a full ping-to-chart solution. Among those products, CARIS Onboard is a product built on decades of hydrographic data processing expertise to provide automated near-real-time processing and product creation to manned and unmanned survey platforms. CARIS Onboard integrates seamlessly with the platform sensors and software to automatically produce real-time products for both the multibeam and laser scanner, including real-time position and motion correction, as well as application of sound velocity data from the Rapidcast.

After defining the required processing workflow and data products for this survey, this workflow is uploaded to CARIS Onboard's Control Centre, a web-based application accessed from any standard web browser. Further, provided there is an internet connection to the platform, Control Centre can be accessed from any internet-connected desktop or mobile device.



DTM and charted features from collected data in HIPS and SIPS for the West Mission Bay Drive Bridge survey.

ty-of-navigation survey, including the industry-standard uncertainty modeling and CUBE processing workflow. Users can also generate standard charting products, such as contours, sounding sets and obstructions, directly from the source data using IHO standard definitions.

For engineering-focused projects, the Engineering Analysis Module add-in provides a suite of additional capabilities, which include dredge/channel maintenance tools, volume computa-

The software is also capable of generating a significant variety of data products using industry-standard exchange formats, from full-density point cloud products to gridded products to decimated contours and spot features.

As the post-processing software of choice for most hydrographic offices around the world, HIPS and SIPS provides access to a full suite of products for any safe-

tions and more.

Conclusion

Teledyne's combined LiDAR and sonar hardware solution improves productivity and efficiency in marine construction applications, including dredging, crane operations, piling and hydrographic survey. Teledyne software provides accurate 3D visualization to assist operators

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“With this single-source solution, users can achieve high-accuracy data for real-time analysis, providing quick responses with less resource requirements.”

with underwater construction and inspection tasks, saving time and money, and ensures a safe work environment.

Teledyne software solutions allow collected data to be quickly processed into informative products to direct construction activities and provides a scalable database to manage the increasing volumes of high-resolution data being collected. Automated processing systems allow products to be derived during the survey with minimal user interaction, reducing training needs and providing the information that matters when it matters.

By leveraging a suite of integrated Teledyne products and services, surveyors can maximize their efficiency both during and after data collection to produce extremely high-quality data sets for their end-users. Teledyne offers a variety of sensor types and software pack-

ages to suit any operating requirement and data product deliverables. **ST**

Since obtaining an M.S. in geospatial and mapping science from the University of Glasgow, Stuart Mason has spent the last 11 years as a hydrographic surveyor, working across a number of hydrographic survey subdisciplines. He is currently the test and verification surveyor for Teledyne Marine's Imaging R&D team based in Denmark.



Burns Foster is the product manager for new product initiatives with Teledyne CARIS, focusing on developing new products and services outside of CARIS's core competencies. He previously spent five years as the product manager for HIPS and SIPS, CARIS's flagship processing software suite.



Gaspar Lima is the product manager for terrestrial products at Teledyne Optech. Lima graduated with a degree in topography in the late '90s and later earned a degree in civil engineering. He has focused his career on connecting construction and geomatics with high-end technology to deliver best-in-class solutions.



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Environmental Telemetry

New Advancements Make Remote Monitoring More Affordable

By Helen Taylor • Matt Trumbo

In the past, telemetry for environmental monitoring applications has been notoriously difficult to set up, expensive to maintain, unreliable and difficult to repair when it fails. As a result, many who could benefit from long-term, continuous water-quality monitoring have struggled to obtain useful results or avoided it all together, essentially losing the opportunity to track, investigate, understand and respond to conditions in the water.

An improved telemetry solution used in conjunction with quality monitoring equipment and an effective data services platform could prove tremendously useful for general coastal deployments, harmful algal bloom monitoring, turbidity monitoring associated with coastal dredging, and other coastal and blue-water applications.

Labor costs to maintain instruments and visit sites for data collection can constitute the bulk of data-gathering costs. A remote-monitoring solution that saves time and improves safety by reducing trips to the field, while also providing near-real-time feedback on problems in the field that can result in data loss, has the potential to significantly reduce total cost of ownership while gathering more useful data over time.

VuLink

Several years ago, In-Situ Inc. identified the need for a data logger and telemetry device that would actually encourage remote monitoring and made the investment

Last spring, In-Situ Inc. demonstrated deployment of its new cellular telemetry device for remote water-quality monitoring, off the coast of Florida. (Inset) Battery-powered VuLink telemetry installs in a 2-in. well or tube for simple and secure deployment.



(Credit: Bill Salazar, In-Situ Inc.)

in research and development efforts necessary to produce a device that was easy to use and would reliably transmit data from anywhere in the world for a reasonable cost. The result is VuLink, a cellular and satellite telemetry device designed to fit and mount in a 2-in./50-mm tube or on a buoy for simple, secure and reliable data transmission.

With one button press, VuLink autodetects In-Situ water-monitoring instruments and indicates system status, including battery life, cellular connection and connection to In-Situ's HydroVu data services platform. After the first button press, VuLink reads every hour and transmits once daily automatically, without software setup or settings changes. Users can perform advanced setup with an iOS or Android device using the VuSitu mobile app. Bluetooth low-energy (BLE) communications support

easy connection without the need for pairing or cables. And beacon-mode BLE communication permits connection to VuLink and connected instruments without physical access to the device—a feature particularly useful with difficult-to-reach devices, such as those on buoys.

Another element essential to VuLink's usability is expanded connectivity. To make it easier to connect to a preferred or local cellular network, VuLink supports all networks that support 4G LTE Category M1/NB-IoT, including Verizon and other traditional CDMA networks. In fact, it's among the first 4G LTE Category M1/NB-IoT devices in the environmental space.

Category M1/NB-IoT will provide the foundation of Internet of Things (IoT) for the next 10 years or more. It increases range for expanded coverage, and, with better signal penetration, many low-signal areas will now be suitable sites for deployment. VuLink also supports 2G for the EU, South Africa and other 2G-centric areas. In-Situ specifically identified the LTE technology as superior to LoRA networks in terms of power consumption, network coverage, bandwidth and total system cost, including gateways.

For data, cellular VuLink has an eSIM on board that enables network changes without a SIM card or physical access. VuLink also comes with free data. Users get free transmissions of a limited number of parameters and readings once per day, and a variety of data packages are available based on user need.

Additionally, VuLink cellular telemetry devices use the Emnify MVNO to gain access to multiple cellular networks anywhere in the world. Emnify typically supports multiple networks in the same country, which can provide superior coverage.

Another advancement is VuLink's extended-life deployment. Because Category M1 and NB-IoT networks offer massive power savings for devices, VuLink can deliver two-to-six times the battery life of similar devices. At faster reporting rates, VuLink offers exponential savings, with more than two years of battery life at 15-min. reporting intervals. Both widely available alkaline batteries and lithium batteries are supported, so battery type can be matched to a particular use case and ambient temperature.

For areas where cellular coverage isn't available or its use isn't permitted, an Iridium satellite version of VuLink gives global coverage regardless of location. Typically, installations outside of cellular-network range are expensive and prone to vandalism, but because VuLink fits in wells or tubes, it's easier to place, and it's protected.

Iridium device feature sets are often compromised by the unique needs of the network, but all relevant features of VuLink work the same across network connectivity. Also, despite the higher power consumption of Iridium SBD data, VuLink battery replacement cycles exceed minimum instrument maintenance cycles, i.e., the device delivers three years of battery life with lithium batteries and one year of battery life with alkaline batteries.

In addition to these features designed to address many of the common complaints about telemetry for environmental monitoring, VuLink also offers conveniences such

as continuous GPS, with automated location setup and real-time buoy location monitoring to determine device locations at any time. SSL encryption of data by default offers protection similar to that offered with online credit card transactions. Automatic barometric compensation removes the effects of atmospheric pressure changes to improve system accuracy, and enhanced in-device alarms enable VuLink to wake up and transmit off schedule when an alarm condition is read.

Putting VuLink to the Test

With VuLink, In-Situ set out to solve many of the common problems with telemetry. But innovation is only useful if it can hold up to the demands of the job. Reliability was a key focus during product development, and water ingress was a primary concern. VuLink is IP68 rated and is completely sealed, with no internal electronics exposed to the atmosphere. A new venting design enables desiccant-free operation without any exposure of internal electronics. The main body is made of Ryton, an exceptionally strong and stable material that enables the device to hold up to 280 lb. And VuLink can be firmware updated over the air to avoid excessive field visits.

Data assurance was also an important consideration. The instrument's internal log, VuLink's internal memory and cloud storage offer triple redundancy to keep data safe. If conditions prevent a transmission, VuLink will transmit unsent data at the next opportunity. And multiple alarm systems can give notification of issues in near real time and limit data loss.

Cost and Compatibility

Other roadblocks to continuous monitoring that VuLink removes relate to connectivity and cost. VuLink can read pulse inputs, arbitrary Modbus registers and SDI-12 inputs, all configured in the VuSitu mobile app, so it can easily connect with third-party instrumentation. And with In-Situ's Load-Bearing Universal Adapter, VuLink can connect to virtually anything.

On cost, it was essential that VuLink land at a price point that made it accessible. In-Situ has worked to ensure that a product that solves the problems of traditional telemetry is available to those who can benefit most from the new technology. Low-maintenance deployment and real-time feedback to prevent data losses have the potential to further reduce total cost of ownership, making VuLink a remarkably affordable piece of equipment.

Application

VuLink is part of a complete remote-monitoring solution that includes In-Situ instrumentation and HydroVu, a subscription-based data services platform that allows the user to select an appropriate level of service for data analysis and management. Coastal application professionals who've considered continuous monitoring, or even attempted it, but have been frustrated by telemetry that's difficult and costly to implement, may find that this solution facilitates the kind of robust monitoring program that dramatically improves efficiency, cost effectiveness and data quality.



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Harmful algal bloom monitoring is one example of an application for which VuLink telemetry is ideal. Deployed fluorometers, including chlorophyll-a, phycocyanin (BGA-PC) and phycoerythrin (BGA-PE), as well as standard sensors including temperature, turbidity, salinity, pH and DO, deliver consistent output. Data-collection techniques and sampling locations remain constant for apples-to-apples data. And continuous algal monitoring makes it possible to catch events spot sampling would miss, speed up response time, and track and analyze trends over time.

As harmful algal blooms become more common due to a warming climate and growing populations in coastal areas, long-term data sets derived from continuous monitoring could be used to heighten our understanding of how and when blooms occur and enhance our ability to predict them.

Another application effective telemetry can support is coastal dredging. Failure to properly manage leakage from buckets or pumps during operations can be extremely costly. Therefore, the ability to monitor turbidity in real time at various depths, provide management with an effective alarm system, and establish baselines prior to the start of a project has obvious benefits.

Additionally, VuLink is ideal for use with buoys. Its IP68 rating, internal GPS, long battery life and the fact that it needs no solar panels make it particularly well suited for buoy deployments.

VuLink's integration of 4G LTE Category M1/NB-IoT

networks brings environmental monitoring in line with other industries tapping the power of Internet-of-Things technology. For these applications and many others, this constitutes a significant advantage. In addition, VuLink is part of a shared ecosystem of products that supports seamless operation, and the device's in-well mounting reduces cost and protects it from damage, even in harsh environments.

Remote monitoring is the most effective way to understand what's happening in the water over time and facilitate timely response to events. VuLink is a simple, reliable telemetry device that addresses familiar challenges related to long-term deployments. It stands to make remote data collection ubiquitous across the environmental monitoring industry.

VuLink will enter the market in the second quarter of 2020. For more information or to participate in the Early Adopter Program, visit www.in-situ.com/vulink or contact In-Situ Product Manager Matt Trumbo at mtrumbo@in-situ.com. **ST**

Helen Taylor brings years of experience in journalism, marketing communications and public relations to her role as content manager for In-Situ. She has written and edited numerous newspaper, magazine and journal articles, edited two books published by Cambridge University Press, and scripted and produced several promotional and educational videos.

Matt Trumbo has worked as In-Situ's software and solutions product manager for over five years. He has over 13 years of experience in hardware/software development and management, focusing on embedded systems, computational intelligence, cloud systems and image processing.

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Oceanology International

Anticipation is rapidly building now that registration has opened for Oceanology International (OI) London 2020, organized by Reed Exhibitions and scheduled for March 17 to 19, 2020 in the ExCel London. For industry professionals, this enormously influential ocean science and technology exhibition and conference series, first staged half a century ago, acts as a convenient and advantageous networking hub and a revelatory shop window for the most radical, beneficial marine technologies and concepts.

In a wider sense, OI also provides a cogent and compelling response to the query: “Why don’t people just come together and do something about environmental issues?” OI’s exhibitors and conference speakers have been doing precisely that through the practical application of sustainable marine science incentives for 50 years, in the course of which the brand’s international profile has expanded to accommodate parallel events in China

Oi oceanology international®
2020 17-19 MARCH 2020, LONDON, EXCEL

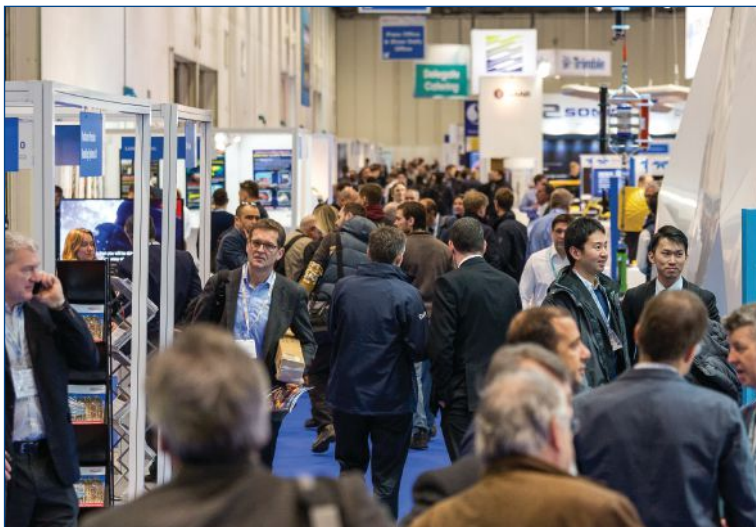
and the U.S. Meanwhile, September 2020 will see the advent of a new OI event in Abu Dhabi with a Middle East region and Indian Ocean focus.

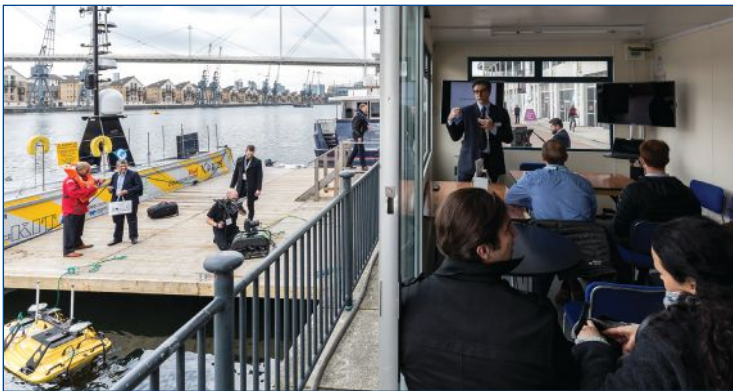
Taken in tandem, this means that an OI expo takes place somewhere in the world every six months, clearly demonstrating that sustainable ocean management solutions are already here, already being deployed and already paving the way for new strategies. OI is committed to upholding and contributing toward the UN’s Sustainable Development Goals (SDGs): 17 goals and 169 targets aiming to stimulate action in areas of critical importance to humanity and the environment.

Exhibition

The London 2020 expo, marking the brand’s 50th anniversary, is expected to be the largest OI event yet held: over 17,000 m² of ExCel London’s indoor exhibition space will be given over to more than 500 companies from over 90 countries, including new pavilions for Italy and Massachusetts, with in excess of 8,000 visitors anticipated to attend. ExCel London’s handy location, adjoining the Royal Victoria Dock, will be exploited to the full by twice as many companies as before, staging daily on-water product demonstrations. These can be watched from elevated dockside viewing platforms or from a covered private meeting area.

The unprecedented range of businesses represented on the exhibition floor will encompass the latest innovations and provide a showcase for product launches in end-user sectors including aquaculture, marine renewables, coastal engineering/protection, telecoms, ocean mining, maritime security, and offshore oil and gas.





Features of particular note will include the Future Tech Hub, wherein 18 small businesses and start-up companies will deliver daily pitch sessions on their new-to-market technologies, and the Ocean ICT Zone, a specialist area highlighting the latest information and communication solutions for the maritime domain.

Program

The OI's conference program has always borne an equivalent significance to the exhibition element, and OI London 2020's agenda emphasizes this with a variety of

new and updated features, including Spotlight on Technology and Spotlight on Clusters conference strands in the renamed Trade and Investment Theatre. Other brand new technical tracks will include: Data Interpretation & AI; Marine Pollution & Environmental Stressors; Offshore Energy Development; and Asset Integrity & Monitoring.

Alongside these, the event will see the welcome return of the one-day Catch The Next Wave conference, celebrating the interdependence of ocean exploration and marine science, and the Ocean Futures Forum, concentrating on the most up-to-the-minute technological breakthroughs in the offshore industries.

"Delegates attending OI London 2020 can look forward to more varied and inspiring conference and exhibition content than ever before, while company representatives wishing to grow their international business profile can register to arrange brokered one-to-one meetings through the Enterprise Europe Network," said David Ince, the event director of Reed Exhibitions.

"After five decades of crusading for responsible marine strategies, and at a crucial environmental juncture, Oceanology International is of more constructive and symbolic importance than ever," he said. "We're looking forward to making the 50th anniversary OI London 2020 event an absolute benchmark of positive synergies, clearly showing how collaborative concepts and procedures can safeguard the world's oceans while simultaneously enabling maritime businesses to thrive."

Show visitors can register via www.oceanologyinternational.com. **ST**

Sound-Speed Profiling

Simplicity Is Key in Evolution of Profilers

By Jim Gardiner

Profilers instruments need to evolve to meet demand for easy-to-use profilers while still delivering accurate and reliable results. This presents a challenge for manufacturers of hydrographic and oceanographic instruments—the kind of challenge the team at Valeport relishes.

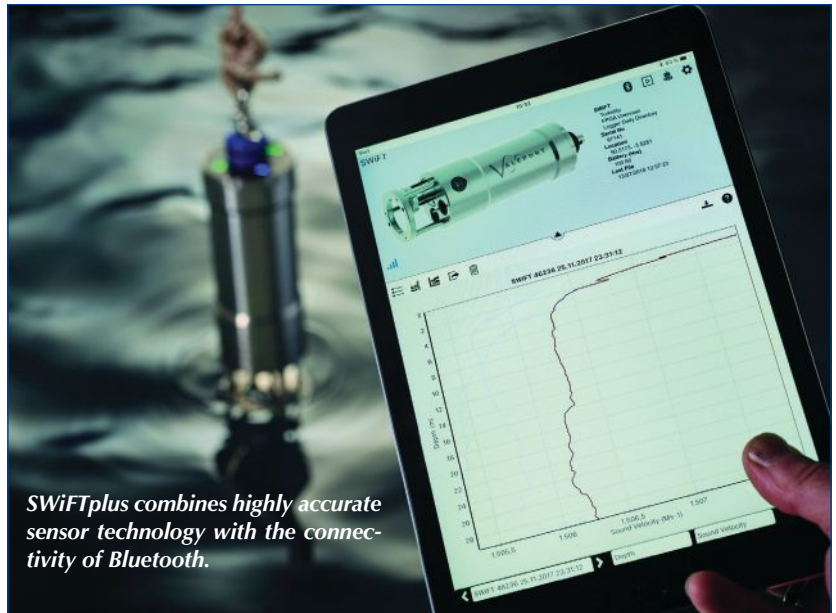
Valeport is committed to pushing the boundaries of marine instrumentation to deliver highly accurate, robust and reliable instrumentation. Even with a successful product in the SWiFT SVP, a sound-speed profiler that is used for coastal, harbor and inland hydrographic surveys, we have continued to develop and improve it.

SWiFT SVP has recently been upgraded to provide enhanced versatility and deployment, with improved depth rating and increased pressure accuracy as standard. But where did the instrument start, and how did we overcome the challenges to develop it?

Origin of the SWiFT

SWiFT's inception lies with the needs of Valeport's customers. The brief for Valeport's research and development team in 2012 was to improve on our miniSVP, which was our previous instrument for sound-velocity, temperature and depth profiling.

Our customers told us that while the measurements they obtained with our miniSVP were very good, the process of taking a sound velocity profile could be improved. Our starting point was to reduce the time it took to obtain a profile and avoid the need for repetition. We also knew that the battery capacity of the instrument could be increased and that battery changes were sometimes problematic. We additionally wanted to find ways of speeding the setup of the instrument. In short, the specification of



the SWiFT SVP was to make it simple while maintaining the quality of the measurement.

In designing the SWiFT SVP, we wanted to introduce GPS so that every profile the instrument produced was time-stamped and geolocated without the user having to log positions manually or cross-reference with another GPS source.

We also took the opportunity to include Bluetooth so that the SWiFT doesn't need to be plugged into a cable to be configured or to download data. Bluetooth also means we can talk to the instrument via mobile apps. The smart-profiling mode was designed to deliver only the data the customer wants, with minimal preconfiguration.

Addressing the need to improve the battery life, we introduced a rechargeable battery with greater than 100 hr. of duration. There is now no need to open the instrument to replace the battery. It is simple and easy to recharge,

so problematic battery changes are a thing of the past.

Users need to quickly and easily see what the probe is doing, so we added status LEDs on the end-cap. We also considered the form factor of the instrument to allow us to supply it with a smaller transit case.

SWiFT SVP comes with our Valeport Connect software. The software was designed to minimize the number of stages required to get the data to where the user wants. In fact, we are now at the stage of fully automated data transfer with no user input required. All the user has to do is lower the SWiFT through the water, recover it back on deck, and by the time he or she is back at the desk the data will be ready.



Deployment of the SWiFT SVP at a training session on RV Callista at Ocean Business 2019 in Southampton, U.K.

Overcoming Engineering Challenges

Our engineers had several challenges to overcome. We had to think about how to fit GPS into the instrument, along with a rechargeable battery and Bluetooth functionality. We also put a great deal of work into the switching mechanism.

A year of work by Valeport's research and development department led to the creation of an end-cap for SWiFT that allows users to easily operate the instrument by turning the switching ring. The success of this solution lies in its simplicity.

The starting point for our engineers was thinking about how SWiFT would be used. It has to be easy to use with cold hands while at sea. The switching ring solution has a very positive tactile feel about it. It turns through 90°, and you can feel it reassuringly click into position.

It was important the action of the switching ring feels right. We couldn't use springs because the instrument is used underwater. We didn't want to use screws in the assembly, as we had to avoid the risk of users opening up the instrument. Another disadvantage of using screws is that they take up valuable mechanical space. The solution was to use nylon to lock the end-cap into place. The next challenge was to get the tension just right—not too loose or too tight.

The end-cap features lights to show when the instrument is switched on, when the Bluetooth is on and connected, and to indicate the battery's level of charge. The inclusion of light-up icons on the end-cap offered up another difficult mechanical challenge that required clever assembly. When you pick up the product, the first thing you notice is the switch ring and lights, so a lot of thought went into getting this right during our development phase.

We also had to consider the best material for construction. We opted for titanium because of its unrivaled durability and corrosion-resistance properties in saltwater. It is the obvious choice for this kind of instrument, and its use is one of the hallmarks of Valeport's suite of instruments.

The result of the year of development was the SWiFT SVP, a simple-to-use instrument that can measure sound

velocity, depth and temperature in water up to 100 m deep, with battery endurance greater than 100 hr. and easy charging via USB. Bluetooth connectivity to iPhone or iPad allows users to download data while on a boat, or set it up to automatically connect, extract the data and send to a PC elsewhere. SWiFT can be used with automated winches and on USVs, as well as manual operation.

Latest Evolution of the SWiFT

One of the first developments was to increase the depth of operation to 200 m. In 2019, this increased further, with the improved SWiFT now operational down to 500 m as standard while retaining all of its popular switching on/off action, LED status indication and Bluetooth communication features. To retain the pressure accuracy at these greater depths, we have

changed from a 0.05 percent full-scale accuracy pressure sensor to a 0.01 percent accuracy pressure sensor.

The biggest challenge with increasing the depth rating to 500 m was the switch end-cap on the instrument. As the construction of this part of the instrument is not titanium, the design had to be changed and tested.

Demand from the dredging sector for easy to use, reliable instruments to measure how much silt is disturbed during dredging led to the introduction of SWiFTplus Turbidity, an instrument with the sound-velocity, depth and temperature profiling capabilities of Valeport's original SWiFT design, with the addition of optics to measure turbidity. SWiFTplus Fluorometer, a profiler that can be supplied with a chlorophyll, fluorescein, rhodamine or phycocyanin sensor, was also developed.

The development of our SWiFTplus range and introduction of optics into the instrument required careful thought from the research and development team and the creation of new circuit boards.

Rigorous Testing Phase

Our testing phase starts with the engineering team developing a prototype product that is tested internally at Valeport. Once our engineers are happy with the results of their testing, they build a set of instruments to be tested in the field. We do this field testing with customers, so that we can get feedback on how the instrument is performing. The field testing is rigorous, and we test the instrument to its limits.

In early 2019, the testing when we increased the depth of operation of SWiFT SVP to 500 m involved re-testing all of the GPS and Bluetooth functionality, as well as pressure testing the complete design. The redesign also coincided with a review of our assembly process to simplify it. We were successful on both counts.

Mechanically, the SWiFT has changed very little from its first iteration, but we have made big advances in the stability and functionality of our firmware. A lot of this has been as a result of our testing, but our customers

“SWiFT SVP has recently been upgraded to provide enhanced versatility and deployment, with improved depth rating and increased pressure accuracy as standard.”

have also made a significant contribution by giving us their feedback. One of the design requirements was the ability to update the instrument firmware in the field by a user, and this has proved invaluable in speeding up the development cycle.

SWiFT SVP in Action

SWiFT SVP was the instrument of choice for Seafloor Systems Inc. when it was looking for a profiler for use on its EchoBoat-ASV.

Seafloor Systems Inc. was founded in 1999 by Navy veteran John Tamplin and is known for its innovative application of hydroacoustic sonar and unmanned marine surface vehicle technology to the survey industry.

The EchoBoat is a USV used for conducting high-resolution hydrographic surveys. The primary sensors are single and multibeam echosounders. Collecting quality sound velocity is a key component to producing accurate high-resolution data, especially in regard to multibeam bathymetric surveying.

Most USVs of EchoBoat's size do not implement sound-velocity profiling on their vessels, instead opting to launch a separate manned vessel to collect profiles. This defeats the purpose of using a USV to conduct surveys.

Seafloor Systems chose the SWiFT SVP as it has all the features deemed necessary for this application. They also chose the instrument for its resolution and quality. The customer reports that the SWiFT has performed beyond expectation, both with regard to its resolution as well as its rugged construction. Seafloor Systems found that SWiFT compared extremely well to other instruments, offering many of the best features in one single instrument.

Calibration

Before each of our Valeport instruments leaves the premises, it will be calibrated in our state-of-the-art laboratories. Our calibration accuracy can be guaranteed. The calibration equipment we use is itself recalibrated regularly by the manufacturer, and we carry out frequent checks of key equipment against secondary standards.

All storage, assembly, service and calibration areas are protected against static electricity, minimizing the risk of circuit board damage by handling and storage. All of our circuit boards are temperature tested to highlight any weakness. All new instruments are also pressure tested before dispatch.

International Success

Hundreds of SWiFT SVP and SWiFTplus models are now in operation across the world, in 40 countries, from Europe to Australasia. Used by customers in a range of sectors, including dredging, oceanography and scientific research, the instrument is well regarded for its ease of use and reliability.

SWiFT will continue to evolve as we improve our portfolio of instruments. We plan to introduce software to allow data to be downloaded onto Android devices. Currently, we are also testing a fully automated winching system that interacts directly with the SWiFT, allowing machine-to-machine interaction without any human intervention. There are several other exciting new developments that will be ready to launch over the next year or so. The advancement of SWiFT to meet our customers' evolving needs will continue. Find out more at www.valeport.co.uk. **ST**

Jim Gardiner is a research scientist at Valeport Ltd. He holds an M.S. in applied marine science and a B.S. (Hons) in ocean science, both from Plymouth University, and he is a chartered marine scientist (IMarEST). Gardiner started his career as an oceanographic analyst at the UKHO before joining Valeport as product manager in 2008. In 2017, he moved to a more R&D-focused role as a research scientist developing, testing and trialling new sensing technologies. He can be reached at jgardiner@valeport.co.uk.



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Inductive-Conductivity Cell

A Primer on High-Accuracy CTD Technology

By Dr. Mark Halverson • Eric Siegel • Dr. Greg Johnson

Conductivity, temperature and depth are core variables used by oceanographers and limnologists to study water properties and dynamics. RBR has been designing and manufacturing precise instrumentation for 45 years and introduced the inductive-conductivity sensor in 2000. Since then, thousands of RBR CTDs with inductive-conductivity cells have been built and deployed.

RBR CTDs have been deployed by major oceanographic centers worldwide into every ocean on Earth, and into the harshest environments, from the abyss to the poles. They have been deployed from many platform types: kayaks, ocean-going research vessels, aircraft and commercial fishing vessels. RBR CTDs have been integrated into ocean gliders, autonomous underwater and surface vehicles, and profiling Argo floats. They are frequently selected as the reliable solution for major citizen science programs.

This article focuses on the RBR CTD's inductive-conductivity cell, including operating principles, unpumped design, accuracy, resolution and stability.

Operating Principles

RBR's conductivity cells function according to Faraday's law of induction. Each cell contains two toroidal coils: a generating coil and a receiving coil. An AC signal is applied to the generating coil, producing a magnetic flux and a resultant electric field, and, finally, a current is induced in the seawater present in the center of the cell.

The current in the seawater passes through the center of the receiving coil and induces a secondary current to flow in the receiving coil. The current in the receiving coil is proportional to the resistance of the water, which is inversely proportional to conductivity.

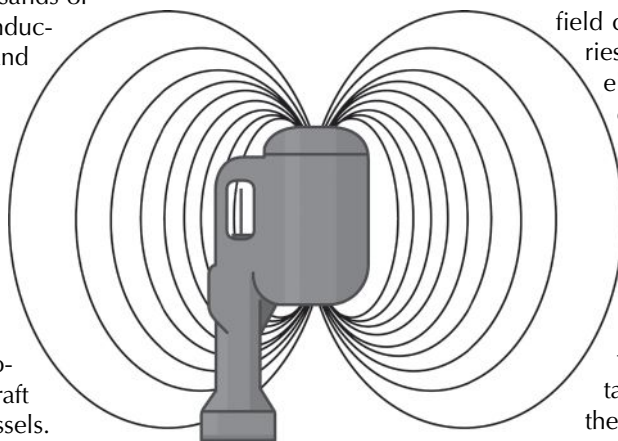
The current driven by the electric field can be conceptualized as a series of closed rings of current traveling through both coils in the conductivity cell, out into the water, then back into the cell. The current rings are most dense inside the cell, and they spread out with distance away from the cell.

Theoretically, the field induced by the conductivity cell extends an infinite distance from the cell. In practice, the majority of the measurement is constrained to the local proximity of the sensor. The high concentration of field lines within the center of the conductivity cell means that most (approximately 80 percent) of the conductivity

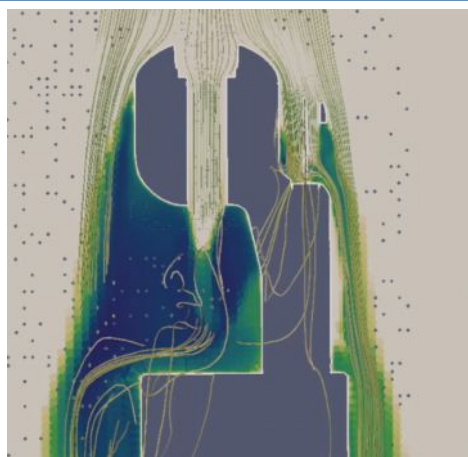
measurement originates from this region. This local spatial extent of the electric field has implications both for calibration and deployment (described later in Proximity Effect).

Design

The primary RBR conductivity cell has a co-located temperature sensor and thus is frequently referred to as a "combined CT cell." There are three versions of the combined CT cell, each rated for a different maximum pressure: 1,000 dbar; 2,000 dbar; and 6,000 dbar. The 1,000-dbar version is made from polyoxymethylene and



Schematic of the RBR conductivity cell. The curved lines represent conceptual invisible lines of magnetic and electric fields surrounding the cell. The temperature sensor is co-located with the conductivity sensor to measure the same water parcel.



(Top) RBR combined conductivity-temperature cells (combined CT cells), with sculpted heads to optimize natural flow and co-located temperature sensors (titanium fitting on the right of each cell). Shown above are the three models, rated for maximum pressures of 1,000 dbar; 2,000 dbar; and 6,000 dbar (left to right). Shown below is the RBRconcerto³ CTD. (Bottom) Reynolds-averaged Navier-Stokes simulation of natural flow through unpumped conductivity cell and temperature sensor at 30-cm/s profile rate.

ceramic, while the 2,000-dbar and 6,000-dbar models use engineered polymers and ceramic.

The combined CT cell was designed to optimize natural water flow through the measurement volume and over the temperature sensor so no pump would be required to circulate water. The thermistor is co-located with the conductivity cell, and the design is sculpted to be hydrodynamically smooth; temperature and conductivity measurements are of the same water parcel. The design features improve the measurement performance in dynamic applications such as profiling through gradients. RBR performed a Reynolds-averaged Navier-Stokes simulation and lab experiment in the Woods Hole Oceanographic

Institution double-diffusive interface tank to demonstrate the combined CT cell design is flushed naturally and does not need a pump in order to circulate water.

Proximity Effect

The proximity effect is the phenomenon that objects close to the conductivity sensor may affect its calibration and the accuracy of its measurements. Conductivity, as measured by the inductive cell, is a weighted average of conductivity over the volume occupied by the current loops, with conductivity being most sensitive within the center cylinder and becoming less sensitive with radial distance. Objects near the outside of the central cylinder may affect the calibration and, therefore, accuracy of the conductivity measurement.

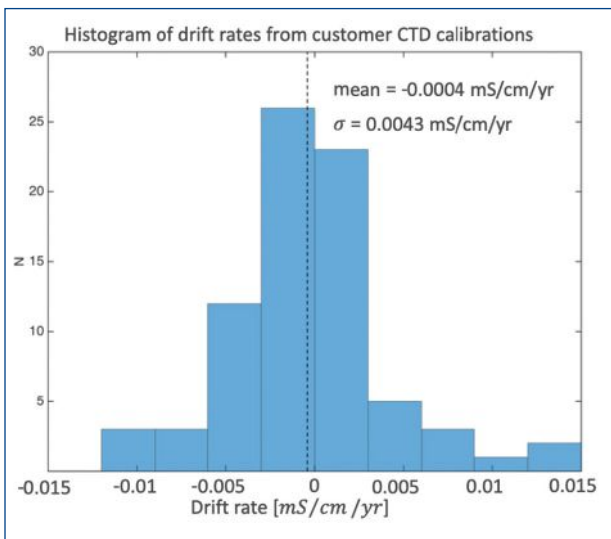
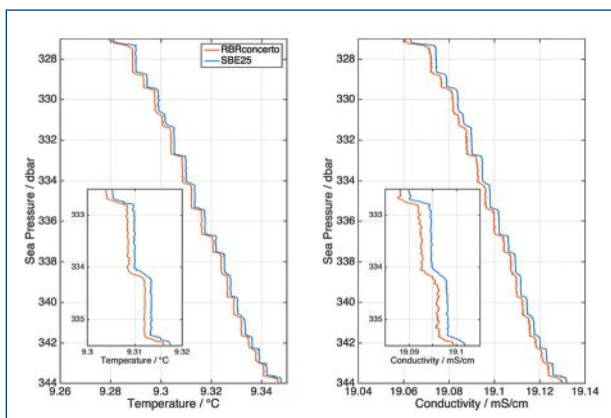
Laboratory experiments at RBR show that an object must be within 15 cm of the conductivity cell before any measurement accuracy is affected. Conductive objects (such as metal deployment frames) closer than 15 cm may bias the conductivity reading higher. Nonconductive objects (such as insulated mooring lines) may bias the conductivity reading lower. The amount of bias is related to the proximity, the relative volume of the material, and the relative difference in conductivity compared to the ambient water.

The proximity effect changes the calibration coefficients of the conductivity cell. The change induced manifests as a scale factor (a multiplier), rather than an offset (an addition or a subtraction). As a point of reference, a standard 0.25-in. (6-mm) insulated steel mooring line located 7.5 cm from the inductive conductivity cell (within the 15-cm zone) changes the conductivity calibration by -0.002 mS/cm at 35 psu. This small amount is still within the initial accuracy specification of ± 0.003 mS/cm.

Permanent (static) objects in the near field of the sensor can be calibrated with those objects present, negating their effects. This is routinely done for instruments built with sensor guards, instruments which have numerous sensors mounted near the conductivity cell, instruments mounted in stainless-steel cages, and conductivity cells mounted on Argo floats with a nearby antenna. When static objects (such as other sensors or guards) are included in the conductivity calibration, the achieved calibration is always within the specified accuracy of ± 0.003 mS/cm. RBR provides mounting clamps to offset the CTD more than 15 cm away from the mooring line.

Advantages of a Naturally Flushed Cell

No Pump Required. Accurate measurement of conductivity, particularly when vertically profiling, requires the sensor to measure the local water parcel. Electrode-based conductivity cells typically have a high-aspect-ratio (tall and narrow) measurement cell and require a pump to actively circulate water through the cell. Without a pump, water tends to move around the outside of the high-aspect-ratio cell, rather than through the central measurement volume of the cell. The RBR inductive-conductivity cell is designed with a low-aspect-ratio cell



(Top) Temperature and conductivity versus sea pressure graphs from profiles in Powell Lake, British Columbia, Canada, which exhibits a thermohaline staircase structure. The insets on each graph focus on two steps to emphasize the fine structure and low noise. (Bottom) Histogram of conductivity drift rate for customers' CTDs returned to RBR for calibration. The mean drift rate is -0.0004 mS/cm/yr ; an order of magnitude smaller than the specified accuracy.

(short and wide) and is sculpted to be naturally flushed. Therefore, the RBR conductivity cell does not require a pump to mechanically circulate water through the measurement region. The temperature sensor is co-located in vertical position with the conductivity cell to measure the same water at the same time for improved derivations of salinity and density.

Low Power. The natural flushing of the RBR conductivity cell allows the RBR CTD to be operated with much lower power compared to a pumped CTD. When sampling at 1 Hz, a pumped CTD requires about 175 mJ of energy per sample, while the RBR CTD requires 18 mJ per sample—90 percent lower power consumption. The lower power enables more measurement opportunities, such as faster sampling and longer deployments, particularly on platforms that have limited power, such as ocean gliders and Argo floats.

Near-Surface Measurements. Electrode-based cells require contact between the sensing electrodes and the water. Measurement accuracy may be affected by even microscopic amounts of fouling or coating of the electrodes, such as by surfactants and oils commonly occurring in surface waters. To reduce the risk of contaminating the sensing electrodes, the standard operating procedure for electrode-based CTDs is to turn the pump off before the CTD reaches the top several meters of water. The RBR inductive-conductivity cell is not affected by microscopic amounts of fouling or coating, so it can measure substantially closer to the air-water interface.

Silent Operation. The inductive conductivity cell has no moving parts: it is silent. The silent operation can improve co-located passive acoustic listening measurements, and the absence of a vibrating pump can improve measurements of turbulence.

Robust Construction. RBR's inductive-conductivity cell is robust. It can be frozen into ice and thawed without damage or changing the calibrated accuracy. Because it is made from composite materials and a ceramic center cylinder, it can withstand shock and impact forces. The robust construction has enabled extreme measurement opportunities such as operation in high-latitude freezing conditions and air deployments of profiling floats.

Performance

Lab Calibration. RBR conductivity measurements are calibrated to a static accuracy of $\pm 0.003 \text{ mS/cm}$, a resolution of 0.001 mS/cm and a precision estimated at $\pm 0.001 \text{ mS/cm}$. When combined with temperature measurements accurate to $\pm 0.002^\circ \text{C}$, an RBR CTD will provide a salinity measurement accurate to within $\pm 0.003 \text{ psu}$. The accuracy specifications for conductivity and temperature are valid over the range of 0 to 85 mS/cm and -5 to 35°C , respectively.

Demonstrated Accuracy. In 2018, two RBRconcerto³ 2,000-dbar CTDs and a Sea-Bird Scientific SBE-9 CTD were cast simultaneously on a rosette during a Fisheries and Oceans Canada cruise in the North Pacific Ocean. Comparing instruments profiled on the same rosette removes uncertainty about whether the two instruments measured the same water mass.

The difference between the two RBRconcerto³ CTDs and the SBE-9 CTD, when averaged over a range of 800 to 2,000 m, was -0.00074 mS/cm and 0.0013 mS/cm (both within the stated accuracy specification for RBR and SBE). The agreement in terms of the pressure-averaged values is reinforced by low dispersion in the differences. In both cases, the dispersion in terms of the standard deviation is less than 0.001 mS/cm .

Demonstrated Resolution. To demonstrate the resolution of the RBR CTD, a profile was taken of the fine-scale thermohaline staircase structure near the bottom of Powell Lake, a deep lake on the west coast of British Columbia, Canada. The lake is filled with relic seawater from the last ice age and is characterized by a series of uniform temperature and salinity layers of approximately 70 cm, separated by approximately 10-cm stratified interfaces. The typical temperature and conductivity differ-

ence between adjacent steps are 0.005°C and 0.002 mS/cm , respectively, making this natural laboratory effective for demonstrating the CTD's resolution.

An RBR*concerto* CTD was mounted onto a protective cage containing a Sea-Bird Scientific SBE-25 CTD. The whole package was profiled to observe the very small gradients in temperature and conductivity through the water. The temperature and conductivity measurements from the RBR*concerto* CTD revealed the same detailed staircase structure as the SBE-25 CTD.

Demonstrated Stability. All oceanographic sensors experience some drift in calibration over time. In a conductivity sensor, the way the cell couples electrically with the water is an important factor for stability. Inductive cells are electrically isolated from the water, providing immunity from corrosion and making them insensitive to contamination from surface oils. Another factor that impacts measurement stability is cell geometry. RBR uses materials with stable geometry over wide ranges in pressure and temperature.

In-situ data from profiling Argo floats provide an estimate of the RBR conductivity cell's long-term stability. Analysis of an RBR CTD deployed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2015 on an Argo float in the Coral Sea shows an average annual drift rate of 0.002 psu/yr when analyzed with standard Argo data quality-control methods. Analysis from more recent Argo floats with RBR CTDs deployed in the Pacific Ocean in the last four years shows

even lower drift rates (study to be presented at the American Geophysical Union Ocean Sciences Meeting, 2020).

RBR CTDs have demonstrated high stability in long-term laboratory and field experiments. Nearly 100 RBR CTDs were considered in an analysis for stability using laboratory calibration data. RBR calculated drift rates using the change in calibration over the time since the CTDs were last sent to RBR for calibration. Over this sample size, the mean conductivity drift was calculated to be -0.0004 mS/cm/yr , an order of magnitude lower than the specified accuracy, proving the stability and durability of the technology. **ST**

Dr. Mark Halverson is a physical oceanographer at RBR with 10 years of postdoctoral experience in observational oceanography. He earned his Ph.D. in physical oceanography from the University of British Columbia and, before that, earned degrees in physics and astrophysics. That is, his gaze changed from upward to downward.

Eric Siegel is a physical oceanographer and RBR's director of sales and marketing. He enjoys collaborating with clients to develop new applications and innovative oceanographic measurement solutions. He has a master's in physical oceanography from University of South Florida and an M.B.A. from Northeastern University.

Dr. Greg Johnson is the president of RBR and has a broad range of experience in oceanographic technology development. He is focused on strengthening RBR's commitment to customer success and product innovation. He has a B.Eng. in electrical engineering from McGill University and a Ph.D. in materials science from University of Manchester.



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IMO Supports SAR Training for Women

As part of its ongoing #WomenInSAR initiative and in support of the International Maritime Organization's (IMO) theme of empowering women, the International Maritime Rescue Federation (IMRF) held its first all-women maritime search and rescue (SAR) training in Morocco in late 2019. The training was supported by the IMO and covered basic knowledge, a practical exercise and best-practice training to enable the women to successfully manage rescue missions in their home countries.

AUV Market Growth Expected

According to a report by Persistence Market Research, the AUV market is expected to be valued at \$371.3 million in 2019, with a CAGR of over 6 percent from 2018 to 2027.

The use of AUVs to monitor seawater quality is on the rise, and industries such as shipping, shipbuilding, coastal aquaculture, fishing, offshore oil and gas, offshore wind, maritime tourism, and tidal and wave energy are projected for robust growth, which will boost the demand for AUVs. An increase in ocean exploration and scientific research will also create opportunities.

XOCEAN Continues Expansion

Ocean data company XOCEAN has completed the acquisition of 4D Ocean, an autonomous hydrographic survey company, as part of the company's strategic global growth plans. The announcement follows the news of XOCEAN's successful €7.9 million funding round.

XOCEAN collects ocean data via USVs and offers seabed mapping, subsea structure inspection and environmental monitoring. The company has recently delivered projects for clients including BP, Equinor, PX Group and the U.K.'s Maritime and Coastguard Agency.

Yamal LNG Fleet Update

Yakov Gakkal, owned by a joint venture between Teekay LNG Partners and China LNG Partners, has joined a fleet of 15 specially designed tankers transporting LNG year-round from one of Russia's most significant export developments in a generation: Yamal LNG.

Built in less than six years and to ARC7 ice class, the fleet of 170,000-m³-capacity vessels has opened the Northern Sea Route to commercial gas shipping, significantly expanded the navigation period in the direction of the Asia-Pacific region, and ensured year-round transportation of gas to customers westward. The fleet is powered by ABB's Azipod propulsion system.

Forum Upgrades Hyperbaric Test Facility

Forum Energy Technologies has completed a three-month upgrade to its hyperbaric testing facility, which will result in an operational time saving of more than 35 percent for clients. Located at the company's Kirkbymoorside base in North Yorkshire, U.K., the pressure test tank is one of the largest in Europe and provides

a well-located facility for the critical testing of subsea equipment. It has been widely used by the oil and gas, defense, and subsea telecommunications industries.

Balmoral Group Invests in Blaze

Engineering outfit Balmoral Group, has taken a 70 percent stake in Blaze Manufacturing Solutions Ltd., an Aberdeenshire-based company. This latest move comes after Balmoral significantly raised its shareholding in another Aberdeenshire company, ACE Winches.

Blaze manufactures fire-safety protection, detection and loss-prevention solutions for the oil and gas, renewable energy, mining, commercial and industrial sectors.

TDI-Brooks Enhances Service Offering

TDI-Brooks has partnered with Geotek Ltd. in the U.K. to expand its nondestructive core scanning services. In addition to its historical offering of MSCL (multi-sensor core logging), TDI-Brooks can now offer XRF chemostratigraphy, 2D X-ray radiography and 3D X-ray CT (computed tomography) services.

All scanning is performed using Geotek's full suite of state-of-the-art equipment mobilized on site at TDI-Brooks's campus in College Station, Texas.

Milestone for Offshore Wind Industry

It has been 10 years since AXYS conducted its inaugural test of the first AXYS WindSentinel at Race Rocks off the coast of British Columbia in 2009, marking a milestone in the offshore wind industry. This successful test launched a new product category: floating LiDAR systems (FLS) that over the last decade has grown into a recognized industry that is changing the pace of offshore wind exploration.

The offshore wind industry has continued to accelerate the adoption of FLS as an attractive alternative to building met masts.

New Volvo Authorized Power Center

Volvo Penta of the Americas has appointed Atlantic Detroit Diesel Allison (ADDA) as a new Authorized Power Center for the marine industry. ADDA is a division of Stewart & Stevenson, a Kirby Corp. It will be responsible for sales and service of Volvo Penta marine diesel and gasoline propulsion systems in New York and northern New Jersey. ADDA will support Volvo Penta's dealers and customers in the region with rapid-response centers located in Lodi, Piscataway and Latham. The company will serve as a resource for parts, service, warranty and training for Volvo Penta's dealer network across the territory.

Canaveral Port Authority Gets Good Rating

Credit-rating agency Fitch Ratings has issued an A rating for approximately \$137 million in Canaveral Port Authority (CPA) port revenue bonds, with the port's bond-rating outlook affirmed as stable. Fitch stated the port's cruise traffic continues to remain strong and drives the port's stable operating profile.

Fitch noted the A rating reflects Port Canaveral's market position as a leading cruise-focused port on the U.S.

East Coast, its aggressive yet flexible capital program, and its conservative debt structure. The A rating and stable outlook enables the port to remain competitive in the global marketplace.

Jamaica Stays on at IMO Council

Jamaica has been reelected to Category C of the Council of the International Maritime Organization (IMO). The country will serve another two-year term until 2021. The council is the governing body of the IMO when the assembly, which normally meets biennially, is not in session.

Restricted Navigation for Space Launches

The U.S. Coast Guard approved the use of a series of automatic identification system private aids to navigation (AIS PATON) to mark restricted navigation areas around commercial space launches. The Coast Guard authorized the Space Exploration Technologies Corp., better known as SpaceX, to use AIS PATON to inform mariners of non-charted restricted zones during sea-based space launches. The zones will be established from Cape Canaveral, Florida, into the Atlantic Ocean based on the flight path. They are designed to keep vessels from entering an active rocket launch area. The first use was scheduled for a December SpaceX launch.

Phoenix Divers Assist Aircraft Recovery

Phoenix International Holdings Inc. divers were contracted by Blount Brothers Construction to assist with the recovery of an aircraft that crashed and sank in the Red River in late 2019. Marine Unit deputies used emergency locator transmitters and sonar to pinpoint and mark where the plane went down. Once found, Phoenix divers rigged up the plane to be hoisted onto the Blount Brothers' barge.

Kraken Looks to Subsea Power Systems

Kraken Robotics Inc. has reached an agreement with the minority shareholder of Kraken Power GmbH to acquire the remaining 25 percent of Kraken Power not currently owned by Kraken.

Kraken anticipates continued growth in Kraken Power's pressure-tolerant batteries and thruster products with a variety of commercial and defense market customers. The subsea battery and energy-storage market will continue to grow from a variety of existing and emerging applications.

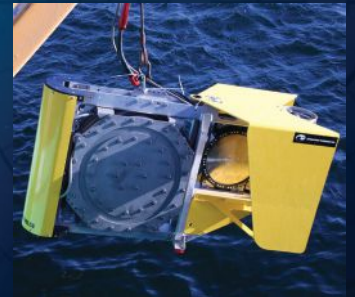
First Providers of Iridium GMDSS Named

Iridium Communications Inc. has announced the first seven companies authorized to provide its Global Maritime Distress and Safety System (GMDSS) services, planned for commercial introduction in the first half of 2020. The companies are: Arion Communications, AST, Marlink, Marsat, NSSGlobal, Satcom Global and Speedcast. Iridium GMDSS will feature safety voice, distress alerting and maritime safety information messaging. The terminal will also enable Iridium's global voice and data services. **ST**



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4K Camera



An ultracompact 4K UHD camera, Mako is for use on multiple platforms, including ROVs, HOVs, ASVs, landers and fixed platforms. Mako has an onboard real-time clock with scheduler that can also be used to synchronize and control any of Arctic Rays' Dragonfish series lights. Scheduling, settings adjustments and video downloading can be done via the standard MCBH connector or Wi-Fi. Arctic Rays LLC.

Bulker-Fit Configuration

Bulk carriers can now benefit from the PureBallast 3 that is specifically adapted to their flow needs. The configuration offers savings in footprint, installation, OPEX and CAPEX. Alfa Laval.

Hijack and Duress Subscriptions

GEOS360 subscriptions are now available for the Insight X2 and VTracker systems. GEOS360 provides travel safeguards, including search and rescue and medivac. Real-time messages notify the IERCC in Houston, Texas, to take immediate action engaging appropriate resources and managing the situation until it is resolved. Nautic Alert.

Heavy-Duty Winch Drives

The new series of eight Brevini heavy-duty winch drives supports hydraulic or electric motor options and provides output torques from 80 to 450 kNm. They are used in auxiliary hoist systems for ship loaders, deck cranes, cable and pipe-laying tensioners, rubber tyre gantry (RTG) cranes, and other maritime equipment. Dana Inc.

Addition to AIS Series

ComNav X5 Class A AIS transceiver with chart plotter is now part of the X-Series range of automatic identification systems. The X5 AIS is SOLAS- and Inland-Waterway-certified, as well as GPS-, GLONASS-, Galileo- and BeiDou-compatible. ComNav Marine Ltd.

Communication Terminals

New maritime voice and data communication terminals Inmarsat Fleet One and FleetBroadband 250 (FB250) both operate on Inmarsat BGAN (Broadband Global Area Network) for reliable communication, whether on land or at sea. Built-in Wi-Fi access points allow smartphone and smart devices to connect directly. Intellian Technologies Inc.

Two-Way Radio Bluetooth Adapter



The BT-520 Bluetooth Adapter (or dongle) easily converts two-way radios to Bluetooth, giving marine users the power to communicate wirelessly. This hybrid solution eases the transition to wireless. Pryme Radio Products.

Sediment Sampler

Capable of collecting up to 12 undisturbed sediment samples simultaneously, the Multiple Corer can be utilized for the sediment-water interface and for benthic fauna. It is suitable for environmental impact assessment throughout the world. Variations to the standard multiple corer design are also available. OSIL.

Fire-Suppression System

3M Novec 1230 at 725 psi (50 bar) is U.S. Coast Guard approved. The fully customizable MN-Series provides greater flexibility when designing or retrofitting a vessel's fire-suppression system and is ideal for commercial or recreational vessels up to 300 ft. Sea-Fire Marine.

Micro Inspection Skid



A new laser survey skid for inspection-class ROVs developed in partnership with iXblue and Nortek delivers high-accuracy inspection capabilities with subsea dynamic laser scanning to enable survey and inspection by low-cost vehicles. The ViewLS data module enables users to easily combine navigation and laser data and extract targets of interest into third-party point cloud analysis software. 2G Robotics Inc.

Offshore Connectivity

Reducing weight and space by up to 60 percent, the fire-resistant RADOX OFL (Oil & Gas Flexible Lightweight) cable solution has a small bend radius and thin wall that makes installation easier and quicker. This could save industrial and offshore facilities several hundred thousands of dollars in structural design. HUBER+SUHNER.

Shallow-Water Push Boat

Powered by two MTU 8V4000M-55RN natural gas engines and designed for use on inland waterways, the push boat is more cost-effective to operate and produces less pollutants and exhaust gases than vessels with conventional propulsion systems. Rolls-Royce Power Systems AG and Robert Allan Ltd.

Subsea Hydraulic Power Units

A new range of SHPUs comes with integrated hydraulic system components and functionalities such as

pressure compensation, filtration, controls and instrumentation. It is suitable for subsea installation tooling and subsea dredging systems. Seatools BV.

P-Clamps

Engineered with separate lock and mounting features that offer engineers the flexibility to rethink the way electrical and fluid systems are configured, P-Clamps can be installed earlier in the assembly process compared to standard AS21919 P-Clamps. They eliminate the need for tools and hardware when installing cable assemblies. TE Connectivity Ltd.

ROV Power Supply

Powering through the tether cable, the Outland Technology Power Supply (OTPS) for the BlueROV2 eliminates the need for batteries. OTPS transfers the power at a high voltage and low current, minimizing power losses through the tether. Outland Technology Inc. and Blue Robotics Inc.

All-Black Antenna Line

Whether for tactical purposes or simply to match a boat's decor, the all-black Full Stealth line of antennas, mounts and cable delivers quality and performance in a sleek modern package. The VHF and AM/FM versions are offered in 4- and 8-ft. lengths. AirWave Marine.

Used Oil Analysis IT Platform

The LubeAnalyst next-generation platform offers a much simpler sample management process, which includes online sample registration and label printing. This helps to minimize the likelihood of errors. Shell Marine.

Magnetron-Free Radar

For the first time, a magnetron-free Commercial Radar/Chart Radar solution is now available in both X-band and S-band. No magnetron means less power consumption, as well as no consumable part. Solid-state NXT radars are both powerful and eco-friendly. FURUNO USA Inc. **ST**



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Vehicle Autonomy Advances With Successful Sea Trials

New standards in long-endurance underwater navigation and automated subsea positioning have been set following the successful completion of a joint project led by Sonardyne International Ltd., with the U.K. National Oceanography Centre (NOC) and L3Harris as partners. The two-year Precise Positioning for Persistent Autonomous Underwater Vehicles (P3AUV) project, partly funded by Innovate UK, set out to integrate existing and emerging technologies to deliver a step-change in unmanned platform endurance and navigational precision. The project also set out to increase the use of autonomy in offshore survey positioning operations using USVs, thus reducing risk to personnel, environmental impact and operating costs. The final project trials, which saw one of the NOC's largest

deployment of AUVs operating in swarms, were completed in Loch Ness, Scotland.

Certification for Cybersecurity Management on LNG Carrier

ClassNK has certified the cybersecurity management system (CSMS) of NYK Group subsidiary NYK LNG Shipmanagement Ltd. and its managed LNG carrier *Pacific Mimosa*. This is the first CSMS certified by the society.

ClassNK released its "Cyber Security Management System for Ships" in March 2019, which provides guidance on ensuring, implementing, maintaining and continuously improving the cybersecurity management system of companies and ships with the goal of safe navigation. It includes management measures regarding protection against cyber risks in the navigation and construction/design stages of ships.

KR and Athens University To Share Tech, Software

The Korean Register (KR) has signed a memorandum of understanding with the National Technical University of Athens, agreeing to share specialist technology and software with the students of the School of Naval Architecture and Marine Engineering.

The agreement was coordinated with the assistance of Ambassador Soo-suk Lim of the Embassy of the Republic of Korea to the Hellenic Republic and is part of wider ongoing cooperation and exchange of maritime technology between Greece and South Korea.

Under the agreement, KR will supply students with its software free of charge, including SeaTrust-Hulls-Can, which is designed to analyze the structural strength of a ship in line with KR's rules and the harmonized CSR. KR is also sharing KR-CON, a bespoke software database of all the International Maritime Organization convention documents, together with full training on both



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software packages. KR's European headquarters is in Athens, and the office oversees 18 branches across Europe and Africa.

Teledyne Participates in JANUS NATO Event

Teledyne Marine has taken part in the second JANUS Interoperability Fest hosted by the NATO STO Centre for Maritime Research and Experimentation (CMRE), based in La Spezia, Italy.

Over the past decade, CMRE has been leading the efforts to develop a digital underwater coding standard to provide a baseline common denominator for underwater acoustic communications. Although there are a number of commercial communication solutions and protocols now available from different suppliers, until recently there has not been a set standard to ensure the interoperability between equipment from the various ACOMMS manufacturers. This standard is called JANUS, now a NATO standard.

Once implemented globally by manufacturers, JANUS will make military and civilian, NATO and non-NATO devices interoperable, providing them all with a common language with which to communicate and arrange to cooperate.

Teledyne Marine participated in the latest JANUS Interoperability Fest with its UTS-9400 deck box and ATM-900 Series modems, with some added capabilities. These included an emergency plug designed for distressed submarine rescue operations and an AIS designed as a status-reporting service to broadcast identification and localization information.

Caterpillar Marine Tech Supports Stena Vessels

Stena has successfully completed sea trials of the first E-Flexer ferry with MaK 12 M 43 C and twin-screw Cat Marine Propulsion drive trains with MPP 1410f propellers, shafts and packaged gearboxes. *Stena Estrid* is the first of Stena RoRo's nine next-generation Ro-Pax vessels in a series that includes five for Stena Line plus vessels on long-term charter for other ferry operators.

KVH, Kongsberg Partner To Offer Maritime IoT

KVH Industries Inc. and Kongsberg Digital have installed their first joint maritime IoT (Internet of Things) system on an active working vessel.

The team installed a KVH Watch VSAT antenna for IoT connectivity and the Kognifai Vessel Insight platform on *Simrad Echo*, a Norwegian research vessel owned and operated

by Kongsberg, which will continue normal operations during the pilot maritime IoT project.

Together, KVH Watch and Kognifai Vessel Insight provide an integrated infrastructure for IoT connectivity and vessel-to-shore data.

This bundled connectivity solution serves as one of the first cases involving an active working vessel using an integrated maritime IoT solution. **ST**

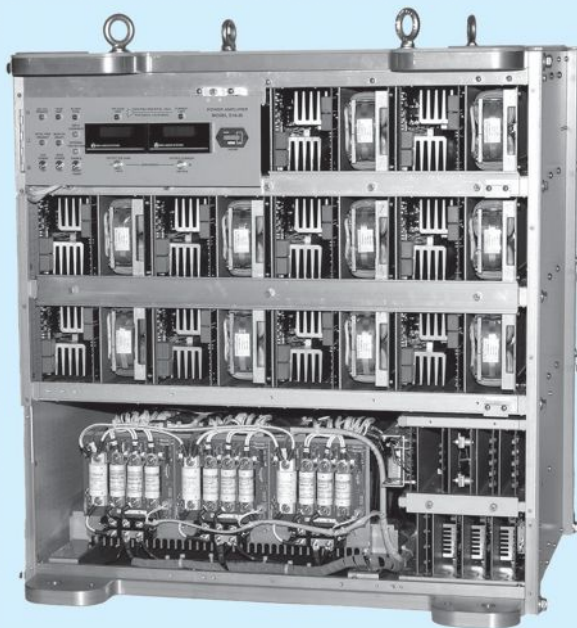
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Developing Automated Analysis of AZFP Data

ASL Environmental Sciences Inc. (ASL), University of Victoria, and the Department of Fisheries and Oceans (DFO) recently completed the first phase of a collaborative research initiative to develop automated analysis tools for data collected by ASL's multifrequency echosounder, the AZFP (acoustic zooplankton fish profiler). Following very promising results, the second phase of this initiative is now underway.

The AZFP provides high temporal and spatial resolution acoustic backscatter. This collaborative research focuses on developing methods and systems to automatically classify backscatter from AZFP data. Computer vision and machine learning will help solve challenges in environmental monitoring with ever-increasing data availability and the need for automation.

Robotic Grippers for Delicate Deep-Sea Species

Brennan Phillips, University of Rhode Island (URI) assistant professor of ocean engineering, has made significant advancements in the field of soft robotic grippers that can gently grasp delicate, obscure deep-sea species.

While on a recent expedition off the coast of Honolulu, Hawaii, he and his colleagues tested soft grippers and other research equipment for midwater exploration, using a new deep-ocean hydraulic system. They also tested new miniature deep-sea cameras, invented at URI. The new systems worked up to 1,200-m depth.

The work was conducted aboard the RV *Falkor*. Use of the ship and the ROV SuBastian was provided by the Schmidt Ocean Institute. Collaborators were from Harvard University and the Monterey Bay Aquarium Research Institute.

Solving the Mystery of Carbon on the Ocean Floor

For years, researchers looking at seafloor sediments would find bits of black carbon along with organic carbon strewn across the ocean floor but did not know where it originated. The challenge with studying deep marine carbon is that it is a mixture of fresh material delivered from the surface and an aged component, the origin of which had been previously unknown.

Now, a new University of Delaware study published in *Nature Communications* shows for the first time that the old carbon found on the seafloor can be directly linked to submicron graphite particles emanating from hydrothermal vents.

Identifying the sources, transport pathways and the fate of this seafloor carbon is key to understanding the dynamics of the marine carbon cycle.

Natural Oxygenation Events Possible Beyond Earth

New research suggests the distinct oxygenation events that created Earth's breathable atmosphere hap-

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pened spontaneously, rather than being a consequence of biological or tectonic revolutions. The study, presented at AGU's Fall Meeting and published in the journal *Science*, shines a light on the history of oxygen on Earth and gives new insight into the prevalence of oxygenated worlds other than our own.

The early Earth had no oxygen in its atmosphere or oceans until roughly 2.4 billion years ago when the first of three major oxygenation events occurred. The reasons for these stepwise increases of oxygen on Earth have been the subject of ongoing scientific debate.

In the new research, scientists modified a well-established conceptual model of marine biogeochemistry so that it could be run over the whole of Earth history and found that it produced the three oxygenation events all by itself. The model demonstrates that a gradual oxygenation of Earth's surface over time should result in distinct oxygenation events in the atmosphere and oceans, comparable to those seen in the geological record.

The new findings suggest that beyond early photosynthetic microbes and the initiation of plate tectonics—both of which were established by around 3 billion years ago—it was simply a matter of time before oxygen would reach the necessary level to support complex life.

This new theory drastically increases the possibility of high-oxygen worlds existing elsewhere.

Wirewalker, Current Profilers Reveal Ocean Processes

Paired with Nortek current profilers, Del Mar Oceanographic's Wirewalker is giving researchers a cost-effective way to answer vital questions about ocean processes. This helps improve environmental monitoring and climate forecasting, which assist in developing climate adaptation measures.

Powered by wave energy captured by a float at the surface and a weight suspended in the water column on a suspension wire, the Wirewalker propels itself down the wire to the desired maximum profiling depth and records data from the attached instruments as it slowly returns up the wire to the surface.

Since development began in 1998, researchers at Scripps Institution of Oceanography have paired the Wirewalker with several instruments, including Nortek's Aquadopp and Signature current profilers, which have provided critical, high-resolution measurements of current velocity.

CSIRO Orders Coring System

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia has purchased a 24-m Giant Piston Corer from OSIL for the RV *Investigator*. The modular deep-sea sediment coring system comprises four 6-m-long barrels, a stainless-steel head with removable lead weights, and a mechanical trigger arm with 1-m-long pilot core. The system has been specified with deck stands, deck storage for the head and barrels, and tools and spares.

The Giant Piston Corer can achieve recovery rates of over 95 percent in soft sediments. **ST**

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Cable Protection System For Taiwan Offshore Wind

Trelleborg's applied technologies operation has been awarded a contract by Ørsted to provide NjordGuard, an integrated cable protection system, for the Greater Changhua 1 & 2a offshore wind farms in Taiwan.

Trelleborg will provide 235 NjordGuard cable protection systems and bellmouths, which will protect all interarray and export cables on the projects.

Production of the 235 NjordGuards and bellmouths will take place in Trelleborg's manufacturing facility in northwest England. Installation is scheduled for 2021.

The Greater Changhua 1 & 2a offshore wind farms comprise 111 turbines installed on jacket foundations and have a combined total capacity of 900 MW. The two wind farms are located 35 and 60 km off the west coast of Changhua County, Taiwan.

NjordGuard is an integrated cable protection system designed and developed to protect offshore wind farm power cables in wind turbine generators and offshore substation platforms.

Easily assembled on a vessel to allow speedy installation, its highly abrasion-resistant API 17L certified Uraduct material enables the protection system to travel over the seabed without damage, thereby providing protection to the cable system.

It facilitates easier installation, reuse and removal without diver and ROV intervention.

Free Data Access to Support UK Offshore Wind Industry

Equinor and Masdar have joined forces with ORE Catapult to share floating offshore wind data via a data-sharing platform. Operational data from the world's first floating offshore wind farm, Hywind Scotland, is now available to access on a free-to-use basis for supply chain businesses and academia through the Offshore Renewable Energy

(ORE) Catapult's Platform for Operational Data (POD) service.

The POD service is designed to offer comprehensive data sets from offshore wind demonstrator sites across the U.K. to improve our understanding of how offshore wind farms operate in real-world conditions and support innovative research, projects and product development.

Under this agreement between Equinor, Masdar and ORE Catapult, subscribers can access a pre-defined set of full-scale measurements from one of Hywind Scotland's five turbines.

By enabling access to this information, the three organizations aim to better engage industry, academia and the offshore wind supply chain in the U.K. and internationally to foster collaboration and drive innovation in floating offshore wind.

The shared long-term goal is to reduce the cost of floating offshore wind, making the technology a cost-competitive industrial solution.

The data shared will include environmental data, motions of the floating wind turbine and loads in the mooring system.

POD was enabled through funding from the Scottish government and is available at <https://pod.ore.catapult.org.uk>.

Framework Agreement for North America Offshore Wind

Nexans, specializing in advanced cabling and connectivity solutions; Eversource, a New England transmission builder; and Ørsted, a player in offshore wind, have announced a framework agreement to reinforce their long-term partnership. It will result in Nexans having the opportunity to provide up to 1,000 km of subsea high-voltage export cables for Ørsted's offshore wind farms in North America. The first delivery is expected by 2022, and the agreement extends until 2027.

Building on Nexans' know-how in submarine cabling systems and its existing manufacturing footprint in Norway and Japan, the Nexans

facility in North America will become the first plant to manufacture subsea high-voltage cables in the U.S.

Nexans' investment in the U.S. facility adds to the group's ambition to increase its submarine cable installation capacity. This includes the building of *Nexans Aurora*, a new state-of-the-art cable-laying vessel with a 10,000-ton capacity.

Collaboration on Rotor Sails In VLCC Design

Norsepower Oy Ltd. has completed a joint development project with SWS (Shanghai Waigaoqiao Ship Building Co. Ltd.) for developing an energy-efficient dual-fuel VLCC design that has gained approval in principle (AiP) from Lloyd's Register and ABS. Under the agreement, Rotor Sails were implemented in the VLCC design for improving fuel efficiency and reducing emissions.

The impact of the installation of Norsepower's Rotor Sail solution, including a review of structural reinforcement and visibility calculation, was reviewed using computational fluid dynamics (CFD), confirming a potential of 6 to 10 percent fuel and emissions savings, dependent on operating routes.

The Norsepower Rotor Sail Solution is a modernized version of the Flettner rotor, a spinning cylinder that uses the Magnus effect to harness wind to propel a ship. The solution is fully automated and senses whenever the wind is strong enough to deliver fuel savings, at which point the rotors start automatically.

In addition to this announcement, Norsepower's Rotor Sails have been installed on board three vessels. Norsepower has also recently started a delivery project of a Rotor Sail to a hybrid ferry owned by Danish shipping company Scandlines.

The handover of AiP certificates to the shipyard demonstrates the potential for reducing emissions in ship designs that is cost effective and allows the shipping industry to address the challenge of reducing greenhouse gas (GHG) emissions by 2050. **ST**

Donations for Fishery Simulator in Greenland

Nine commercial fishery companies have donated in total 3.2 million DKK to Danish training institute the Greenland Maritime Center for investment in a state-of-the-art K-Sim Fishery simulator from Kongsberg Digital.

A first of its kind in Denmark, the K-Sim Fishery simulator will enable students to gain vital competence in diverse fishery situations, including aft-deck operations, and is scheduled for installation in 2020.

Introduced by Kongsberg Digital in 2018, K-Sim Fishery is based on sophisticated K-Sim Navigation simulator technology, with added functionality and instruments specific to commercial fishing, including Kongsberg Maritime (Simrad) echosounders, sonars and trawl monitoring systems.

The new K-Sim Fishery simulator will be built upon one of Greenland Maritime Center's existing K-Sim Navigation bridge simulators. The upgrade will include a highly detailed fishing vessel model with advanced hydrodynamic modeling for ultimate realism in behavior and a new customized sailing area to accommodate exercises in Greenland waters.

Additionally, the extension will feature new consoles and instruments for training on maneuvering, fish finding and fish catching.

New Apprenticeship Program For UK Marine Surveyors

An industry-backed initiative led by the Institute of Marine Engineering, Science & Technology (IMarEST) to develop a four-year degree-level apprenticeship for those who aspire to become professional marine surveyors has been formally approved by the U.K. government's Department for Education.

In recent years, employers such as classification societies, P&I Clubs and other specialist insurers, as well as governmental bodies such as the U.K.'s Maritime Coastguard Authority (MCA), have struggled to recruit

and retain competent seafarers and other surveyor candidates. They increasingly have to import talent from overseas.

The shortage in qualified surveyors is exacerbated because, in stark comparison to the dwindling number of large ships on the U.K. Ship Register, the number of workboats and other smaller tonnage U.K. vessels has swollen.

Research conducted by the National Workboat Association found the shortage was affecting their members by delaying pre-purchase, on and off charter, condition surveys, damage and warranty surveys, MCA Code surveys and IMCA operational safety inspections.

To address the problem, an alliance of industry partners coalesced into the Trailblazer Group to create an apprenticeship program.

The apprenticeship takes candidates with relevant A-level qualifications or equivalent and provides them both academic studies and specialist practical training to produce competent and self-reliant surveyors at the end of the four-year program.

First-Ever Refueling of Containership with BFO

IKEA Transport & Logistics Services, the CMA CGM Group and the GoodShipping Program have successfully completed their 2019 biofuel test program on CMA CGM vessels, following the positive trials of heavy fuel oil-equivalent (HFO) biofuel oil (GoodFuels BFO) during CMA CGM *Alexander Von Humboldt's* North Europe-Asia trip in September and October 2019.

This latest development follows the world premiere refueling of a containership with sustainable biofuel in March 2019.

During the unprecedented trial, sustainable BFO was used in a blend with conventional fossil-based marine fuels to power a vessel on a major oceangoing route. Both applications of the BFO showed a positive result, thus proving the technical compatibility of

sustainable marine biofuels. These developments demonstrate the viability of advanced biofuels to meet current and future environmental regulations and emissions reductions targets, delivering a more sustainable shipping industry.

The BFO was supplied by GoodFuels and is the first ever HFO-equivalent biofuel. All GoodFuels sustainable marine fuels are virtually SOx free and deliver 80 to 90 percent well-to-propeller CO₂ reduction versus fossil equivalents.

Ammonia-Fueled Ship Design Principle Approved

Lloyd's Register (LR) has granted approval in principle to Dalian Shipbuilding Industry Co. (DSIC) and MAN Energy Solutions for an ammonia-fueled 23,000-TEU ultralarge containership (ULCS) concept design, the first ammonia-as-fuel design of its kind in China.

LR facilitated hazard identification (HAZID) workshops to determine potential hazards throughout the design phase, covering areas limited to the ammonia-fueled engine and the external piping systems. LR also provides technical guidance regarding the ship's design and the provision of technical materials, in accordance with the goals and functional requirements from current and anticipated regulatory rules, procedures and guidelines.

Data Visualization for Great White Shark Images

Oxford-based Zegami, a data visualization company, has been engaged by the Monterey Bay Aquarium to strengthen its project to monitor and protect the great white shark population in the northeastern Pacific.

Zegami will help bring structure to the aquarium's large collection of visual data: pictures of great white shark fins spotted off the coasts of California to Baja, Mexico.

The team from the aquarium has been working for over 15 years to track individual white sharks in the area. So far, they have identified and researched 475 individual white sharks, with a catalog of over 2,000 images of white shark fins. **ST**

people

Sylvia Boer, 37, is the new director of Amsterdam IJmuiden Offshore Ports (AYOP). She will serve as the linchpin between members of the association for offshore companies, government bodies and stakeholders. Boer's appointment is designed to leverage the major opportunities AYOP sees for offshore wind and oil and gas in the Amsterdam and IJmuiden region. She has been working for Damen Shipyards Group over the past eight years.



Lloyd's Register has appointed **Markus Büsig** as its Marine & Offshore area manager for North Europe. Büsig, 52, joins from MPC Münchmeyer Petersen & Co. Group, Hamburg, an international firm focused on the finance and management of maritime assets, where he led MPC Marine, a provider of marine technical and commercial services to the shipping and shipbuilding industry. In his decade at MPC Group, Büsig successfully supported and restructured a number of companies, returning them to profit.



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Dr. Eduardo Vaz has joined RBR as the senior business development manager. Vaz brings technical expertise and international business development experience in physics, computing and sustainability projects. RBR has also expanded to France with sales and business development activities directed by **Didier Clec'h**. He brings many years of instrumentation experience and trusted relationships working in the French oceanographic community.

Anemoui Marine Technologies has appointed shipping technology expert **Kim Diederichsen** as CEO to take the company's wind-assisted propulsion systems to a global market for tanker, bulk, ro-ro and other vessel owners.

Pacific Green Technologies Group welcomes **Steven Matthew** as sales director of its new Asia office, located in Hong Kong. Matthew will focus on marine and environmental technologies.

Patrick Lehodey, head of the Marine Ecosystems Modeling team at CLS, was awarded the Étoiles de l'Europe prize in recognition of his work on MESOPP, a European and Australian project studying the role of the huge micronecton biomasses that contribute to CO₂ sequestration in the Southern Ocean.

Integral Consulting has hired **Patrick Friend** as a strategic adviser in its Marine Science and Engineering group. Friend has a Ph.D. in sediment dynamics and more than 20 years of experience in project delivery and management in coastal and marine sciences.

Phoenix International Holdings Inc. has promoted **Matthew Long** to corporate vice president. Long will retain his duties as the general manager of Phoenix's Largo, Maryland, operations and assume responsibilities for company-wide financial forecasting, reporting and budgeting.

The Marine Technology Society's membership has elected **Dr. Josh Kohut**, a professor at Rutgers University at the Center for Ocean Observing Leadership, to serve on its board of directors as the vice president of education until December 31, 2022. Kohut will develop and maintain positive and productive relationships with academic institutions, laboratories and research institutes and help develop opportunities for students.

The National Ocean Industries Association (NOIA) has hired **Richard England** and **Ashley Parkins** as the new vice president of government affairs and the director of meetings and events, respectively. In addition, **Justin Williams** has been promoted to vice president of communications.

The Korean Register (KR) has appointed **Hyung-chul Lee** as its 24th chairman and CEO. Lee joined KR in 1988 and served recently as executive vice president of the classification society. **ST**

contracts

COWI, Kongens Lyngby, Denmark, has awarded a nearshore geotechnical site investigation for CPH City & Port Development's Lynetteholmen megaproject in Copenhagen. The site investigation will inform the detailed design of the new artificial island, which will cover approximately 275 hectares and increase the Danish capital's land mass by around 2 percent. Fugro.

Nautilus Labs, New York, New York, has signed an agreement to join a group of dedicated application providers for the Fleet Data service. The Fleet Data API (Application Programming Interface) will help automate data collection as part of Nautilus Platform, a fleet optimization user interface that provides shipping owners and operators with predictive analytics to reduce fuel consumption, improve decision making, and meet international and local environmental standards in real time. Inmarsat.

Damen Shipyards Group, Gorinchem, Netherlands, signed a technical cooperation contract to provide design, engineering and technical assistance for the construction of a scientific marine research vessel for DIMAR (Direccion Maritima – Maritime Authority) that will be the largest and most complex vessel ever to be built in Colombia. Cotecmar.

VIKING Life-Saving Equipment, Esbjerg, Denmark, has secured a contract to protect over 40 ships in a Hamburg container ship fleet against container fires using VIKING's HydroPen system. VShips.

OneOcean, Enfield, England, has been selected to supply its integrated OneOcean platform to bring together all navigational, regulatory and environmental requirements using PassageManager, Regs4Ships and EnviroManager. Thome Group.

ACO Marine, Prague, Czech Republic, has expanded its presence

in Asia with a new sales and service agreement. Seven Bridges Maritime (Vietnam).

Travelport, Langley, England, has been awarded a new long-term technology contract to support the shipping industry. Eurasia Travel Network.

Høglund Marine Solutions, Tønsberg, Norway, has signed a memorandum of understanding to help generate and export big data from ships. DNV GL. **ST**

meetings

MARCH

March 9-10—World Ocean Summit, Tokyo, Japan. +971 552215208, oceansummit@economist.com or www.woi.economist.com/world-ocean-summit.

March 17-19—Oceanology International, London, England. +44 (0)20 82712133 or www.oceanologyinternational.com.

March 23-25—International Lidar Mapping Forum, Washington, D.C. www.lidarmap.org.

March 24-26—Challenge of Science Leadership Training, Cambridge, England. info@scienceleadership.co.uk or www.scienceleadership.co.uk.

March 25—AUVSI Hill Day, msmithsky@auvsi.org or www.auvsi.org/events/hill-day/auvsi-hill-day-science-and-tech-fair-2020.

March 31-April 1—Decommissioning & Abandonment Summit, Houston, Texas. www.decommissionworld.com/gom.

APRIL

April 6-9—OCEANS 2020 Singapore, Singapore. info@oceans2020singapore.org or https://singapore20.oceansconference.org.

April 13-16—MTS Buoy Workshop, Wilmington, North Carolina. rickcole@rdsea.com.

April 21-24—International Partnering Forum on Offshore Wind, Providence, Rhode Island. www.offshorewindus.org/2020ipf.

MAY

May 4-7—AUVSI XPONENTIAL, Boston, Massachusetts. meetings@auvsi.org or www.xponential.org.

May 4-7—Offshore Technology Conference, Houston, Texas. 972-952-9494, meetings@otcnet.org or http://2020.otcnet.org.

May 6-7—Remote Hydrography Conference, Southampton, England. helen@ths.org.uk or www.ths.org.uk/content.asp?page=99.

May 18-19—Maritime Transport Efficiency Conference, Geneva, Switzerland. bernard.schopfer@maxcomm.ch.

May 19-21—International Conference on Ocean Energy (ICOE), Washington, D.C. www.icoe2020.org.

May 19-21—MegaRust, San Diego, California. 703-836-6727, asnehq@navalengineers.org or www.navalengineers.org/Symposia/MegaRust-2020.

May 19-21—OceanTech Program, Zhoushan, China. +852 2881 5889 or katherinelee@together-expo.com.

May 26-28—UDT, Rotterdam, Netherlands. www.udt-global.com.

JUNE

June 3-4—BlueTech Expo, Washington, D.C. 703-850-1448, rich.lawson@iostia.org or www.BlueTechExpo.org.

June 3-4—LNG Latin America 2020 International Congress, Buenos Aires, Argentina. http://lnglatinamerica.com.

June 9-11—CLEAN PACIFIC, Seattle, Washington. https://2020.cleanpacific.org.

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

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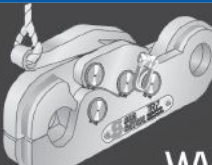
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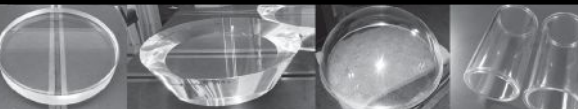
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Maritime Degrees Bring Biggest Return on College Investment—Charles Southall

Charles Southall is the vice president of engineering and design for Huntington Ingalls Industries' Newport News Shipbuilding (NNS). Southall is responsible for all ship design, construction engineering, fleet engineering services and test engineering. He joined NNS in 1988 as a submarine engineer and has a bachelor's degree in mechanical engineering technology from Old Dominion University.



If you asked most high-school seniors what majors give the best return on their investment, I'd guess few would think of degrees centered on maritime careers.

Yet two recent studies just came out with that surprising finding.

A Bankrate study (www.bankrate.com/career/most-valuable-college-majors) found that naval architecture and marine engineering top the list of most valuable college majors. Another study from the Georgetown University Center on Education and the Workforce (<https://cew.georgetown.edu/cew-reports/collegeroi>) ranked the return on investment for a college education at 4,500 colleges, looking at the best long-term net economic gain.

As expected, many Ivy League schools surfaced, but two public schools also made the Top 10 list. Both were maritime academies. In fact, the Maine Maritime Academy (ranked sixth) actually outranked Harvard (eighth). In 10th place was the United States Merchant Marine Academy.

Despite repeated calls for more engineers and STEM majors, few high-school students know about the incredible opportunities available in naval and marine and sea technology industries.

Like many in these fields, I learned about these careers by living on the coast. I grew up in a

small southeastern Virginia town on the Chesapeake Bay. As the grandson of a commercial fisherman and the son of a career NASA employee and private flight instructor, I was encouraged toward technology and the sea. I wanted to be part of the shipbuilding industry the moment I first stepped aboard a submarine as a college student. I was lucky to have an encouraging family who valued technology education.

Today, we must find a way to reach out and promote the rewarding and lucrative benefits of these careers, especially to those not living on the coasts, or we will continue to lose out on a valuable talent resource desperately needed, especially in the defense industry. For example, my company, Huntington Ingalls Industries' (HII) Newport News Shipbuilding, has hired over 800 engineers in 2019. These talented women and men will help us fulfill the Navy's recent contract for a two-ship buy of *Ford*-class aircraft carriers; and, along with General Dynamics, the recent contract to build nine additional *Virginia*-class nuclear submarines. We need new talent like never before—and must find creative ways of encouraging aspiring engineers and designers across America to consider a maritime industry career.

The defense industry must compete for this talent with many other manufacturing sectors. Graduates from top engineering schools like the University of Michigan and the Webb Institute are courted by engineering firms worldwide. The same can be said of other STEM majors. Our industry must make a more concerted effort to attract this talent by focusing on three key areas. First, we must reach beyond the two coasts to educate a diverse population of American high-school students about these potential majors. Second, we must collaborate with more universities to expose students to these careers. And, finally, we

need to more proactively amplify and promote studies that clearly indicate the high value and return on investment for those entering these critical fields.

When looking at potential colleges, more students must be made aware of the limited universities that offer naval and marine degrees. Unfortunately, they must often decide on a university before even knowing their intended majors. Working with guidance counselors, science teachers and STEM programs to expose students to these specialized majors is crucial. For those who do choose a university offering these degrees, we can provide engaging real-life case studies and educational projects. For example, our shipyard in Newport News recently conducted a webinar with the Webb Institute on a *USS Gerald R. Ford* aircraft carrier build. That was an incredibly powerful experience, not just for the students but for my career engineers who were very proud to give back; a real win-win for the nation. We have to be more creative and aggressive in advocating for our field in the early stages of education because that is when our recruiting pool shrinks considerably due to a simple lack of awareness.

As college debt grows, more and more students are looking at the return on their investment and the value of their education. This is a vastly untapped selling point, giving our industry a distinct advantage in differentiating ourselves from competing industries.

Susan Jacobs, vice president of human resources at HII, believes students often don't understand what defense careers entail. "These degrees provide a critical skill in an industry that helps safeguard our freedoms," she said.

As students seek meaningful careers that make a difference, helping build technology and infrastructure to enhance national security is truly a mission that matters. **ST**

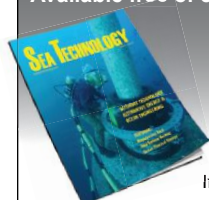
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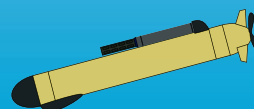
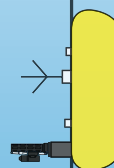
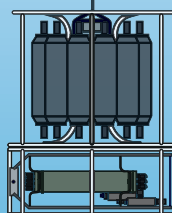
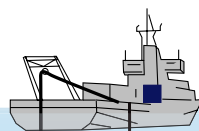
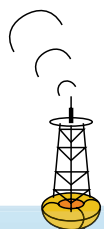
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Oxygen

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