

SEA TECHNOLOGY[®]

www.sea-technology.com

FEBRUARY 2021

**Instrumentation:
Measurement
Processing &
Analysis**

**FEATURING:
Measuring Hypoxia
Positioning, Navigation Tech
Machine Learning for Data QC**



A brilliant oxygen sensor pairs perfectly
with a phenomenal CTD.



Discover how the RBRconcerto³ CTD and RBRcoda T.ODO dissolved oxygen optode can improve your profiling, mooring, and vehicle measurements. Available with faster sampling, lower power consumption, and wipeable foils.

RBR
rbr-global.com

SENSORS | LOGGERS | SYSTEMS | OEM

TOTAL OCEAN MARKET COVERAGE

2021

JANUARY

Annual Review & Forecast

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

MARCH

Electronic Charting/Vessel Management/
Ports & Harbors/Dredging/Homeland Security

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

**AUVSI XPONENTIAL 2021 (Part 1), May 4-6, Virtual

MAY

Communications, Telemetry, Data Processing

**CLEAN PACIFIC, June 28-30, Seattle, WA

**UDT, dates TBD, Rostock, Germany

JUNE

Seafloor Mapping/Sonar Systems/Vessels

JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

**Offshore Technology Conference, August 16-19, Houston, TX

**AUVSI XPONENTIAL 2021 (Part 2), August 16-19, Atlanta, GA

AUGUST

Ocean Resources Development

**Global OCEANS 2021 San Diego – Porto, September 20-23,
San Diego, CA (Hybrid)

**SEG 2021, September 26-October 1, Denver, CO

SEPTEMBER

Geophysical Exploration

**Ocean Business, October 12-14, Southampton, UK

**Offshore Energy, October 26-27, Amsterdam, The Netherlands

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

**CLEAN GULF 2021, November 16-18, San Antonio, TX

NOVEMBER

Undersea Defense/Antisubmarine Warfare

DECEMBER

Diving, Underwater Vehicles & Imaging

**These events are dependent on COVID-19 restrictions.

SEA TECHNOLOGY®

WORLDWIDE INFORMATION LEADER FOR
MARINE BUSINESS, SCIENCE & ENGINEERING

The only magazine that addresses the
total oceanographic field from undersea
defense to offshore oil...globally

Recognized by tens of thousands as the
authority for design, engineering, and
application of equipment and services
for government and industry.

...and most of all, IT SELLS!

**ADVERTISING CLOSES ON
THE 15TH OF THE MONTH
PRECEDING ISSUE DATE**

BONUS INFORMATION TO KEEP OUR READERS UP-TO-DATE

- Capital Report
- Company Profiles
- Contracts
- Environmental Monitoring
- International
- Marine Renewables
- Marine Resources
- Meetings
- Navy Currents
- Ocean Business
- Ocean Engineering
- Ocean Research
- People
- Product Development
- Reviews
- Soapbox

OTHER OPPORTUNITIES

- Advertorials
- Sea Technology Buyers Guide/Directory
- Sea Tech e-News
- Commercial Fisheries News
- Fish Farming News
- Fish Farmers Phone Book/Directory
- Commercial Marine Directory
- Direct mail list rentals
- Article reprints/PDFs
- Banner and skyscraper Web ads
- Sponsored e-blasts

EDITORIAL CONTACT

Aileen Torres-Bennett

ADVERTISING CONTACTS

C. Amos Bussmann
Sue Ingle Owen

Follow Us On:



Compass Publications, Inc.

4600 N. Fairfax Dr., Suite 304, Arlington, VA 22203-1553 • Tel: 703.524.3136 •

oceanbiz@sea-technology.com (ed

chnology.com (

1963 – 2021 Celebrating More Than

50 Years of Serving the Global Ocean Community

CONTENTS

FEBRUARY 2021
Volume 62, No. 2

FEATURES

8

INNOVATIVE HYPOXIA MEASUREMENT

Doug Wilson (*Caribbean Wind LLC*) and Darius Miller (*Soundnine Inc.*) describe a collaboration involving CTDO sensors and the Ultibuoy in the Chesapeake Bay.

14

FISHING FOR OCEANOGRAPHIC DATA

Linus Stoltz (*Oregon State University*), Jeremy Childress (*Sexton Corp.*) and Francis Chan (*Oregon State University*) introduce new tools that are energizing a partnership between fishing communities and scientists.

17

INS + USBL

Hollie Moran (*Applied Acoustics Engineering Ltd.*) explains how a collaboration produced a highly accurate positioning system.

20

WAYFINDER DVL

Bill Meachum and Nathan Hui (*Teledyne RDI*) outline the verification of performance and integration of a DVL for small ROVs and AUVs.

23

AUTOMATIC RADAR DATA QUALITY CONTROL

Dr. Rune Gangeskar (*Miros AS*) discusses how to apply deep learning and AI to ocean wave and current measurements.

DEPARTMENTS

6

Soundings

7

Editorial

28

International

30

Product Development

32

Marine Renewables

33

Contracts

34

Marine Electronics

35

Marine Resources

36

Ocean Research

37

Meetings/People

38

Professional Services Directory

39

Soapbox

40

Advertiser Index

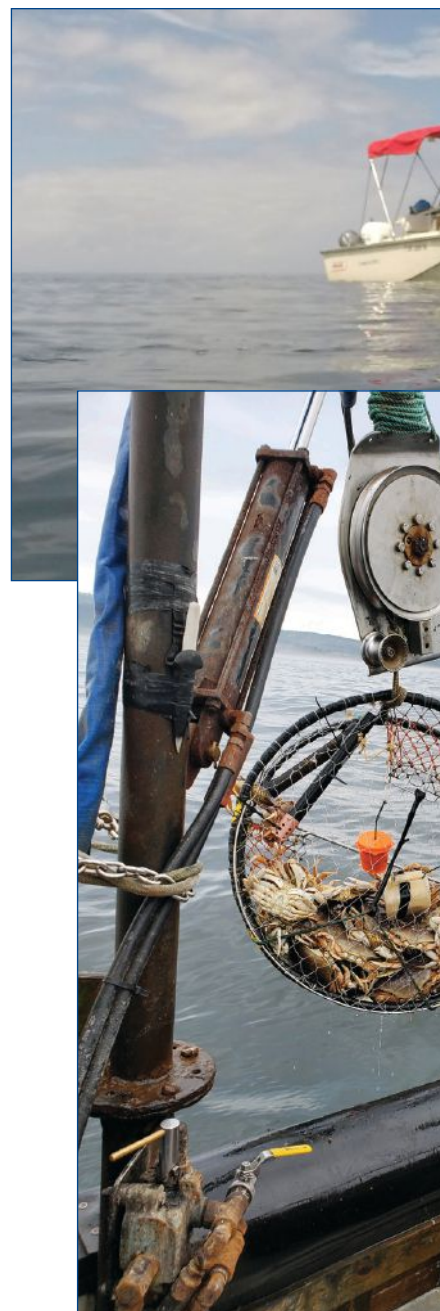
COVER IMAGE

Metocean Services International single-point current meters and flotation prepared for deployment on deepwater mooring in Namibia, 2019.

NEXT MONTH

Vessel management based on machine learning ... Autonomous port management ... Platform to manage maritime navigation, compliance ... Maritime drones for homeland security ... NASA PACE mission for ocean monitoring.

Copyright 2021 by Compass Publications, Inc. *Sea Technology* (ISSN 0093-3651) is published monthly by Compass Publications, Inc., 4600 N. Fairfax Dr., Suite 304, Arlington, VA 22203; (703) 524-3136. All rights reserved. Neither this publication nor any part of it may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of Compass Publications Inc. Periodicals postage paid at Arlington, Virginia, and additional mailing offices. Subscriptions may be purchased at the following rates: domestic, \$60 one year; \$80 two years; foreign air mail, \$144. Single copies \$4.50 plus shipping and handling (current issue only). POSTMASTER: send address changes to Compass Publications, Inc., P.O. Box 600, Deer Isle, ME 04627-0600. CUSTOMER SERVICE, Tel. 1-800-989-5253 or 1-207-348-1057.

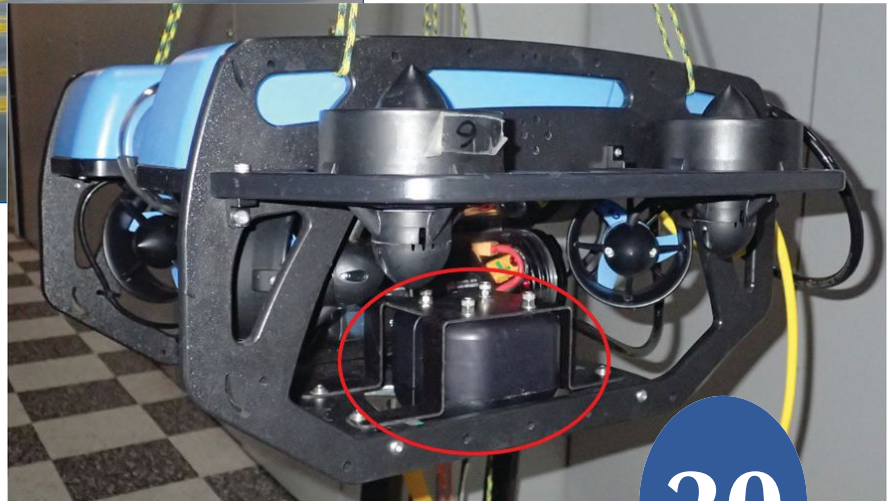




8



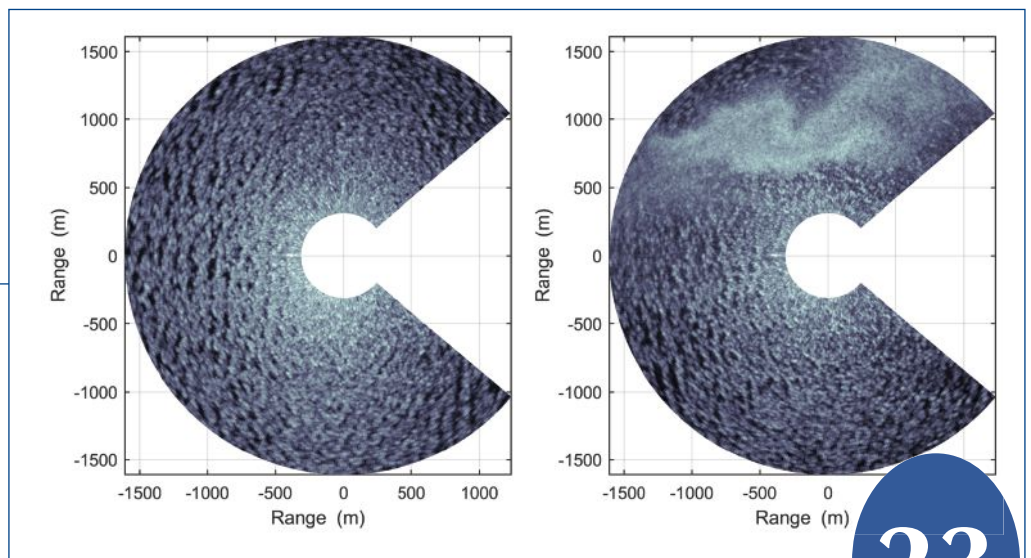
14



20



17



23

)) New US Tri-Service Maritime Strategy. The U.S. Navy, Marine Corps and Coast Guard released a new tri-service maritime strategy today, entitled “Advantage at Sea.” The document provides strategic guidance on how the sea services will prevail in day-to-day competition, crisis and conflict over the next decade. It also directs the services to deepen tri-service integration, aggressively pursue force modernization, and continue robust cooperation with allies and partners. Advantage at Sea places particular focus on China and Russia due to their increasing maritime aggressiveness, demonstrated intent to dominate key international waters and clear desire to remake the international order in their favor. “China’s and Russia’s revisionist approaches in the maritime environment threaten U.S. interests, undermine alliances and partnerships, and degrade the free and open international order,” the document states. “Moreover, China’s and Russia’s aggressive naval growth and modernization are eroding U.S. military advantages.” The strategy also emphasizes the maritime domain is integral not only to U.S. security and prosperity but to those of all nations. The oceans connect global markets, provide essential resources, and link societies and businesses. Shared interests create opportunities for greater cooperation with allies and partners. The future fleet will combine legacy assets with new and smaller ships, lighter amphibious ships, modernized aircraft, expanded logistics, resilient space capabilities, and optionally manned and unmanned platforms. To read the full strategy, visit: www.uscg.mil/tsms.

)) Center for Marine Acoustics Established. The U.S. Bureau of Ocean Energy Management (BOEM) has established a new Center for Marine Acoustics (CMA), an initiative that will strengthen BOEM’s role as a driving force within the regulatory community on sound in the marine environment. Staffed by highly skilled and knowledgeable acoustics and modeling experts, the CMA will address both naturally occurring sounds and sounds generated by the industrial activities that BOEM regulates, including offshore oil and gas, renewable energy, and marine minerals development. The CMA will augment and focus its marine acoustics expertise on cutting-edge research and applications, including studies of sound-source impacts and customized underwater acoustic impact models to inform agency decision making. It will make sure BOEM is fast, nimble and forward-thinking on marine acoustics. BOEM expects the CMA to establish the agency as a trusted voice on marine acoustics. This includes being a trusted source for research to understand the biological impacts of machine-made sound, models for characterizing impacts, and standards for drawing the line between what levels of noise are acceptable and what levels are not. Learn more at: www.boem.gov/center-marine-acoustics.

)) Apply for NOAA Hydrographic Panel. NOAA is soliciting nominations for membership on the Hydrographic Services Review Panel, a federal advisory committee that advises the NOAA administrator on the agency’s hydrographic programs, products, data and technology. Nominations must be received by April 26, 2021, for a term that starts in 2022. Nominations are on a rolling admission and those received after April 26, 2021, will be kept on file and may be used for future panel vacancies. The panel advises NOAA on operations and research issues related to hydrographic surveying, nautical charts, tides and currents, geodetic and geospatial measurements, and coastal preparedness. Applicants should have expertise in marine navigation and technology; port administration; marine shipping or other intermodal transportation industries; cartography and geographic information systems; geodesy; physical oceanography; coastal resource management, including coastal preparedness and emergency response; or other science-related fields. Learn more at: www.nauticalcharts.noaa.gov/hsrp/hsrp.html.

)) ShipFC Project to Develop Ammonia Fuel Cells. Interest in ammonia-powered fuel cells for the maritime sector is growing, but stakeholders have been hesitant to commit to investments in large-scale systems. Now the ShipFC project, granted funding from EU’s Research and Innovation program Horizon 2020 under its Fuel Cells and Hydrogen Joint Undertaking, is aiming to secure a place for ammonia in the future of deep-sea shipping. The project will equip the offshore supply vessel *Viking Energy*, owned and operated by Eidesvik and on contract to energy major Equinor, with a 2-MW ammonia fuel cell, allowing it to operate for at least 3,000 hr. annually on clean fuel. Following the completion of that phase, the project will ramp up to qualifying 20-MW fuel cell solutions for ocean-going vessels. The ultimate goal of the project is to demonstrate the feasibility of ammonia fuel cells for ocean-going vessels and long sea voyages.

)) Don’t Delay on BWMS Installation. ClassNK has been analyzing the retrofitting status of ballast water management systems (BWMS) on its registered ships periodically since 2018. The status has been updated based on the latest data, and ClassNK has confirmed that installation deadlines based on the BWMS Convention for many of its registered ships are still concentrated in the year 2022. As of the end of November 2020, 7,220 of the 9,159 ships registered with ClassNK are obligated to install BWMS in accordance with the convention. Among these, 3,982 ships have completed the installation, leaving 3,238 ships that still require attention. As difficulties are expected in the installation of BWMS, ClassNK recommends installing well in advance of 2022. You can refer to the technical information TEC-1086 for guidance on BWMS plan examinations at <https://tinyurl.com/ycts4kk7>. **ST**

ADVERTISING REPRESENTATIVES:

HEADQUARTERS

C. Amos Bussmann
4600 N. Fairfax Dr., Suite 304
Arlington, VA 22203-1553
Tel: (703) 524-3136
seatechads@sea-technology.com

EASTERN U.S.A. & CANADA/G.O.M.

Ray Mahr, Jr.
RRK Consultants Ltd.
17476 Slipper Shell Way, Ste. 6
Lewes, DE 19958
Tel: (302) 569-0019 (M)
rmahrjr@gmail.com

WESTERN U.S.A. & CANADA

John Sabo
Barbara Sabo
Gregory Sabo
John Sabo Associates
447 Herondo St. #305
Hermosa Beach, CA 90254
Tel: (310) 374-2301
bsabo@jsaboassoc.com

EUROPE

John Gold
John F. Gold & Associates
"Highview"
18a Aultone Way
Sutton, Surrey, SM1 3LE, England
Phone/FAX Nat'l: 020-8641-7717
Int'l: +44-20-8641-7717
johnfgold@gmail.com



Sea Technology back issues available on microform.

Contact: NA Publishing, Inc.
P.O. Box 998, Ann Arbor, MI 48106-0998
1-800-420-6272

COMPASS PUBLICATIONS, INC.

4600 N. Fairfax Dr., Suite 304
Arlington, VA 22203-1553
Tel: (703) 524-3136

oceanbiz@sea-technology.com
www.sea-technology.com

publishers of:

*Sea Technology
Commercial Fisheries News
Fish Farming News
Commercial Marine Directory
Fish Farmers Phone Book/Directory
Sea Technology Buyers Guide/Directory
Sea Tech e-News*

*Celebrating more than 57 years
of serving the global ocean community
- Since 1963 -*

1 Race 4 Oceans Challenge Tackles Oceans Crisis

Enactus, the largest experiential learning platform dedicated to developing the next generation of leaders with a head for business and a heart for the world, unifies its network of global business, academic and university student leaders with a single vision: to create a better, more sustainable world. The 72,000 Enactus students span 1,800 campuses in 35 countries, positively impacting the lives of 1.3 million people each year.

In September 2019, Enactus launched 1 Race 4 Oceans, a global endeavor sponsored by Wilo Foundation and a private donor, which seeks to challenge Enactus students around the world to address the degradation of ocean ecosystems. The health of our oceans is a high priority for the next generation of leaders, yet most don't have the expertise to engage in addressing issues such as overfishing, pollution, climate change and habitat loss. By directly challenging Enactus students to learn and address shifts in ocean ecosystems, Enactus is driving awareness, passion and new opportunities to protect, adapt and leverage ocean ecosystems in a more sustainable manner.

In February 2020, Enactus teams from 20 countries entered 107 projects that help advance UN Sustainable Development Goal 14: Life Below Water. These 107 projects underwent rigorous evaluation by subject matter experts, race sponsors and Enactus alumni. The top four projects advanced to the 1 Race 4 Oceans Impact Competition, held in conjunction with the Enactus World Cup 2020, a virtual event.

In first place was EarthSuds, a social enterprise launched by Wilfrid Laurier University, Canada, which makes sulfate-free, paraben-free, cruelty-free and vegan single-use dissolvable tablets of shampoo, conditioner and body wash. Aimed at creating a plastic-free economy where sustainability does not compromise quality, EarthSuds prevents waste from ending up in oceans.

In second place was Project Dariya, launched by the Sri Guru Gobind Singh College of Commerce in India, which collects and responsibly disposes of plastic waste before it reaches the ocean. Dariya stretches a device across rivers, amassing trash from the flowing water. A plastic bank is then set up to barter the plastic, thus, creating sustainable livelihoods in the process.

The first- and second-place teams won investment funding to scale their projects.

The University of Puerto Rico Río Piedras team was a finalist for better community management of water sources through project Remora, utilizing an innovative waste collection system and creating awareness with educational workshops promoting sustainable maintenance of the island's environment.

Another finalist was the Federal University of Pará team in Brazil with Anamã, which focuses on reducing microplastic fish contamination by stopping ocean-bound plastic in the Amazon's urban rivers using low-cost eco-barriers. Captured plastic is turned into thread and used by at-risk communities to create new, sustainable plastic products such as face masks and fishing nets.

Thanks to the commitment of the Enactus students who participated in 1 Race 4 Oceans in 2020, 73,020 people in 20 countries benefited from improved economic opportunities, health standards and more. Plus, the projects from the 2020 competition created 764 jobs in communities in need. The sustained investment of generous partners fuels opportunities for Enactus students to apply their business knowledge and passion to make the world a better place by tackling the oceans crisis.

Year two of 1 Race 4 Oceans is on, and joining 1 Race 4 Oceans are two new Enactus World Races—the Race to Rethink Plastic and the Race for Climate Action. Learn more at: plus.enactus.org/s/opportunities. **ST**

Innovative Hypoxia Measurement

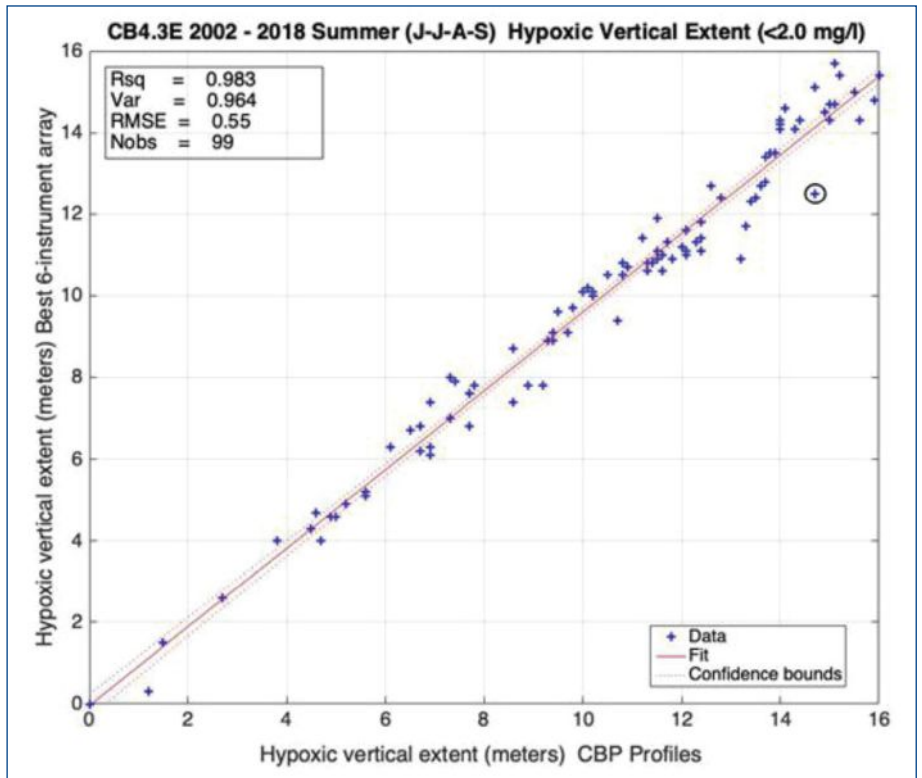
Collaboration with CTDO Sensors, Ultibuoy in Chesapeake Bay

By Doug Wilson • Darius Miller

When leaders make policy decisions, it is important that they make those decisions with good data in hand. This is especially true of choices that impact the environment and our natural resources. Chesapeake Bay is a prime example of an area where better policy decisions are aided by better data.

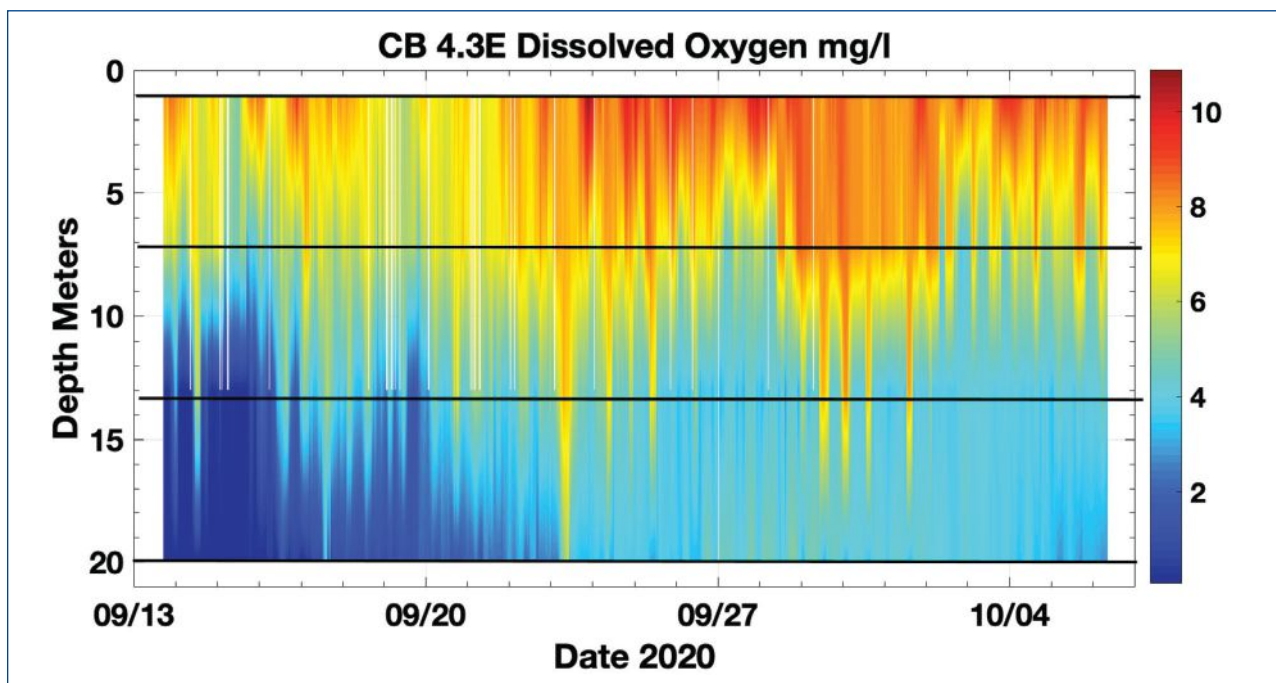
Chesapeake Bay covers 4,480 sq. mi. and stretches from Havre de Grace, Maryland, to Virginia Beach, Virginia. According to the U.S. Environmental Protection Agency (EPA), 500 million pounds of seafood, including oysters, blue crabs and striped bass, are harvested from the bay each year. In a 2009 report, NOAA estimated the annual haul in Virginia and Maryland alone contributed to 34,000 jobs, with an economic impact of \$3.39 billion.

While commercial fishing in Chesapeake Bay is a thriving industry, it is under threat from extreme seasonal hypoxia caused by excessive nutrient input. Increased levels of nitrogen and phosphorous introduced to the bay through agricultural runoff, wastewater treatment effluent and air pollution promote spring blooms of algae growth. As the excess nutrients are consumed, the algae die off and sink to the bottom, where they are decomposed by bacteria. These bacteria consume oxygen from the water and cause dissolved oxygen (DO) levels to decrease. When the algae load is too high, the oxygen level can fall dramatically and create hypoxic dead zones with DO concentration less



Wilson's results supporting estimation of vertical profiles from fixed-depth sensors.

than 2 mg/l. These dead zones can be lethal to fish, oysters and crabs. Hypoxia in Chesapeake Bay generally occurs during the summer as rising temperatures cause increased phytoplankton productivity, subsequent decomposition and vertical stratification, all of which contribute to the formation of dead zones.



Second-deployment DO measurements show significant short-term fluctuation. (Credit: Doug Wilson, Caribbean Wind)

The Chesapeake Bay Program (CBP) is a multi-agency regional partnership managed by the Environmental Protection Agency. The CBP monitors dissolved oxygen levels to assess the bay's health and restoration progress. Researchers go out on the bay once or twice per month to measure vertical profiles of water properties, including dissolved oxygen, at a set of standard locations. These measurements require multiple small-boat cruises with lowered instruments and water samples. CBP uses these data to estimate the total volume of hypoxic water in the bay. The resources required make higher frequency sampling impractical.

Estimated hypoxic volume (the size of the dead zone) is an important indicator of bay health, as it is closely tied to total nutrient input and increases have broad negative impacts. University of Maryland Center for Environmental Science researchers Ming Li and Wenfei Ni suggest that rising temperatures associated with global climate change will lead to an increase in hypoxia in the bay. A joint study Li and Ni published with Andrew Ross from Princeton University and Raymond Najarr from Pennsylvania State University, titled "Large Projected Decline in Dissolved Oxygen in a Eutrophic Estuary Due to Climate Change," suggests that Chesapeake Bay could see a 10 to 30 percent increase in hypoxic and anoxic volume as we move into the 21st century. Studies like these highlight the importance of reliable, real-time data on hypoxic levels throughout Chesapeake Bay.

Real-Time Monitoring Solution

The Chesapeake Bay Trust (CBT) is a nonprofit dedicated to improving the watershed of Chesapeake Bay and

other areas. In early 2019, the CBT issued a request for proposals to demonstrate a cost-effective, real-time, dissolved-oxygen vertical monitoring system for characterizing mainstem Chesapeake Bay hypoxia. The hope was to explore new methods of hypoxic volume estimation based on continuous measurement rather than on typically infrequent profiles.

Doug Wilson of Caribbean Wind LLC (co-author of this article) saw an opportunity to deliver a system that could provide continuous, real-time, vertical profiles of dissolved oxygen using just a few sensors at selected depths. The full vertical profiles could then be estimated by extrapolation between the fixed-depth sensors. Existing research supported approaches like this: Bever et al ("Estimating Hypoxic Volume in the Chesapeake Bay Using Two Continuously Sampled Oxygen Profiles," 2018) showed that hypoxic volume can be accurately estimated if continuous DO data are available from only a few strategically positioned vertical profiles.

There were two major problems. First, existing sensors with real-time capability were expensive, at more than \$15,000 per sensor. Second, typical buoy systems with the ability to report subsurface measurements in real time were costly to acquire and maintain. They often required larger vessels with cranes or specialized research vessels to deploy and recover.

Over the previous year, Doug Wilson had collaborated with Darius Miller of Soundnine Inc. (co-author of this article) to support researchers at the University of the Virgin Islands (UVI) studying how fluctuations in temperature impact coral and fish populations. In the UVI project, Soundnine (www.soundnine.com) leveraged existing sensor and inductive communication technologies and created two new instruments that contributed to a unique and successful monitoring project. Wilson knew Soundnine had a new miniature buoy system designed for subsurface inductive communications and a new real-time



The system was deployed from a 19-ft. center-console boat. (Credit: Doug Wilson, Caribbean Wind) (Bottom right) New sensor designed by Soundnine with inductive communications, CTD and PME microDOT sensor (guard screen removed). (Credit: Darius Miller, Soundnine Inc.)



conductivity, temperature and depth (CTD) sensor.

Wilson also had experience with the miniDOT Logger from Precision Measurement Engineering (PME, www.pme.com). The miniDOT is a small, accurate, submersible logging instrument that measures dissolved oxygen with an optical fluorescence method. He reached out and started a collaborative effort to combine these innovative technologies from different companies and meet the Chesapeake Bay Trust challenge.

Wilson proposed Soundnine integrate the PME sensor with its new CTD, but the miniDOT was too large. Fortunately PME was already working on a new, smaller sensor. A number of researchers familiar with the miniDOT Logger had previously requested PME offer a smaller oxygen sensor for various applications. PME determined they could develop a smaller sensor and maintain the same accuracy and long-term stability to help researchers meet their complex water measurement challenges. The final version of PME's research and development efforts became the microDOT sensor, which is a robust and low-power optical oxygen sensor. The microDOT provides stability, requires less calibration than other sensors currently available and is ideal for a wide range of monitoring needs.

Caribbean Wind and Soundnine proposed to meet the CBT proposal requirements with a new measurement instrument: a combination of the Soundnine CTD sensor with the PME microDOT DO sensor. These new instruments would mount below Soundnine's Ultibuoy, a miniature buoy with integrated controller, telemetry and inductive communications. The controller on the Ultibuoy includes batteries, cellular modem, GPS and inductive communications. All antennas are internal to maximize reliability. The buoy and controller are fully submersible, so the system can be pulled tens of meters underwater in storms and continue normal operation. The entire system would cost much less than any existing real-time system; its small size would minimize cost of deployment and maintenance.

The proposed CTDO sensor with the Ultibuoy would make a compact and efficient real-time monitoring system, but Wilson still had to show that vertical profiles could be accurately estimated from a few fixed depth measurements. He conducted an analysis of existing dissolved-oxygen reports at a representative fixed station from 2002 to 2018, looking at data collected each year between June and September. He ran simulations with various sensor depths to identify variances between existing and proposed methods of measurement. Dependent upon the proposed number of sensors to be used, the original 1-m resolution profiles could be recreated with variances from 0.980 to 0.994.

The proposal was compelling and CBT awarded the contract to Caribbean Wind and Soundnine for a first deployment in May 2020. PME delivered calibrated microDOT sensors. Soundnine designed a new instrument incorporating the microDOT, temperature sensor, conductivity cell, inductive telemetry and batteries. The instrument clamps to the anchor mooring cable, which also serves as an electrical conductor for the inductive communications system. Sensors can be positioned at any depth. The pilot deployment site was in 21 m of water at CBP sampling station site 4.3E, which is where the initial analyses were done.

Deployment and Findings

The deployment of the CTDO mooring and sensors occurred in two phases in 2020, with the first taking place from May 30 to June 19, and the second from



EvoLogics®

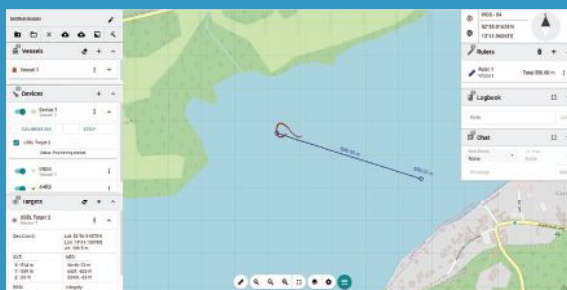
SMART SUBSEA SOLUTIONS

Delivering data in most adverse conditions: underwater acoustic modems with advanced communication technology and networking

Accurate USBL and LBL positioning of underwater assets

Modem emulator and other cost-saving developer tools

Autonomous surface vehicle for bathymetry, monitoring and AUV support



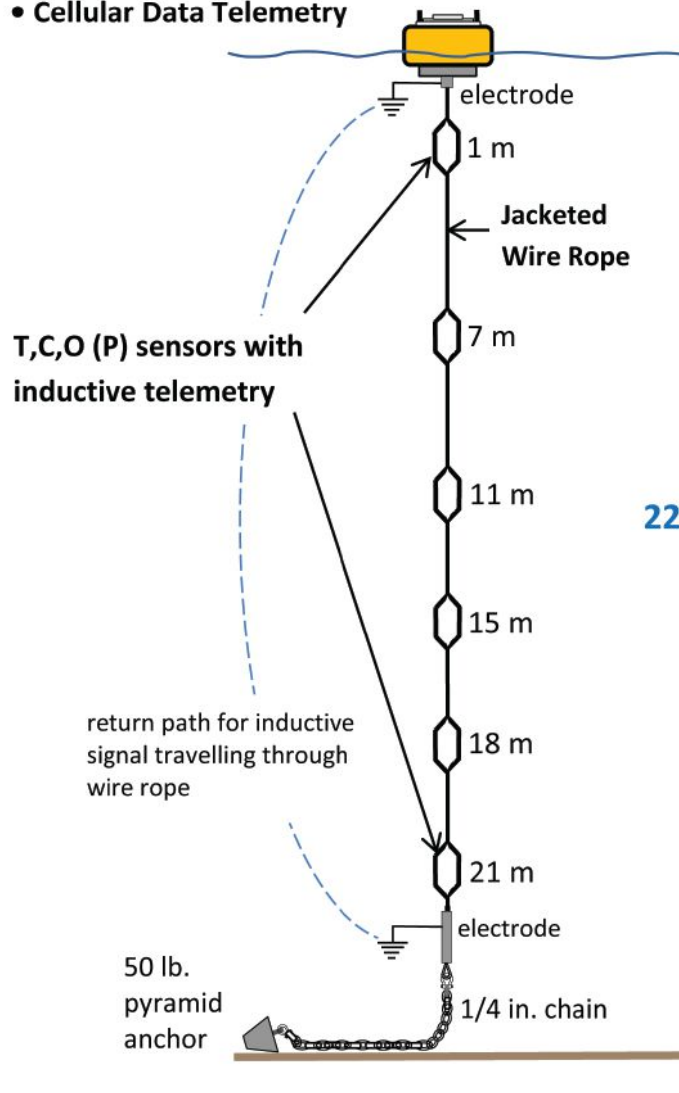
SiNAPS 2.0

UPGRADED ACOUSTIC
POSITIONING SOFTWARE

AVAILABLE
NOW

Soundnine Ultibuoy with:

- Inductive Underwater Telemetry
- GPS
- Cellular Data Telemetry



Ultibuoy mooring diagram.

September 13 to October 6. In keeping with the sustainability requirement and low-cost solution, Caribbean Wind was able to deploy the system from a 19-ft. center-console boat with two people. For each deployment, measurements were collected every 10 min. and forwarded by cellular modem to a Soundnine cloud server.

The first deployment successfully demonstrated some critical features of the system. The controller maintained full battery voltage with solar charging over three weeks. The buoy provided adequate flotation. There was a cellular network disruption during the deployment, and the controller successfully buffered data and forwarded the data when the disruption ended. The inductive commu-

nication system was very reliable, yielding high data returns. Sensors provided reliable data with minimal change in battery voltage, suggesting they could operate for five years or more on the same batteries.

Following the first deployment, Caribbean Wind applied minor upgrades to the buoy and sensors, including application of anti-fouling to the sensors. Anti-fouling incorporated copper tape on surfaces and better copper mesh sensor covers. Further, the Soundnine database system was updated to convert raw sensor data into engineering values for pressure, conductivity and salinity, and to apply calibration adjustments to the DO sensors.

During the second deployment, there was a 99.6 percent data return rate with 14,100 instrument records, and all sensors reported all variables for the entire time. In addition to standard CTDO sampling, the second deployment also included a data-denial experiment with two internally recording DO sensors located between real-time sensors to evaluate the difference between four- and six-sensor arrays. Over the 25-day record, mean differences were minimal, with hypoxic conditions ending on the same date and revealing time-integrated hypoxia totals differing by less than 5 percent.

The second deployment ended early when the buoy was accidentally snagged before dawn by a survey team and dragged several kilometers. The entire system continued operating and survived the encounter with only cosmetic damage to the buoy hull. Future deployments will require a beacon light to prevent such encounters.

Overall, the test deployments proved conclusively that hypoxia can be successfully monitored using a lightweight, low-power, real-time inductive CTDO mooring with sensors at fixed depths. The system did a good job of capturing the vertical structure and variability of dissolved oxygen (and other parameters) at the test location, confirming the preliminary analysis in the proposal. Data collected using Soundnine inductive communications were robust. The survey team encounter, while unfortunate, increased confidence in the mechanical robustness of the entire system.

Through the collaborative efforts of Caribbean Wind, Soundnine and PME, the project led to the development of a new, low-cost instrument meeting CBT guidelines with optical dissolved oxygen measurement technology integrated into a CTD sensor. This sensor was successfully tested in difficult environmental conditions. The instrument is estimated to run for five years of seasonal deployments at a cost of less than \$40,000 for a six-sensor mooring.

Impacts and Implications for the Future

This successful demonstration of a cost-effective, reliable, low-maintenance, real-time hypoxia measurement system in Chesapeake Bay provides policy makers and organizations like CBP with tools required to advance environmental protection and restoration efforts. The im-



***“While commercial fishing
in Chesapeake Bay
is a thriving industry,
it is under threat
from extreme seasonal hypoxia
caused by excessive nutrient input.”***

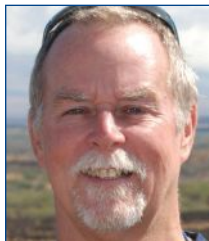
plications of this project extend beyond Chesapeake Bay and may positively impact other areas suffering hypoxic conditions, like the Gulf of Mexico, salmon farms and recreational fisheries. The team effort between Caribbean Wind, Soundnine and PME shows how collaboration leads to innovative solutions, advances our understanding of the world, and helps leaders better navigate troubled waters.

“It’s always exciting when researchers come to us to help solve complex water measurement challenges. Our technology is providing valuable data and ongoing monitoring to positively impact environmental decisions and water quality management,” said PME CEO Kristin Elliott. “Understanding how watersheds and surrounding areas contribute to the overall health of a critical ecosystem supports the local environment and economy.”

Acknowledgments

Caribbean Wind LLC would like to acknowledge the support of the Chesapeake Bay Trust, Annapolis, Maryland. **ST**

Doug Wilson is an oceanographer and president of Caribbean Wind LLC. Prior to forming the oceanography consulting firm, he was an oceanographer at NOAA, studying ocean, coastal and estuarine dynamics. He is active in the ocean observing community and has served leadership roles in MARACOOS, IOCARIBE-GOOS and the Marine Technology Society. You can contact him at: doug@coastaloceanobs.com.



Darius Miller is president and founder of Soundnine Inc. He earned his engineering degree at the Massachusetts Institute of Technology and was recruited by Sea-Bird Electronics, where he served as principal engineer until 2009. In 2011 he founded Soundnine to develop innovative technologies in service of the oceanographic and maritime communities.

are you covered?

AN RJE FINGER IS YOUR INSURANCE POLICY

Never lose sight of what you need.

- Easily mark or relocate anything in the water
- Assortment of off-the-shelf pingers
- Capability to develop specialty products

25 YEARS

RJEINT.COM | 949-727-9399

[f](#) [t](#)

SUBSALVE USA

UNDERWATER LIFT BAGS
ENGINEERED FROM THE BOTTOM UP!

The World's Best
Underwater Lift Bags
from 25 lbs. to 50 tons,
Water Load Test Bags to 50 tons.
IMCA Compliant.
ABS Approved.

INNOVATORS IN BUOYANCY AND ENGINEERED INFLATABLES.

MARK VIORCA • RAPID RECOVERY SYSTEMS • AIRCRAFT LIFTING BAGS
WATER LOAD TEST BAGS • VEHICLE RECOVERY SYSTEMS • CABLE & PIPELINE FLOATS
LIFEBOAT DAVIT TEST KITS • FEND-AIR • INFLAT-A-TANK • PIPE PLUGGERS

P.O. Box 2030, North Kingstown, RI 02852, USA
Tel: +1 401 884 8801 Fax: +1 401 884 8868
www.subsalve.com richard@subsalve.com

Fishing for Oceanographic Data

New Tools Energize Partnership of Fishing Communities and Scientists

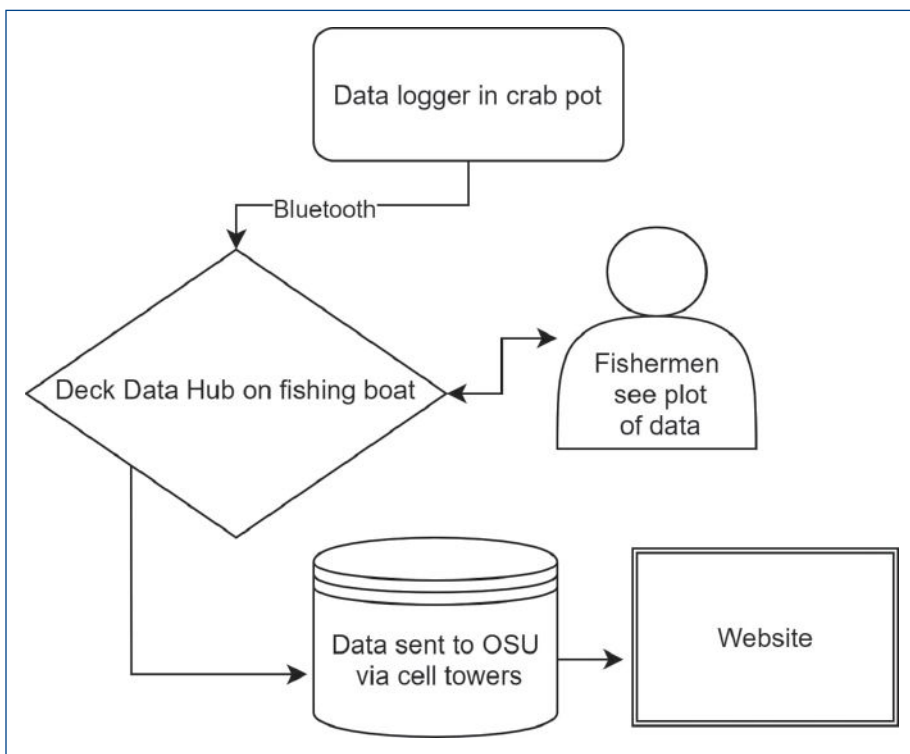
By Linus Stoltz • Jeremy Childress • Francis Chan

Around the world, coastal ecosystems are under rising threat from low-oxygen, or hypoxic, zones. In many systems, hypoxia is the consequence of excess nutrient pollution, but in productive coastal upwelling systems, it reflects the combined effects of declining levels of dissolved oxygen (DO) in the sea and changes in wind-driven currents from climate change.

Off the Oregon coast, hypoxic zones have been growing in intensity and frequency in recent decades. These low-oxygen zones were first noticed by fishermen who target Dungeness crabs (*Metacarcinus magister*), the region's most valuable fishery. Beginning in the spring, northerly winds drive upwelling currents that bring cold, deep, nutrient-rich but oxygen-poor water onto the continental shelf.

The high nutrient content in this water triggers blooms of phytoplankton, or microscopic plants. When the amount of phytoplankton exceeds the ecosystem's capacity to consume them, the excess phytoplankton sink to the seafloor to be decomposed by bacteria. This process depletes oxygen and drives bottom waters that are already low in oxygen into hypoxia ($<1.4 \text{ ml L}^{-1}$) or anoxia (zero DO). When this happens, fishermen pull up empty pots, or pots where crabs have been suffocated as hypoxic waters move into fishing grounds.

While hypoxia recurs each summer, it is neither homogeneous nor easily predictable. An area can be hypoxic, while waters just kilometers away can be well-ox-



Data flow.

ygenated; this creates uncertainty for fishermen at sea. Fishermen are left wondering: will they catch crab in this region, or will their pots come back empty due to hypoxia?

In the longer term, the difficulty of detecting and tracking the growth of hypoxic zones across years handicaps scientific efforts to make robust projections of what fish habitats will look like in the face of climate change. Having access to more environmental data, such as the finer-scale descriptions of the amount of DO in the wa-

ter, could inform managers' assessments of commercially important fish and invertebrate species.

A Natural Partnership

In the summer of 2009, the first partnership between researchers at Oregon State University (OSU) and Dungeness crab fishermen to study oxygen was formed to better understand the spatial extent of hypoxia on the continental shelf. This study demonstrated the proof of concept for DO sensors designed to be mounted inside crab pots. By utilizing crab pots as a platform of opportunity, oceanographers were able to increase spatial coverage of observations without having to rely on scientific vessels that have limited availability and cost tens of thousands of dollars a day to operate.

However, these sensors were fairly large, lacked wireless capabilities, and required sending units back to researchers to recover the data, leaving the oxygen information unavailable to the fishermen in real time. The power requirements of these sensors were also quite large, allowing only about four weeks of data to be recorded. As limited as these first-generation sensors were, their use demonstrated that oxygen could be measured outside of research-purposed endeavors.

There are several programs in Oregon that maintain moorings and gliders to monitor dissolved oxygen. These observations are spatially limited, and the fishing community may not be working where these observations are made. Due to the patchy nature of hypoxia, increasing observations are key to understanding and improving predictions of how changing DO impacts coastal ecosystems and fisheries.

New Technology, Same Partnership

An opportunity to build from the initial concept of collaboration on DO observation between scientists and fishermen came in 2018. With funding from NOAA's National Centers for Coastal Ocean Science under their Coastal Hypoxia Research Program, a team from OSU, the Sexton Corp. and Lowell Instruments began work to develop a new class of low-cost, low-profile, smart DO sensors that can be deployed in commercial crab pots.

Projects around the world have partnered with fishermen to observe the ocean, for example, the eMOLT project off the U.S. Northeast coast and the Moana Project in New Zealand. These efforts have been primarily focused on collecting temperature and salinity data. The new technology involved demonstrates the ability to collect temperature and DO data in near real time.

Spurred by conversations with commercial fishermen, the size of the sensors is important in order not to reduce the volume within crab pots. The new equipment is 66 percent smaller than the first generation of sensor. Another important feature is a smart sensor that does not require intervention by fishermen on busy decks, which has been accomplished through a combination of automatic data transfer and wireless capabilities.



A fisherman stands next to a crab pot with sensor installed.

Using a combination of off-the-shelf DO sensors and readily customizable communication and data-display systems, the team developed a sensor and accompanying data communication system that met the requirements for size, accuracy, cost, survivability, power endurance and user-friendliness. The team selected a DO sensor from In-Situ, the patent holder of the optode-based technology and supplier to the oceanographic sensor industry. The optode-based technology, where DO is measured by changes in fluorescence proportional to the amount of DO in the water, has a proven track record of performance in scientific research. Multiple units can be readily calibrated in the lab at once.

The sensors were augmented with low-power Bluetooth connectivity to a deck data hub that receives and plots data. After displaying the data for the fishermen, the unit then transmits raw data files along with GPS coordinates over the cellular network to a data server at OSU. The sensors are packaged in a rugged enclosure that protects the sensitive optode sampling surface from crabs and can be easily mounted inside a crab pot. The sensor package can be deployed for up to 12 weeks when sampling at a 15-min. interval.

With this system, information on DO levels, along with bottom-water temperature, is automatically displayed inside the wheelhouse whenever a pot with a sen-

***“This effort joins work
across the globe to supply
small, inexpensive, easily deployed
oceanographic sensors
in commercial fisheries.”***

sor is brought aboard. This allows fishermen to factor in DO levels in deciding whether and where to set the next string of pots. At the same time, data are transmitted to researchers without the need for any added attention by fishermen.

Traditionally, fishermen often do not receive collected data until they have been processed, which could be days to weeks after the vessel returns to port. With this technology, fishermen are the first ones to see the data. Prior to the availability of this technology, fishermen would set a string of pots not knowing if DO would remain high enough to catch crabs. Increasing bottom temperature also accentuates DO sensitivity for marine life. By being able to track oxygen and temperature over their fishing grounds, fishermen have a tool at their disposal that can help them to better adapt to changing ocean hypoxia and bottom-water warming.

With an updated set of sensors in the works, a round-table meeting with fishermen and scientists took place in December 2019. The fishermen provided feedback on how best to implement the collaborative project and connected researchers to other individuals in the fleet who would be interested in participating. Thanks to fishermen's support, eight fishing vessels covering the span of the Oregon coast signed on to participate in the pilot year of the project.

As a project that relied on interactions between fishermen and scientists, the restrictions put in place because of COVID-19 created new challenges for the team. A university ban on travel restricted our ability to meet fishermen at the docks to help set up the DO system. Subsequently, the equipment had to be mailed to fishermen, and a series of instructional videos were created to facilitate setup and use.

Despite logistic impediments due to COVID-19, the pilot phase of the project was able to collect 40 unique time series over significant portions of the Oregon coast, with each vessel typically deploying five DO sensors. A first look at the data shows a relatively mild hypoxia season for the summer of 2020. Direct observations from fishermen of crab catch are consistent with elevated DO concentrations.

Looking to the Future

In addition to the commercial fishing community, this project expanded the stakeholder engagement to the charter fleet. Next year, researchers will be working with fishermen to interpret bottom temperature and DO in-

formation with the intention to incorporate the real-time data into fishing practices that can help the fishery adapt to the continued intensification of hypoxia. For researchers, the data collected by these fishermen will provide a much more comprehensive picture of the size and location of hypoxic zones. By comparing in-water DO data to numerical model predictions, forecasts and projections of change can be improved.

Spring 2020 saw the first use of the new technology in Oregon, and use of this system has already begun to spread. On the U.S. East Coast, the emergence of hypoxia in Cape Cod Bay in 2019 heightened the need for an operational DO monitoring program. Fortunately, the newly developed system has proven to be readily transferable. An industry partner on the project, Lowell Instruments LLC, has provided sensors for a collaboration between Massachusetts Division of Marine Fisheries, the Woods Hole Oceanographic Institution, Center for Coastal Studies and lobster fishermen to monitor DO conditions in Cape Cod waters via lobster pots.

The application of collaborative, fishermen-supported hypoxia monitoring in Oregon and Massachusetts is just the beginning. This effort joins work across the globe to supply small, inexpensive, easily deployed oceanographic sensors in commercial fisheries. Climate change will interact with nutrient pollution to increase the prevalence and severity of hypoxia in coastal ecosystems around the world. This, along with intensification of other environmental stressors such as ocean acidification, will place new demands for information that can be used to adjust fishing practices and better manage fisheries. The demand for information cannot be met by scientific ocean observing systems alone. By investing in new technologies and collaborations, fishermen, scientists and managers can face a changing ocean with the right tools and the right partners.

Acknowledgments

The authors would like to thank: Kipp Shearman, Ph.D., Oregon State University; Jack Barth, Ph.D., Oregon State University; and Nick Lowell, Lowell Instruments. Special thanks to the following fishermen: Curtis Gann, Bernie and Jim Lindley, Dave Bailey, Pat and Mark Kemmish, Justin Gifford, Greg Niles, Grant Rilette, and Andy Martin.

This article is the result of research that was funded by NOAA's National Centers for Coastal Ocean Science Competitive Research Program under award NA18NOS4780169 to Oregon State University. This is CHRP Contribution 253. **ST**

Linus Stoltz is a marine resource management graduate student at Oregon State University (OSU). He is interested in collaborative partnerships that promote fishery resiliency in the face of climate change.

Jeremy Childress is the president and CEO of Sexton Corp., a manufacturer of custom underwater products. An OSU marine resource management alumnus, this research is built upon his thesis work.

Francis Chan is the director for the Cooperative Institute for Marine Resources Studies at OSU. He has been studying oxygen dynamics on the Oregon coast for nearly two decades.

INS + USBL

Collaboration Yields Highly Accurate Positioning System

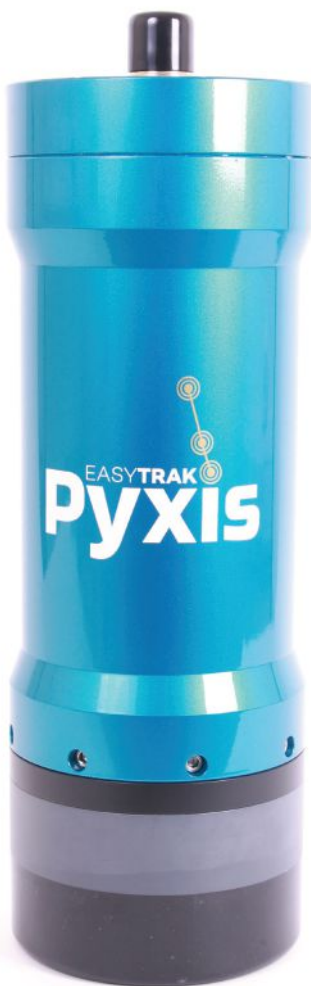
By Hollie Moran

Look closely at the Southern Sky on a clear night in February or March. In the distance, a small and very faint constellation can be seen, one that was identified by ancient Greek astronomers to be the mast of the *Argo Navis*, the mythological ship crewed by Jason and his Argonauts. As one of the 88 modern star constellations, it is known as Pyxis, abbreviated from “Pyxis Nautica,” the Latin term for a mariner’s compass.

Transitioning from the celestial stage to the oceans of the Earth, the Pyxis name gives itself to another form of marine apparatus: the Pyxis INS + USBL system, a technological development brought to life by collaborative teams, pulling together like those ancient Argonauts, in search of a common goal.

Baseline Systems

Ultrashort baseline (USBL) systems are not a new concept. Along with short baseline (SBL) and long baseline (LBL) systems, they are one of the three generally accepted methods of underwater positioning used extensively offshore since their development in the latter part of the 20th century. Unlike SBL and LBL systems, which calculate subsea positions by measuring distances from multiple sources, a USBL system uses a single, multi-element transceiver to send acoustic signals to the target transponder. On receiving the signal, the transponder sends a reply, and the elapsed time between the transceiver’s initial transmission and the reception of the return signal is measured and converted into a range. To turn that into a subsea position, the transceiver also measures the angle of the transmissions and mea-



sures the phase shift of the return across the multiple transducer elements from which the direction of reply can be determined. The combination of these calculations reveals the position of the target transponder, and by rapidly repeating this function, the location of dynamic targets such as unmanned vehicles and towed objects can be continuously updated and plotted.

Consisting of its single transceiver and surface control console, a major advantage of a USBL system is the ease and speed at which it can be deployed. These comparatively compact and portable systems are easily transportable and can be switched between vessels of opportunity without difficult installation or complicated calibrations. The multiple arrays associated with SBL and LBL systems do not allow the same agility.

The disadvantage is that positioning accuracy and performance will not be as good as with LBL systems, as the narrow baseline measurements will translate into increasing positional errors as the range increases.

Furthermore, the additional sensors required for USBL operation to compensate for pitch, roll and other vessel movement will introduce their own errors, and these errors need to be taken into account when determining the overall accuracy of the system.

Sensors such as GNSS receivers, motion reference units (MRUs) and gyrocompasses can all be integrated to reduce USBL positioning error, but bringing together all of these peripherals can result in a complicated, lengthy and possibly costly calibration process, and it's the avoidance of this very process that lies at the heart of the Pyxis system.



be required to operate quickly and seamlessly as soon as offshore operations demanded.

Following a detailed investigation into the inertial navigation market, French manufacturer SBG Systems was selected as a partner for this project. SBG Systems is an independent organization with the same vision and shared ideals as Applied Acoustics, and it is considered a leader in the field of MEMS-based motion-sensing systems. SBG's knowledge and experience of the marine industry would prove to be a significant asset during the development of the Pyxis INS + USBL system.

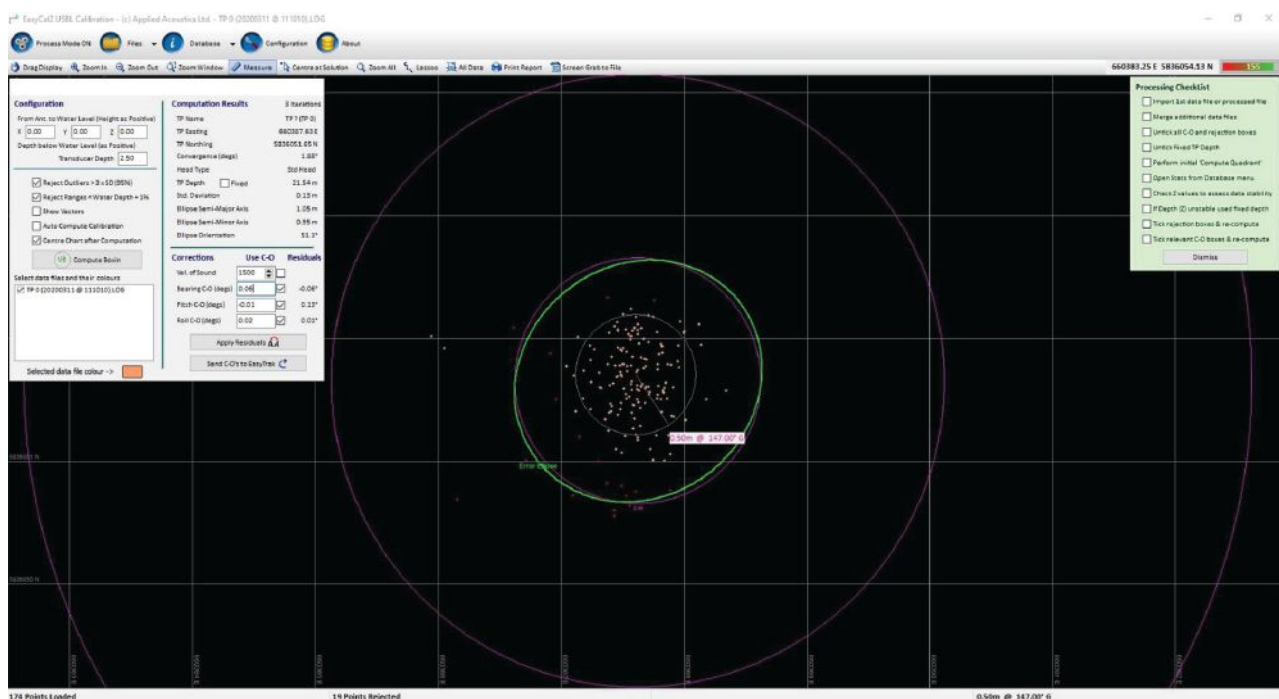
SBG's specialization in MEMS-based technology was also a primary consideration when selecting a partner for this project, as the possible alternative solution would have been an obstacle to one of the principal design features of the Pyxis system; fiber-optic gyros (FOGs) has been used with USBLs to create integrated, inertially aided positioning systems, but the strictly ITAR-controlled FOGs generally require export licenses that can impede the delivery process. Recent advances in MEMS technology have brought their performance characteristics closer to those of their fiber-optic counterparts. Improvements in error budgets, stability and sensitivity now allow MEMS to be used as an integrated INS component of USBL systems, capable of outstanding results and able to perform in the harsh environment of the offshore industry.

The first steps toward an integrated system began toward the end of 2018, involving a great deal of

Combining INS with USBL

Building on the success of the Nexus and Nexus 2 USBL systems, the natural next step for Applied Acoustics was to develop a new generation of highly accurate positioning system, one that would combine the highest possible levels of USBL accuracy with a highly advanced inertial navigation system (INS). The combination of these two complementary technologies would provide the platform for a highly accurate, long-range tracking system.

As well as delivering cutting-edge positioning performance, the system would need to be fully integrated and factory calibrated at Applied Acoustics' U.K. facility; it would need to fall outside of ITAR regulations so that international shipping could take place without obstructive export procedures; and it would



USBL calibration.

“Accurate positioning data in this field [UXO surveys] are critical to locate and return to individual targets, as well as for hazardous site mapping.”

cross-channel cooperation between the two sets of development teams. The SBG team created an OEM version of its Navsight Apogee Marine INS package, designed to be built into the transceiver of the Pyxis system, thus permitting the creation of a closely coupled inertially aided USBL system. It's this close coupling that allows a one-off factory calibration to take place so no further procedures are required in the field. More important than its ability to form part of an integrated system, the performance characteristics of the Navsight Apogee Marine INS were crucial in Applied Acoustics' selection decision. With a pitch-and-roll accuracy of 0.008°, and a 0.025° heading accuracy, it was apparent that coupling this to a high-end acoustic system would generate exceptional subsea tracking performance.

Testing

While mechanical integration progressed, the first in-water tests of the integrated system prototype were scheduled for the summer of 2019. The Applied Acoustics test center incorporates a freshwater lake, over 2 km in length and with a maximum depth of 20 m, particularly suited to the testing of shallow-water acoustic systems.

A notable feature of all Applied Acoustics' USBL systems is their ability to track targets close to the water surface at extremely shallow depression angles. The enhanced multi-path rejection of the Pyxis system and its proprietary Sigma 2 acoustic protocols, coupled to the MEMS-based INS, would be a key component in significantly improving the new system. Shallow-water range testing did indeed prove that capability, delivering final test results of 0.45 percent slant range accuracy at depression angles of 10° in the omni-directional version of Applied Acoustics' two transceiver offerings. The directional transceiver with a 150° acoustic beam pattern, as expected, produced a much higher slant range accuracy of 0.12 percent at minimum depression angles of 20°. Couple that with its 3,000-m range capability, and the potential to fulfill long-range, high-accuracy requirements becomes apparent.

Applications

The range capability at shallow depths lends itself to the tracking of towed bodies such as side scan sonars and other towed sonar arrays. In addition, with the advent of offshore wind turbine installations, a common area of

use has come from unexploded ordnance (UXO) surveys. These surveys are generally carried out using a multiple array of towed magnetometers, often in conjunction with side scan sonars. Accurate positioning data in this field are critical to locate and return to individual targets, as well as for hazardous site mapping.

The tracking of multiple objects is a common feature of most USBL systems. This is typically carried out sequentially, with individual targets being interrogated one after the other. A feature of the Pyxis system is its common interrogate frequency, or “multi-fire,” which allows a single pulse to interrogate up to 10 target transponders at once, collecting and filtering the individual replies to plot all 10 targets much more rapidly than by the traditional sequential method. This fast update rate ensures that surveys can be conducted more quickly, more economically and, most importantly, with a greater degree of confidence.

With advances being made in USBL technology, it's imperative that all component parts of the system keep pace with the changes. While the benefits of the INS module have been well documented, the system also requires a robust GNSS input, which is why the complete package includes Hemisphere's DGPS products to ensure that Pyxis becomes a turnkey system ready to operate from the outset.

While the surface system is the complete calibrated package, it is important not to underestimate the significance of the target transponder. To complement and even enhance the Pyxis system, Applied Acoustics has designed a range of transponders to enable the full potential of Pyxis to be realized. The 1100 series range of transponders has been updated to incorporate Applied Acoustics' MiQ data telemetry functions. Using the Sigma 2 protocols as a carrier, data can be transferred through an uplink or a downlink, effectively turning the transponder into an acoustic modem, as well as continuing to operate in its primary role as a positioning beacon.

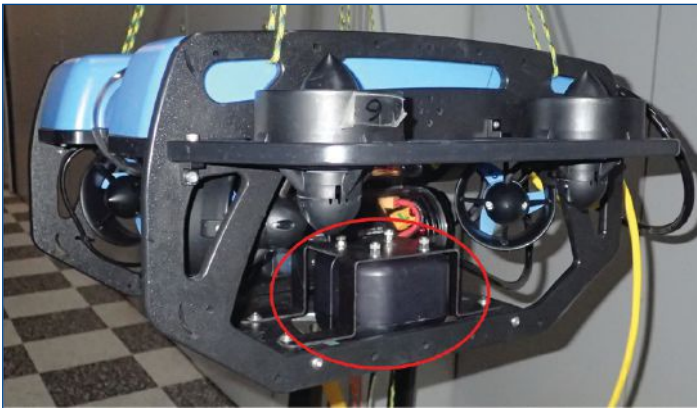
With this attention to detail given to every facet of the system, and with the combined expertise of two leading names in marine technology, the initial concept of Pyxis INS + USBL has become a reality greater than the sum of its parts. The collaboration between two disciplines, and two countries, perfectly demonstrates the ability of the ocean technology community to continually cross boundaries. **ST**

Hollie Moran is the sales manager of Applied Acoustic Engineering Ltd.

Wayfinder DVL

Verifying Performance, Integration of DVL for Small ROVs, AUVs

By Bill Meachum • Nathan Hui



(Left) Wayfinder DVL installed on BlueROV2 in heavy configuration. (Right) Wayfinder DVL and ROV tank testing.

Teledyne RDI (TRDI) has been manufacturing high-quality Doppler velocity logs (DVLs) for over 25 years. Thousands of these DVLs are on ROVs and AUVs, including Hydroid REMUS, Teledyne Gavia SeaRaptor, Kongsberg HUGIN, Bluefin Knifefish, ISE Explorer and SOC Autosub, to help provide both positioning and navigation.

On larger vehicles, which have been using DVLs for years, tightly controlled autonomous functions such as station-keeping (holding position) are possible using the high-resolution velocity-over-bottom feedback from the DVL. In many vehicles, the DVL also provides navigation (location) using dead reckoning. The DVL is combined with accurate heading, attitude and inertial sensors to achieve very high location accuracy over long underwater deployments.

Like larger vehicles, the newest classes of small ROVs and AUVs have a much easier time doing their job if they (and their operators) know where they are and can control their motion well. Wayfinder is Teledyne RDI's smallest DVL to date (at 10-by-10-by-7 cm), and it provides the fast, high-quality velocity measurement needed to keep small vehicles on track. Wayfinder uses a 600-kHz phased-array transducer to create four acoustic beams

that together provide 3D vehicle velocity and altitude over bottom. Its new Proteus electronics platform provides high-performance in a small package, and it uses proven bottom-tracking algorithms developed and improved over several decades.

For less advanced users, the Wayfinder DVL needed to be easier to integrate onto vehicles, so user interface and integration utilities were developed and included. The DVL comes with Wayfinder Tools, a Python-based GUI that provides all the necessary utilities. It also comes with a Python open-source driver intended to run on vehicle platforms to handle setup, commands, data extraction and other interactions.

This article will cover the verification of the Wayfinder DVL performance and ability to integrate on a vehicle.

Performance

The core functionality of a DVL is its ability to measure velocity over the bottom reliably and accurately. This performance is verified during testing in a few major categories: velocity accuracy, zero-velocity performance, single-ping standard deviation and dynamic range tracking.



Wayfinder DVL specifications.		
Parameter	Value	Units
Size	10 x 10 x 7	cm
Accuracy (offset)	$\pm 1.15\%$ (± 0.1)	cm/s
Single-ping standard deviation	10	mm/s

Accuracy. Scale-factor error is defined as relative error in distance traveled compared to a known reference. This specification is important in navigation solutions, or when accurate velocity is required for control or pilot feedback. These tests are performed via tank accuracy testing versus a known distance traveled, and lake and ocean testing versus GPS. Wayfinder DVL’s accuracy, with “base accuracy” enabled, was measured to be within ± 1.15 percent as specified.

Accuracy Offset. Bias offset (zero-velocity error) is defined as the velocities measured when the unit is not moving. This is important for positioning, with the DVL providing the vehicle control system with high-resolution, real-time velocity over bottom at or near zero velocity so that it can stay on location. Additionally, in navigation applications where a vehicle stays still often or for long periods, the accuracy offset can add significant error to the overall position.

The test is performed by taking DVL measurements at multiple locations at different altitudes while completely stationary in a large test tank. Accuracy offset was measured to be within ± 1 mm/sec in the test tank (but was 0 in greater than 90 percent of samples).

Single-Ping Standard Deviation. This is the standard deviation of the bottom velocity measurement for a given velocity over bottom. This varies somewhat with altitude and velocity. The standard deviation was measured to be 10 mm/s at a velocity of 1.5 m/s.

Dynamic Range Tracking. Dynamic range tracking is a series of tests where the DVL is exposed to increasing and decreasing altitude, tilted mounting and sloping bottom in simulated and real-world situations. The tests are used to verify that the DVL can detect and track the bottom in dynamic and non-ideal situations, and that the algorithms that filter bad data and/or provide partial (three-beam solution) velocities are working properly. These tests are used to tune the algorithm during development and to verify that Wayfinder bottom tracking meets the high expectations established by TRDI’s existing DVL products.

Vehicle Integration

As mentioned earlier, DVLs are commonly integrated on ROVs and AUVs to aid in positioning and navigation. Thus, demonstrating the ease with which Wayfinder DVL can be integrated with a vehicle is critical to enabling a new set of users to do custom integrations. Since the target application is small underwater vehicles, we opted to demonstrate this integration on the Blue Robotics BlueROV2.

The Blue Robotics BlueROV2 is a low-cost ROV aimed at the inspection and research communities. In its base configuration, it provides 5° of freedom (three axes of lateral movement, plus roll and yaw) with 100-m depth rating. However, in order to successfully integrate the Wayfinder DVL, the full 6° of freedom was required for proper control, so the Blue Robotics heavy configuration retrofit was added.

This ROV is controlled by an onboard Pixhawk flight controller running ArduSub firmware, paired with a single-board Linux companion computer (Raspberry Pi). The onboard flight controller is responsible for all the sensor fusion and low-level motor controls, while the companion computer is responsible for providing high-level communications between the flight controller, external sensors and the topside control station.

As an ROV, the BlueROV2 is connected to the surface via tether. On the BlueROV2, this provides Ethernet connectivity between the companion computer and the topside control station. On the topside control station, the end-user can interface with the flight controller using mission control software such as QGroundControl.

Integration Architecture. The BlueROV2 is a modular ROV that can be configured to meet a wide variety of mission profiles, and it provides several modular interfaces to which Wayfinder DVL can be attached. In the heavy configuration, there is available space immediately to the left and right of the battery container. Placing the DVL in these locations is ideal, as the ROV frame protects the DVL from accidental impacts, while still providing it with enough clearance for the transducer face to see the seafloor.

The BlueROV2 also provides several penetrator positions in the rear endcap on the electronics container. These allow the Wayfinder DVL cable to be potted into a cable penetrator and easily installed onto the rear endcap. From there, the DVL cable splits into two sets of wires: power and communications. The power wires attach to the BlueROV2-provided screw terminal block within the electronics housing that distributes raw battery voltage (14 to 17 V). The communications wires are soldered to a USB-to-RS232 adapter (FTDI USB-RS232), which plugs into the Raspberry Pi.

Integration Script. In order to integrate with the BlueROV2, the Pixhawk flight controller needs to be provided with the velocity data from the Wayfinder DVL. The visual odometry capability in the ArduSub firmware was leveraged for this purpose. Visual odometry sensors measure the translational and rotational velocities of a vehicle by measuring the change of speed at which an image is taken from a camera fixed on the vehicle. A DVL does

essentially the same thing, providing the translational velocities. The rotational velocity can then be provided by another sensor to provide the full translational and rotational velocities desired by the visual odometry libraries.

Interfacing with the Wayfinder DVL is significantly simpler than in previous Teledyne RDI DVLs due to the availability of the Python driver, as well as the binary structure of the data stream. The Python driver provides a callback function with updated velocity and beam range data every time the Wayfinder has completed a ping. The velocity data are then transformed from the instrument coordinate frame to the vehicle coordinate frame, then fed into the Pixhawk flight controller as visual odometry inputs.

Integration Testing and Performance, Tuning. In order to leverage the improvements afforded by integrating a DVL, the baseline vehicle performance must be very tight. Station-keeping using DVL inputs requires that the vehicle be able to react to and precisely counter small velocities and perturbations to reliably hit the programmed setpoint. This is accomplished by a pose controller for rotational stability.

Once the vehicle is reliably stable, the position-hold control loops can be tuned. The ArduSub firmware has a three-layered position control loop: position-controlling velocity, velocity-controlling acceleration and acceleration-controlling motor setpoint. These need to be individually tuned to ensure maximum performance. This is commonly done starting from the acceleration loop, which ensures that the vehicle can utilize the full extent of its performance envelope.

Station-Keeping Performance. To test the performance of the position-hold controller, the vehicle was placed in a test tank and allowed to hold its position for several minutes. The position of the vehicle was monitored by placing a plumb bob just above a known position on the hull of the vehicle. During testing, the vehicle exhibited the expected performance.

Tests verifying the ability of the position-hold controller to react to external perturbations were also performed. The vehicle was placed in a larger test tank, then pushed and pulled using poles and the tether. The vehicle returned to its original orientation and position quickly and reliably.

“DVLs are commonly integrated on ROVs and AUVs to aid in positioning and navigation.”

Notes on Waypoint Navigation. A further extension of position-hold in ArduSub is waypoint navigation. In ArduSub, position-hold is implemented by having the vehicle attempt to hold at a global setpoint. This setpoint can then be moved around to move the vehicle to a new position. Waypoint navigation is then simply setting the setpoint to the next waypoint.

This was not possible in the test tank due to structural steel members affecting the compass on the vehicle. Tests at Miramar Lake showed that the vehicle can roughly follow a waypoint mission; however, it was unable to accurately perform turns, most likely again due to the compass being buried inside the vehicle near the motor controllers. This functionality has not been fully vetted by ArduSub developers and can be resolved by future end-users.

Conclusion

The goal of the Wayfinder project was to provide a small, high-performance DVL that could easily be integrated into small ROV, and eventually AUV, platforms. By leveraging a new small electronics platform, an updated transducer design and proven bottom-tracking algorithms, the Wayfinder DVL was able to achieve the performance and reliability targets. To prove the ease of integration, the first integration was performed in house, using the new tools provided. The Wayfinder DVL has been put through its paces by a team who knows DVLs and integration. With many upgrades already in the works, this is only the beginning. Find out more at: <https://teledynardi.myshopify.com>. **ST**

Bill Meachum is a system engineer at Teledyne RDI in Poway, California.

Nathan Hui is a firmware engineer at Teledyne RDI.



SAAB SEA EYE



SAAB

Automatic Radar Data Quality Control

Applying Deep Learning, AI to Ocean Wave, Current Measurements

By Dr. Rune Gangeskar

Ocean waves, currents and vessels’ speed through water (STW) can be reliably measured by processing digitized images from conventional marine X-band navigation radars. Wave patterns become visible to the radar due to several modulation mechanisms and electromagnetic backscatter from short, wind-generated waves. Radar images are digitized by hardware especially developed for this application. Digitized images can also be acquired directly from radars with digital data feed, commonly known as internet protocol (IP) radars, eliminating the need for additional digitalization hardware. Images are processed by dedicated algorithms to provide the user with real-time wave spectra, integrated wave parameters, surface current vectors and STW. Wavex by Miro, a company based in Asker, Norway, is one example of such a system, based on DNV GL-type-approved hardware and algorithms developed over recent decades.

To further increase the performance of such systems and provide users with reasonable output 24/7, strategies for handling non-ideal measurement conditions must be further improved. Examples are lack of wind and heavy

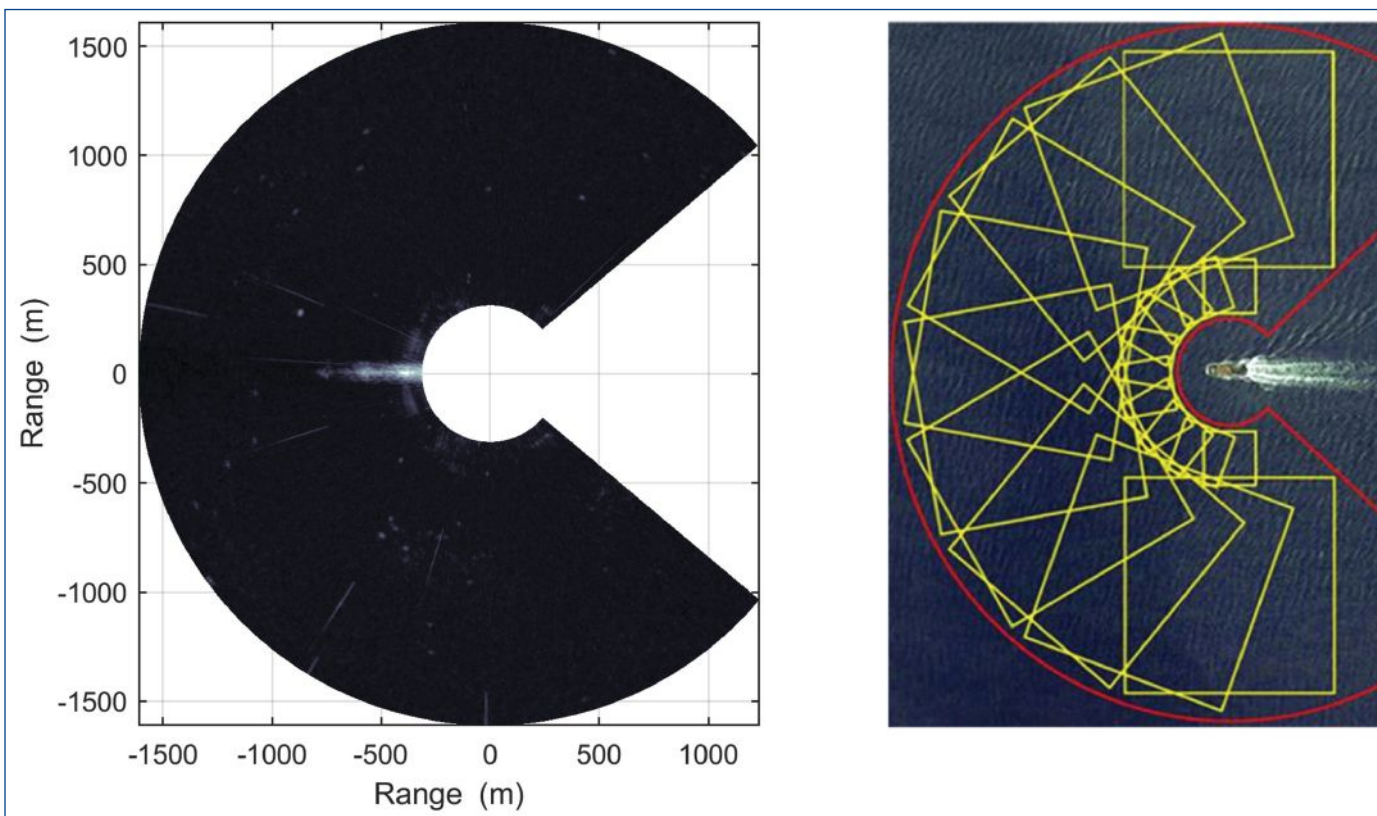
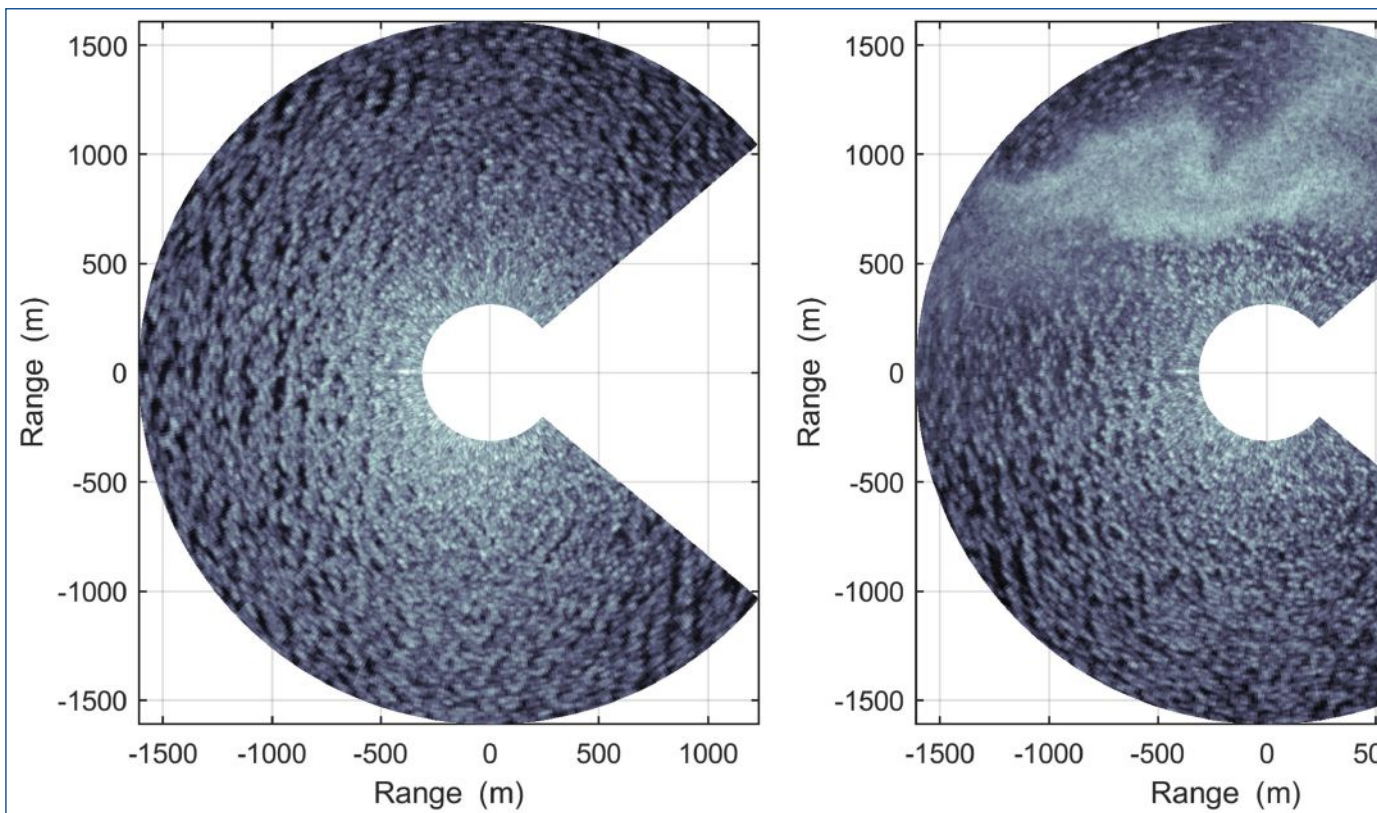
and disturbing precipitation in the field of view. Detecting challenging conditions is required to process data properly to obtain high accuracy, for instance, by omitting disturbed data when averaging, and to give users information if data are of reduced quality.

Deep learning is a machine-learning technique, i.e., a subset of artificial intelligence (AI), which learns features and tasks directly from data. Hence, it is often referred to as end-to-end learning. In deep learning, the manual extraction of features from data, which is usually required in other types of machine learning, is automatically taken care of by the technique itself. Data can be images, text or sound.

Many techniques used in deep learning have been known for decades. The use of deep learning has surged during the last few years due to major improvements within high-performance computing (e.g., graphics processing units) and increased availability of large amounts of labeled data, along with considerably increased data accuracy for many applications. Most deep-learning methods use neural network architectures, thus the term “deep neural networks.” One frequently used type of

System	Fixed/ moving	Radar brand	Radar model	An- tenna height (m)	Cartesian midpoint range (m)	Cartesian midpoint grazing angle (°)	Radar range resolution (m)	Radar antenna length (ft)	Radar antenna revolutions per min.	Radar output power (kW)
BW RYE	Moving	Furuno	FAR-2218	27	750	2.1	10.5	6.5	42	12
North Sea	Fixed	Sperry	Bridgemaster II	43.2	958	2.6	8.25	4	25	12
Canadian coast	Fixed	Furuno	FAR-2117	25.7	745	2.0	10.5	6.5	48	12
African coast	Fixed	Furuno	FAR-2127	98	1250	4.5	10.5	8	48	25
Ekofisk	Fixed	Terma	Scanter 5202	92	1504	3.5	3.0	11.8	15	N/A
Arctic Lady	Moving	JRC	JMA-9922-6XA	60	950	3.6	10.5	6.2	22	25

Important parameters for the six systems used in this work.



(Top) Examples of digitized radar images. (Left) No precipitation or wind drop. Wave patterns are clearly visible, and the entire image is suitable for wave and current measurements. (Right) Strong shower disturbing upper part of radar image, making that part less suitable for measurements. (Bottom) (Left) Example of digitized radar image during a wind drop. Sea echo is almost completely lost, leaving only noise in the image and making the image unsuitable for wave and current measurements. (Right) Illustration of how Cartesian image sections of various sizes can be extracted from a polar image.



deep neural network is a convolutional neural network (CNN), which is especially well suited for working with image data.

Based on deep learning and CNNs, a method has been developed and tested to detect disturbing precipitation and wind drops in X-band radar images. “Disturbing” refers to conditions where the reliability of wave-height measurements and the corresponding scaling of wave spectra are significantly reduced. Millions of images have been classified for training and validation, covering a wide range of measurement conditions, geometries and radar types. Overall, accuracies of 97.3 and 99.6 percent for precipitation and wind-drop detection, respectively, have been obtained during the test and verification stage across various fixed and moving installations, without requiring any installation-dependent adjustment or calibration. The method is integrated into a wave measurement system, providing a reliable and useful automatic data quality control, resulting in further increased data quality and value for the customer.

Data Acquisition

Data used for development and verification were acquired from six different Wavex systems at: the dry bulk carrier *BW RYE* of BW Dry Cargo (Copenhagen, Denmark), crossing the Atlantic Ocean during the periods of interest; the fixed site Ekofisk in the North Sea; the LNG carrier *Arctic Lady* of Høegh LNG (Oslo, Norway), crossing the Norwegian Sea during the period of interest; and fixed sites off the coast of Nova Scotia in Canada, in the North Sea and at the southeast coast of Africa. The data were collected from January 2008 to April 2019.

The systems cover a wide range of measurement conditions and geometries, as well as radar types.

Data Classification

More than 7 million Cartesian image sections extracted from digitized radar images were sorted into three groups for both precipitation and wind drops: images with no precipitation/wind drop, referred to as category 0; images with precipitation/wind drop and notable influence on the significant wave height (H_{mo}), referred to as category 1; and unclassified images. The classification was carried out based on visual evaluation of the images, time series of the significant wave height (H_{mo}) from both radar-based systems and references, and time series of wind data. Labeling of data was done

independently for precipitation and wind drops.

Convolutional Neural Network

The CNN was developed and trained using the MATLAB Deep Learning Toolbox. After experimenting with

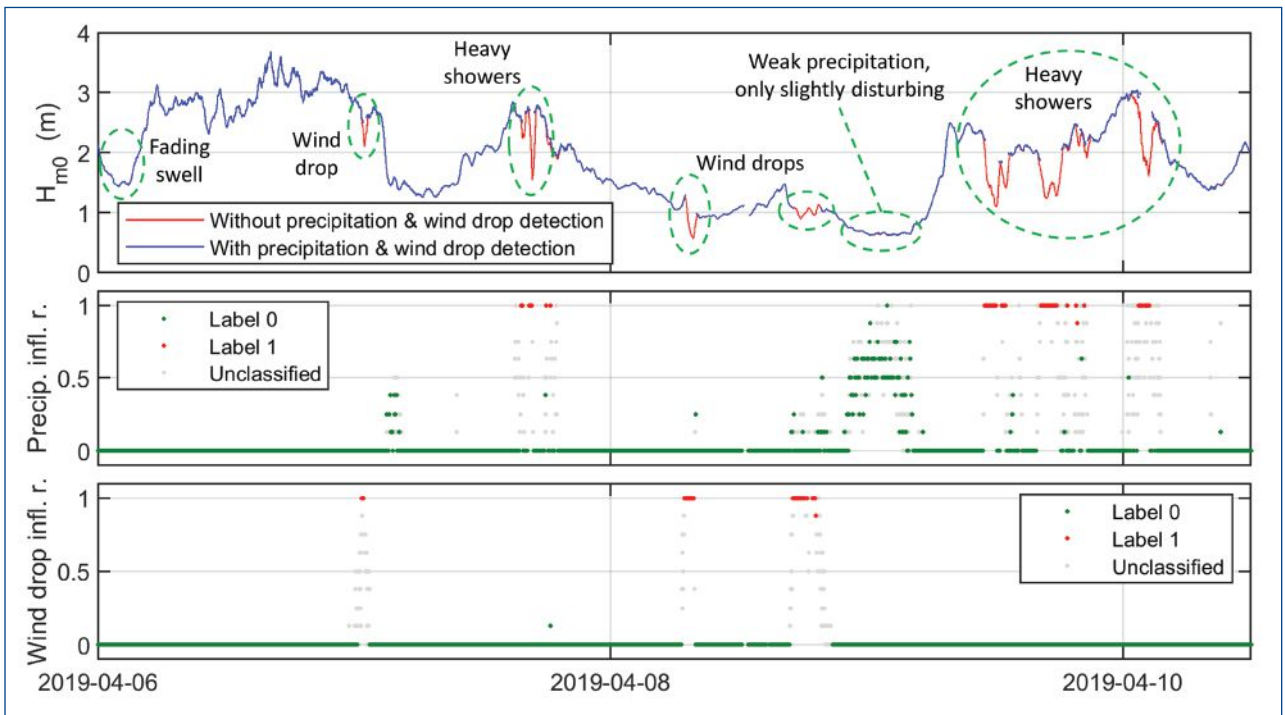
different network configurations, a CNN constructed of 23 layers was chosen. The network has a typical CNN structure, with image input followed by five groups consisting of a two-dimensional convolutional layer, a batch normalization layer, a rectified linear unit (ReLU) layer, and a max-pooling layer. The max-pooling layer of the last group is replaced by a fully connected layer, followed by a softmax layer and the classification layer. The size of the input layer matches the size of the Cartesian images, which was set to 500 m throughout this project. The images are gray scale, so the number of input channels is one. The same network architecture is used for both precipitation and wind-drop detection, though two different and independent networks have been trained for the two tasks.

Data were randomly selected out of the available labeled images, using 75 percent of the data for training and 25 percent for validation. The number of images from category 0 and category 1 were chosen with a ratio of 3:1. This ratio was chosen based on experimenting with data from the various systems, putting more weight on situations without precipitation/wind drops during training, to obtain a desired balance between false positives and false negatives. It is important to sustain a data capture rate as high as possible and not to throw away reasonable data. Furthermore, the ratio also reflects typical conditions across most geographical areas, in which dry spell and some wind are more frequent than precipitation or dead calm.

The first few trainings and validations were carried out on data from only one or a few systems, and then tested on data from other and different systems, in order to confirm that the CNN was suited for being transferred across various installations. Then, training and validation were performed simultaneously on all systems to obtain optimal CNNs for the entire range of radar types, geometries and measurement conditions. A stochastic gradient descent with momentum (SGDM) optimizer was used during training. Validation accuracies for precipitation were 98.5, 93.9 and 97.3 percent for category 0, category 1 and the total data, respectively. Corresponding numbers for wind drops were 99.7, 99.4 and 99.6 percent. For training, all numbers were 100 percent.

System Integration of CNN. Wave measurements are based on data sets consisting of series of digitized radar images. Precipitation and wind-drop detection is applied to every single Cartesian section in every single polar image. If less than 50 percent of the images in one Cartesian section are significantly disturbed by precipitation or wind drops, that section is accepted and used in further calculations.

The next step is the spatial consideration, in which at least two undisturbed Cartesian sections are required from the preceding temporal processing to approve the current measurement. This will in most cases ensure that the measurement is reasonable. Temporal averaging of wave measurements includes only approved data, and the output from the averaging is considered as good if at least 50 percent of the single data sets have given approved measurements.



(Top) H_{m0} and precipitation/wind-drop influence ratios from the Wavex at BW RYE during an eventful period. Time series of H_{m0} is shown in the upper plot, with and without precipitation and wind-drop detection activated. Only data tagged as good are shown: The red parts show how data are disturbed and passed through the system when precipitation and wind-drop detection is not applied. Incidents of precipitation and wind drops are observed, as well as varying H_{m0} due to changing amounts of swell only. Interesting events are indicated in the plot, and it is clearly visible how the system recognizes and tags the various conditions. Lower plots show precipitation and wind-drop influence ratios. The influence ratio is the ratio of Cartesian sections significantly influenced by precipitation/wind drops. An influence ratio of 1 means that all Cartesian sections are significantly influenced. Influence ratios are indicated with a color related to the true label of the data set; green means no precipitation/wind drops, red means precipitation/wind drop, and gray means that the data set is unclassified. (Bottom) Typical graphical user interface (GUI) setup showing various data from Wavex after completed processing and automatic data quality control.

System Test and Verification

The novel automatic data control functionality has been verified based on months of continuous data from the six installations, covering many incidents of wind drops and precipitation of various strengths, as well as varying H_{m0} due to changing amounts of swell only. In this context, swell refers to ocean surface gravity waves that arrive after being generated and having propagated from distant weather systems. When only considering time series of H_{m0} , it is difficult or even impossible to distinguish between situations with fading swells and disturbing precipitation or wind drops; a fading swell causes the actual H_{m0} to decrease, because H_{m0} is made up of all the wave contributions on the ocean surface, whereas disturbing precipitation or a wind drop causes the measured H_{m0} to decrease erroneously because it reduces or even totally erases wave patterns in the radar images. The new data control functionality recognizes and correctly tags the various situations, allowing for optimized processing of data and improved information flow to the user.

Conclusion

Ocean waves, currents and vessels' STW can be reliably measured based on input from conventional marine X-band navigation radars, using a variety of methods developed and improved during recent decades. To provide the user with a reasonable output 24/7, real-life conditions such as heavy precipitation and wind drops need to be recognized to properly process the data and to inform the user about any reduction in data quality.

A method based on deep learning and CNNs has been developed and tested to detect disturbing precipitation and wind drops in X-band radar images. The method does not require an installation-dependent threshold or calibration, i.e., it works across different systems with different geometries and radar types, with overall accuracies of 97.3 and 99.6 percent for precipitation and wind drops, respectively. The method is integrated into a wave measurement system for additional automatic data quality control, providing further improved data quality, information and value to the customer.

Acknowledgments

The author would like to thank BW Dry Cargo and Høegh LNG for making available and approving data to be used for this work. The author would also like to thank other external partners, as well as V. S. Bertelsen and G. Prytz from Miros, for support with acquiring data and providing valuable information and input during the project. **ST**

Dr. Rune Gangeskar holds a Ph.D. in physics and instrumentation from the University of Oslo. He is a senior development manager with Miros AS, in Asker, Norway, where he is involved in developing measurement principles, algorithms, mathematical models and software for various radar-based systems measuring environmental data at sea.



Ocean Power - gosubsea 3000®

Li-Ion PowerPack™ - Underwater power solutions

Highly reliable, efficient and safe Li-Ion batteries
Made for harsh offshore and subsea conditions
such as offshore Oil & Gas, scientific and
AUV or ROV equipment

SubCtech GmbH
www.subctech.com
info@subctech.com

API17P
Offshore
certified

COTS

Vehicle

Energy Storage System

Subsea

RD & System Integration

ISO 9001

SubCtech

EVERYWHERE THERE'S WEATHER

Sensors to Measure:

- Relative Humidity
- Precipitation
- Temperature
- Pressure
- Visibility
- Wind

WWW.YOUNGUSA.COM

YOUNG

international

Fugro Ops Center in Middle East

Fugro has opened a new state-of-the-art remote operations center (ROC) in Abu Dhabi, which is now delivering remote and autonomous solutions to clients in the Middle East and India (MEI) region. The new ROC is the latest addition to Fugro's global network of ROCs, which now consists of eight centers.

By combining the ROC's capabilities with new USV operations, Fugro's teams can perform offshore work from onshore. During the coronavirus pandemic, Fugro is deploying remote solutions in the Middle East, enabling vital marine site characterization and asset integrity projects such as rig positioning to stay on schedule.

KR Revises Rules for Membrane LNG Carriers

The Korean Register (KR) has developed new class rules that completely revise the existing structural rules for membrane-type LNG carriers. The new class rules apply the concept of EDW (equivalent design wave) based on direct load analysis to determine structural arrangements and scantling that meet the structural strength, buckling and fatigue strength criteria for various load scenarios, and re-verify by applying direct structural analysis.

COVID Testing Center for Crew Changes

Philippines- and Singapore-based crew specialist CF Sharp has established its own COVID-19 testing center in Manila to speed up its crew change process.

Sharp is assisting crew changes for commercial vessels docked off the Philippine coast and has set up a coronavirus testing regime at the company's Seafarer Family Center in Manila.

ABB Joins European Clean Hydrogen Alliance

ABB has been granted membership into the European Clean Hydrogen Alliance (ECH2A), the official EU body focused on an ambitious deployment of hydrogen (H₂) technologies by 2030, as a means to reduce carbon emissions and help achieve European carbon neutrality by 2050. Peter Terwiesch will be ABB's executive sponsor in the Alliance and will be actively working with governments and other Alliance members to scale up the hydrogen value chain across Europe.

The use of hydrogen has been identified as crucial to achieve the objectives of the European Clean Deal and Europe's clean-energy transition. Hydrogen only emits water and heat when used; no carbon. Hydrogen complements electricity and offers a solution to decarbonize industrial processes and economic sectors.

Aquatec Turns 30

Subsea instrumentation designer and manufacturer Aquatec Group is celebrating its 30th anniversary with conservation fundraising. For every click on its corporate timeline online at <https://bit.ly/3gGHpWV>, the company adds an amount up to a fixed sum that will be donated

from its own funds to the Marine Conservation Society.

With this action, the firm, established in 1990, commemorates its three decades in the industry creating instruments and services aimed at safeguarding marine mammals, as well as measuring, logging, communicating and interpreting underwater data.

RINA Fleet Operating Center in Greece

RINA has opened a fleet operating center in newly expanded offices in Piraeus, Greece. This will enhance the ship classification society's management of RINA-classed vessels worldwide. The new center will integrate various data in real time on a single platform, including ship records and certificates, ship plans, manuals and calculations, and shipboard automation and meteo-marine information. Ships' performance monitoring will be completed with optimization analytics, based on both historical data and AI-powered predictions.

Inmarsat Fast-Tracks Start-Ups

Inmarsat has fast-tracked two start-ups to Certified Application Provider (CAP) status as part of the Decarbonising Shipping initiative run by venture developer Rainmaking.

Solutions by VesselBot and PortXchange have been accentuated by Rainmaking's Trade and Transport Impact initiative, which seeks to harness the power of start-ups and advanced technologies to meet UN targets on greenhouse gas (GHG) emissions. As CAP participants, the companies will provide dedicated applications for Inmarsat's Internet of Things (IoT) platform for Fleet Xpress: Fleet Data. The platform collects data from onboard sensors and pre-processes them for upload to a central cloud database accessible by an owner's software or third-party applications.

GeoAcoustics Independent Again

GeoAcoustics Ltd. has returned to independent ownership following divestment from Kongsberg Maritime AS. Kongsberg acquired the company in 2008, and it was part of the sensors and robotics business area.

Based in Great Yarmouth, U.K., GeoAcoustics has been manufacturing marine survey equipment for more than 42 years, specifically, sonar survey systems for engineering, geophysics and naval survey applications.

New KVH Watch Solution Partners

TMS Maritime Solutions, a provider of IoT sensors and applications to vessels, has joined the KVH Watch Solution Partner program and will offer KVH Watch connectivity to enable real-time data transfers, leading to actionable insights. KVH Watch connectivity will allow TMS's trained technicians to support clients remotely for preventive maintenance and on-demand troubleshooting, rather than waiting for vessels to come into port.

ioCurrents has also joined the partner program. The company is the creator of the MarineInsight platform, which uses machine-learning algorithms to support maritime maintenance and fuel optimization. KVH Watch's dedicated connectivity will enable ioCurrents to use

real-time data to provide customers with actionable insights and engage in real-time video troubleshooting sessions during the course of a sea voyage.

First Construction Milestone for NSMV

The U.S. Department of Transportation's Maritime Administration (MARAD) has launched a new era in maritime education with the cutting of steel for the new National Security Multi-Mission Vessel (NSMV) at Philly Shipyard Inc. This is the initial major construction milestone for the first purpose-built, state-of-the-art training vessel for U.S. state maritime academies.

The NSMV will also be available to support humanitarian assistance and disaster-relief missions.

Glomex Reinvests in Americas

Glomex s.r.l. has partnered with distributor GA Communications. The Baltimore-based company is now the exclusive provider of Glomex's full range of marine and RV products in North and South America. The new entity will operate as Glomex Americas.

Support for COVID Vaccine Distribution

The Panama Canal will join the World Economic Forum's Supply Chain & Transport Industry Action Group's efforts to achieve globally inclusive, safe and sustainable distribution of COVID-19 vaccines.

This charter affirms the transportation industry's commitment to unite the public and private sectors with the planning and preparedness efforts for COVID-19 vaccine transportation and distribution.

Elbit to Acquire Sparton

Elbit Systems Ltd.'s U.S. subsidiary, Elbit Systems of America LLC, has signed an agreement with an affiliate of Cerberus Capital Management L.P. for the acquisition of Sparton Corp. The transaction is conditioned on various closing conditions, including receipt of U.S. regulatory approvals. Headquartered in De Leon Springs, Florida, Sparton is a developer, producer and supplier of electronic systems supporting undersea warfare for the U.S. Navy and allied military forces.

Support for Hydrographer Training

Subsea Europe Services GmbH has pledged to support HafenCity University in training a new generation of marine hydrographers by ensuring availability of the latest hydroacoustic technology aboard the new survey boat *DVocean*. Based in Hamburg, HafenCity University is the only facility in Germany certified to the highest standards of training for marine surveyors.

Joint Research for Green Tankers

DNV GL and HHI Group will develop future-proof tanker designs. Using DNV GL's data-based carbon robust model to its very large crude carrier and medium-range tanker ships, HHI Group found that an LNG fuel propulsion system and energy-saving devices can enable a vessel to meet the new Carbon Intensity Indicator (entering into force in 2023) over its expected lifetime. **ST**



pCO₂

General Oceanics, Inc. introduces its **new model 8050 autonomous pCO₂ monitoring system**. Continuous measurement, recording and transmission of sea surface CO₂ levels.

- **Efficient equilibration of sea water and confined air head space.**
- **Infrared analysis of CO₂ concentrations.**
- **Automatic calibration.**
- **Integrated computer and control software.**
- **Integrated GPS location and atmospheric conditions.**
- **Satellite data transmission.**

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

General Oceanics Inc.

1295 N.W. 163 St., Miami, FL 33169

Tel: (305) 621-2882, Fax: (305) 621-1710

E-mail: Sales@GeneralOceanics.com

<http://www.GeneralOceanics.com>

Looking for more news from the ocean world?

READ SEA TECHNOLOGY'S BLOG

Visit our blog site, where we cover everything from marine technologies to industry, academic and NGO research development.

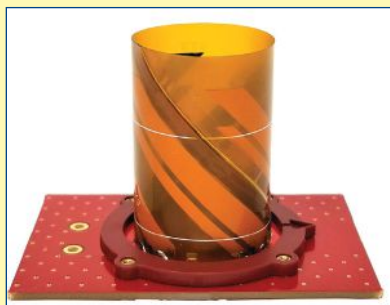
You can comment, like and share posts, and subscribe to receive email updates from the blog.

sea-technology.com/blog

productdevelopment

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

Active Iridium Helical Antennas



The housed HC610 and the embedded HC610E are lightweight and compact. They receive the Iridium Satellite Time and Location (STL) signals, which are used by STL terminals to provide worldwide position, navigation and timing independent of GPS/GNSS via an encrypted satellite broadcast signal. Tallysman Wireless Inc.

Antifouling Solutions

Oceanic Protect+, Oceanic Flex+, Olympic Protect+, Olympic Flex+ and Olympic Protect have been added to the Olympic+ and Oceanic+ antifouling range of hull coatings. They offer better control of the leached layer and an enhanced mechanical strength. Hempel A/S.

Ballast Water Treatment

BIO-SEA has successfully passed all land and shipboard testing and is now IMO G8-approved without any operational restrictions. Available as a skid-mounted system or a modular package to aid retrofit, the BIO-SEA range of ballast water treatment systems has been designed for flow rates between 10 and 2,000 m³/h. BIO-UV Group.

Seawater Pressure Regulator

Customized 436 Series regulators are capable of reaching set pressures up to 190 PSIG. The series also includes regulators that extend the low end of the range to below 5 PSIG. They are suitable for a wide range of marine applications, including desalination, cooling and

flushing. Warren Controls Corp.

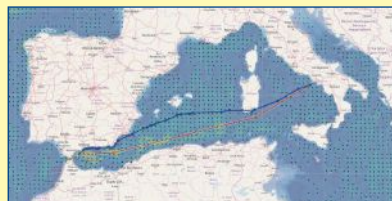
User Terminals for LEO Sat

Dedicated user terminals for the global low-earth orbit (LEO) satellite communications provider OneWeb are ready for delivery this year. A wide range of dedicated OneWeb user terminal types with a variety of antenna sizes is available. Intellian Ltd. and OneWeb.

UV Disinfection

Various equipment is designed to combat viruses. The products adhere to standards set by the U.S. Environmental Agency, indicating that they do not cause "unreasonable risks of adverse effects on human health or the environment." Larson Electronics LLC.

Voyage Optimization Service



VoyOpt selects the most secure forecast using Earth observation and satellite data, probability algorithms, seasonal data, current weather, and climatology to deliver the most reliable weather prediction. VoyOpt calculates voyage plans based on optimal engine power and speed, significantly lowering fuel burn and emissions while enabling highly accurate arrival time estimates. Global Maritime Services Ltd.

Satcom System

Digitalization, which has typically been reserved for large vessels, is now available for smaller crafts. Orion Edge V enables a VSAT-like communications experience over L-band with access to a cloud-based system, offering a wide range of telecom services. IEC Telecom

and Thuraya Telecommunications Co.

Climate Control

BlueComfort applies to commercial vessels up to 300 ft. It comprises a self-contained chiller unit and diesel-fired coolant heater for fast cabin warm-ups and cool-downs independent of ambient and seawater temperatures. Webasto Group.

Multi-Instrument Frames



These customized frames can accommodate a large variety of instruments from various manufacturers. Sensors are integrated into a single simplified data reporting system that allows the end-user to remotely access all readings (in real time or near real time) from a single software window/webpage. OSIL.

Joystick

AVENTICS Marex 3D Joystick system has been modified for easy integration into existing vessels. Designed to enable single-handed operation of yachts, speedboats and pleasure craft, the joystick provides the user with precision in maneuvers and optional dynamic positioning. Emerson Automation Solutions.

Instrument Display

VL Flex 52 gauge supports a broad range of sensors and can be programmed for up to 22 sets of data with a tap from a mobile device. The 1.44-in. display has a single data layout with a large numeric value and colored bar graph. Unlike analog gauges, it can be configured to display two data sets simultaneously. Alarms can be set to trigger at configured thresholds. Veratron US Inc.

Onboard USB Charging

The USB Charger Receptacle charges small electronics with lithium-ion batteries. It fits any standard box or bracket and uses common faceplates. An integrated LED illuminates to indicate when power is on to the USB and line voltage is available. Hubbell Marine Electrical Products.

Cable Tech

ARTEMIS Survey is a high-frequency electromagnetic cable and pipeline survey system that has been tested in the North Sea. It can detect any broken or abandoned cables, without the need for power or tone generation, in real time and at deeper depths than typical technology. Soil Machine Dynamics Ltd. and N-Sea NL.

Inhibiting Corrosion

VpCI-396 is a Micro-Corrosion Inhibiting Coating option that is solvent-based moisture-cure urethane. It can be used as a direct-to-metal primer and, in some cases, a top-coat. It is suitable for ballast tanks or structural steel, and tanks in a chemical- or water-vapor rich industrial environment. Cortec Corp.

Electro-Optical Connectors

3O-1F3 has three electrical contacts and one optical fiber, qualified to 6 km at 2° C. 3O-4F2 is a miniaturized 1.25-mm ferrule with self-alignment features and two 16-AWG electrical conductors for power. BIRNS Inc.

Silicone Sealant

BoatLIFE Marine Silicone Rubber Sealant is acid-free and non-corrosive. Unaffected by light, salt spray, ozone, smog or temperature extremes, it won't shrink, crack or dry out and remains flexible throughout its service life. It is ideal for ports, windshields, fittings and above-the-waterline thru-hulls. Life Industries Corp.

COVID Cleaning Service

This new service helps vessel owners and crew respond to COVID-19 outbreaks. The service includes complete disinfection of closed

areas on a vessel, as well as care for the crew, including sanitized transfers between the vessel and COVID-safe accommodation in Rotterdam during the treatment. DisinfectYour.com.

Rugged Computer

M-Max HR 3U CU has a conduction-cooled system with a variety of mounting options. It features COTS technology and conforms to MIL-

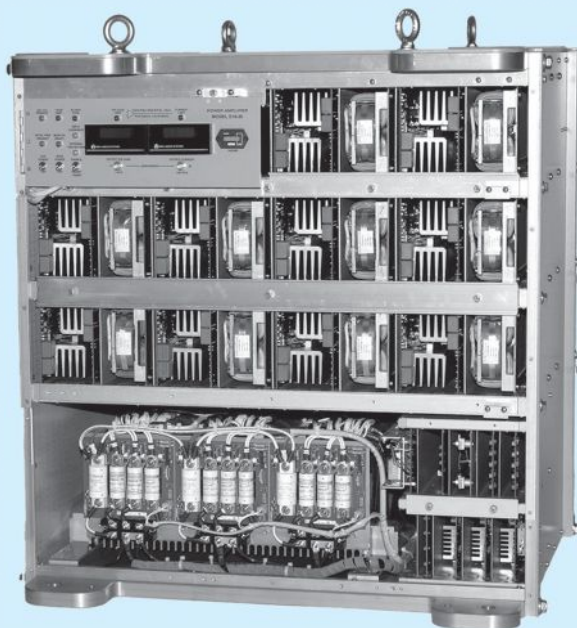
STD-810 and is IP66 rated. It can withstand 40-g shock, 2.5-g vibration and temperatures from -40 to +50° C. MicroMax Computer Intelligence.

Data Visualization Tool

TM Insights converts real-time data into intuitive reports and charts in order to identify trends and uncover hidden problem areas. Tero Marine AS. **ST**

POWER AMPLIFIERS SWITCHING & LINEAR

For more than 30 years we have been
building amplifiers to drive reactive loads.



Model S16-20

20kVA continuous; 50kVA 20% duty
35 x 31.5 x 35.5 inches; 985 lbs.

Visit our Web site www.instrumentsinc.com



Instruments, Inc.

7263 Engineer Rd., San Diego, CA 92111-1493
(858) 571-1111 FAX (858) 571-0188 info@instrumentsinc.com
Copyright 2021

50-MW Wave Energy Array In Vietnam

Eco Wave Power, a publicly traded wave energy developer, has signed a memorandum of understanding (MOU) with MSMART Future Technology as the basis for the development of a 50-MW wave energy array in Vietnam.

In the first phase, Eco Wave Power will perform an in-depth feasibility study at the selected site in Vietnam. The study will include the installation of a wave-measurement buoy. After the study, the parties will establish a joint venture company in Vietnam.

Monitoring Construction Noise For Marine Mammal Safety

Seiche has won an Ørsted contract to ensure marine mammal safety during construction of the world's largest offshore wind farm, Hornsea Two. Seiche has mobilized two key vessels on Ørsted's Hornsea Two offshore wind farm site to manage Ørsted's commitment to ensure that impacts to marine mammals during construction activities are negligible.

The team from Seiche will ensure compliance with procedures that seek to minimize the effects of construction noise on the local marine population. Key species known to occur in the project area are: harbor porpoise, white-beaked dolphins, minke whales, and grey and harbor seals.

First Integrated Rules for Floating Offshore Wind

As the first successful pilots transition into the first commercial projects, floating offshore wind is opening up new vistas to offshore wind generation. To help expand the segment, DNV GL has released the first integrated rule set for floating offshore wind structures: DNVGL-RU-OU-0512. The rules provide both new entrants and experienced stakeholders a set of well-tested rules and standardized processes for these new structures. The rules cover all potential hull shapes, in-

cluding barge, semi-submersible, vertical floating columns (spar) and tension-leg platform. The basic classification scope covers the floating structure, including mooring systems, with an additional voluntary class notation covering the power generation system, including the tower. The rules are also designed to scale, with data-based services and condition-based monitoring.

Initiative to Develop Multi-GW Wave Farms

AW-Energy Oy (AWE) will provide answers on how to prepare and deploy large-megawatt wave farms in a project funded by the European Maritime and Fisheries Fund through the Blue Economy Window program.

The project aims to: ensure market readiness of WaveRoller solutions by preparing processes for projects with 5-10 MW capacity, ahead of the EU target of 150-MW installed capacity by 2030; facilitate the market uptake of wave energy by developing a scalable business and service model to support future wave farms totaling 200 GW+; and develop a roadmap for global replication that covers life-cycle services and operational support.

The three-year project will see AW-Energy develop processes to deliver the world's first large-scale wave farm, with up to 24 integrated WaveRoller units. This work will assist in securing eight wave farm projects to deliver a capacity of 150 MW, with an estimated annual electricity production of 400 GWh.

Opportunities for Companies To Enter Marine Tech

Marine-i invites businesses that are not currently operating in marine tech to consider how they could bring their skills, products and services to fuel innovation in the sector, with a base in Cornwall.

Partly funded by the European Regional Development Fund, Marine-i is designed to help the marine tech sector in Cornwall and the Isles of Scilly grow.

Marine-i has identified that the emerging floating offshore wind industry presents a significant opportunity for manufacturing and construction in the region. Another area ripe for development is offshore energy storage, transmission and control systems. Opportunities also exist for companies skilled in machine learning, cybersecurity and autonomous systems. Find out more at: www.marine-i.co.uk/news/article/127/not-in-marine-technology-take-the-opportunity.

Fugro, NYK to Serve Japan

Fugro and NYK Group have signed an MOU to provide offshore geotechnical services in Japan. They will also collaborate on a feasibility study into jointly operating a specialist investigation vessel for renewables projects. This partnership will benefit from Fugro's technical and operational expertise in offshore wind and NYK's knowledge of the Japanese market.

Rock Installation Vessel For US Offshore Wind

Great Lakes Dredge & Dock Co. LLC has chosen Ulstein Design & Solutions BV to design the first U.S.-flagged, Jones Act-compliant, inclined-fallpipe vessel for sub-sea-rock installation. The vessel will primarily serve the growing needs in U.S. offshore wind, installing protective layers of rock at offshore wind turbine foundations by means of an inclined fall pipe system. The vessel will help establish a U.S.-based rock supply chain network.

Dominion Progresses with Virginia Offshore Wind Plans

Dominion Energy has filed with the U.S. Bureau of Ocean Energy Management (BOEM) the required construction and operations plan (COP) to build the 2,640-MW Coastal Virginia Offshore Wind (CVOW) commercial project, the largest planned offshore wind farm in the U.S. CVOW's first phase, a two turbine, 12-MW pilot project, is already operational. Pending approval, CVOW should be completed in 2026, providing power for up to 660,000 homes. **ST**

contracts

Wärtsilä's, Helsinki, Finland, Hybrid Upgrade solution has been selected for retrofitting two offshore construction vessels. This will allow less use of the ships' engines, with correspondingly lower levels of exhaust emissions while operating in dynamic positioning mode, and will lower emission levels in all other operational modes. Østensjø Rederi.

Hyundai Heavy Industries (HHI), Busan, South Korea, which controls about 10 percent of the global new-build market, has reached an agreement to utilize Jotun HullSkater to proactively inspect and clean vessel hulls during outfitting to ensure optimal environmental performance and protection. HMM Co. Ltd. and Jotun.

Norsepower Oy Ltd., Helsinki, Finland, has a first newbuild order to install a record five tilting Rotor Sails on board a large bulk carrier. This is the first installation of Rotor Sails on this vessel type. Undisclosed.

e5 Lab Inc., Tokyo, Japan, has signed a joint research agreement on cybersecurity. The first joint research project will be a proof of concept on Marindows, a comprehensive digital platform for ships being developed by e5 Lab. ClassNK.

DNV GL, Houston, Texas, will verify that the infrastructure for the Tri-on project complies with local and global safety requirements. DNV GL will participate in design-review activities and site surveillance during construction, commissioning and installation of the floating production unit. BHP.

Kongsberg Maritime, Kongsberg, Norway, has been selected to supply a large electric winch package for a pelagic trawler/purse seiner currently being built in Denmark. Astrid Fiskeri A/S.

The Maritime Authority of Jamaica, Kingston, Jamaica, has signed

a memorandum of understanding for reciprocal recognition of STCW certificates for seafarers for their nationals. Jamaican seafarers will now be able to serve on Kenyan-flagged vessels, and vice versa. This undertaking establishes a Joint Committee on Shipping and Maritime Affairs. Republic of Kenya.

Echandia, Stockholm, Sweden, has signed an agreement for 23 modern electric ferries for the South Indian city of Kochi's public transport. The project comprises a total of 78 zero-emission vessels, which is the world's largest fleet of electric ferries. Siemens.

Sterling PlanB (SPBES), Vancouver, Canada, has made a new partnership agreement that will provide U.S. industrial and marine customers with local representation and technical support for its energy storage solutions. Industrial Service Solutions.

Oceaneering International, Houston, Texas, has been awarded a contract for the supply of the first-ever 20,000-psi-rated subsea hydraulic junction plates and associated connection hardware for field development in the Gulf of Mexico. One-Subsea.

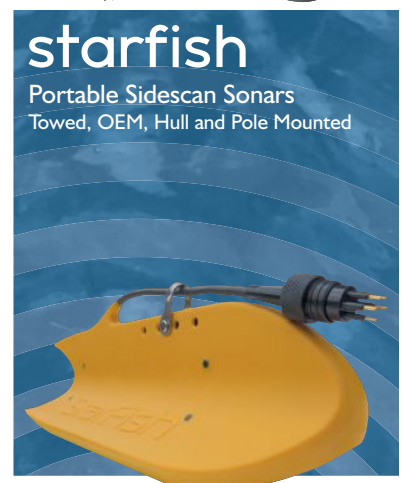
Safeway, Dordrecht, Netherlands, has been awarded a contract to supply its Seagull motion-compensated gangway system for installation on the CSV *Normand Baltic*. Heerema Marine Contractors.

Planet Ocean Ltd., Surrey, U.K., has signed an exclusive representation agreement with a Dutch manufacturer of oceanographic, hydrographic and meteorological instruments. Planet Ocean will provide pre- and post-sales support from its Surrey base. Obscape BV.

MetOcean Telematics, Dartmouth, Canada, has been awarded a five-year blanket purchase agreement to supply its search-and-rescue buoy, the Iridium Self Locating Datum Marker Buoy (iSLDMB). U.S. Coast Guard. **ST**



enquiries@blueprintsubsea.com
sound by design



find out more
www.blueprintsubsea.com



Platform to Digitize Manual Port Operations

Innovex One, a provider of port management software, is embarking on a collaboration to automate and digitize Singapore's last-mile delivery of launch operations at its Marina South Pier (MCP) and West Coast Pier (WCP). Innovex One will launch its new Counter Service Digital Platform, a contactless counter-services software that will streamline the current time-consuming manual operations at MCP and WCP. The project is being conducted in collaboration with GAC Group, Bernhard Schulte, HHH Marine Launch, DM Sea Logistics and KanLian Ferry. The trial will begin at WCP, then extend into MCP.

The Counter Service Digital Platform will obviate the need for physical counter services and replace repetitive processes with the digitalization of core services, including passenger management and loose-cargo management. Passengers will receive booking and QR codes on email or apps prior to boarding. Onboarding, the QR code is scanned and registered, and the information is fed directly to the ship agent and launch company. Universal display panels will be deployed at the piers. These will offer immediate arrival and departure time information, the estimated time of arrival of the vessel, and the boarding location. The piers will also host storage solutions to securely store loose items or spare-parts cargo for pickup by shipping agents or boatmen.

The Counter Service Digital Platform will provide an open API for data exchange and transactions with any solutions or systems, ensuring interoperability and scalability with new digital innovations.

GX5 Satellite Launches

Inmarsat has commercially introduced the GX5 service, the company's newest, most powerful geostationary satellite to date. GX5 is the 14th satellite currently in service with Inmarsat and provides addi-

tional capacity to Europe and the Middle East on the Fleet Xpress (GX) Ka-band high-speed satellite broadband service designed for the maritime industry.

The satellite, launched in November 2019, delivers approximately double the combined capacity of the entire existing GX fleet (GX1 to GX4). Together with a significantly expanded ground-station network and enhanced cloud-based processing, GX5 supplements the global coverage of GX and supports the rapid growth in customer demand for GX services in the region.

A fully funded technology roadmap plans for seven more satellite launches over the next four years.

ISM Compliance Support For Cybersecurity

ClassNK Consulting Service Co. Ltd. (NKCS) has launched ISM compliance support for cybersecurity to support ship management companies. Regarding IMO Resolution MSC.428(98), which recommends that a safety management system should take into account cyber risk management in accordance with the ISM Code requirements, the number of flag states making it compulsory from 2021 is increasing. In particular, the U.S. Coast Guard will make this recommendation mandatory for U.S.-flagged vessels and foreign-flagged vessels that call on ports in the U.S.

Detailed information is lacking at present, and NKCS is aware that many shipping companies are struggling with the specifics of how to handle this issue. NKCS has launched the service to incorporate cyber risk management into an existing SMS manual to support ship management companies in complying with ISM requirements for cybersecurity. Based on a systematic and comprehensive approach to the cyber risks that may occur on board and the recommended elements (identify, protect, detect, respond and recover) to be included in line with the MSC.428(98), NKCS provides a manual, network conceptu-

al diagram and risk assessment template that is customizable.

EMEC to Assess Verdant Power Performance

The European Marine Energy Centre (EMEC) has initiated an independent power performance assessment for Verdant Power following the deployment of three fifth-generation (Gen5) tidal stream turbines in New York City's East River in October 2020.

The EMEC team joined Verdant Power virtually to witness the start-up of the Triframe Gen5 turbines, which began producing power within an hour of slack tides at the Roosevelt Island Tidal Energy (RITE) Project site.

This is the first remote witness of a power performance assessment that has been carried out by EMEC according to ISO/IEC 17025 methods and procedures and was made possible by months of preparation over 2020 due to the COVID pandemic restricting travel.

Verdant Power is expected to hit the full power curve in early 2021, after which EMEC will deliver an internationally recognized test report providing third-party verification of operational results.

Scottish Marine Tech Park

Malin Group's innovative vision for a marine technology hub on the Clyde at Old Kilpatrick has moved one step closer to becoming a reality with the confirmation of £1,980,000 of funding from the Scottish Government's Clyde Mission to West Dunbartonshire Council, enabling the Malin Group to progress to stage two in its development. This entails redevelopment of the quayside.

Once complete, the Scottish Marine Technology Park (SMTP) will include several large fabrication facilities, room for a large number of smaller suppliers, and a deepwater jetty with an 1,100-tonne ship hoist that will be the largest of its kind in Europe. The SMTP, due to be completed in 2024, will become a center of excellence for marine engineering and complex marine manufacturing. **ST**

Career Guidance

ISO/PAS 24438, Ships and marine technology – Maritime education and training – Maritime career guidance, is a tool for anyone considering a career in the industry, as well as for maritime professionals assessing their future goals and career path. It covers a wide range of considerations, such as personal circumstances and academic background; previous work experience, knowledge and skills; short- and long-term goals; education and training requirements; current and future job opportunities; and more.

The publicly available specification will help professionals make the best decisions to reach their career objectives while helping shipowners, shipyards and other industry stakeholders meet increasing demands for qualified, trained staff.

It is available at: www.iso.org.

Lost Fishing Gear Cleanup

A new arrival to the Patagonian toothfish industry, Pesquera Azul, is taking initiative to recover and deliver lost fishing gear to shore, aiming to reclaim contaminated fishing grounds and reduce the impact of fishing on the marine ecosystem.

Pesquera Azul is a Norwegian-owned longline-fishing company operating out of Uruguay. The company's new vessel, *Ocean Azul*, will be equipped with the Ghost Gear Cleaner to collect and store lost gear on board. The new boat will also employ stronger line to reduce breakage, reducing both lost catch and lost gear.

Lost fishing gear is a major issue facing the global fishing industry, including in the Antarctic region, where *Ocean Azul* will be working. Some productive fishing grounds in the region are contaminated by lost equipment. Pesquera Azul hopes to set a precedent to encourage others to join the cleanup effort.

Free BioBase EcoSound Subscriptions for Conservation

C-MAP has opened its BioBase EcoSound platform to include free

subscriptions to qualifying organizations. Owned by Navico and operated through C-MAP, BioBase is a platform for aquatic biologists, environmental researchers and government agencies that play a vital role in monitoring programs related to long-term changes to vegetation density, water quality and bottom hardness.

Navico is providing free BioBase EcoSound subscriptions with up to 20 GB of storage to environmental agencies, nonprofits and universities engaged in aquatic resource management and research in an effort to further the goals of aquatic conservation by maximizing access to a scientific tool used for the analysis, management and preservation of critical water bodies. Navico will also offer discounts on Lowrance hardware for qualifying U.S.-based agencies and universities.

The EcoSound product processes raw data from Lowrance or Simrad sonar logs, creating detailed maps and data outputs of bathymetry, aquatic vegetation abundance and bottom hardness. In addition, the BioBase EcoSat product processes high-resolution satellite imagery from a number of sources, creating maps of emergent vegetation and bottom composition in areas often too shallow for boat-based data collection.

Climate Change Threatens World Heritage Sites

Climate change is now the biggest threat to natural World Heritage, according to a report published by IUCN (International Union for Conservation of Nature).

A third (33 percent) of natural World Heritage sites are threatened by climate change, including the world's largest coral reef, the Great Barrier Reef, assessed as having a "critical" outlook for the first time. Ocean warming, acidification and extreme weather have contributed to dramatic coral decline and resultant decreasing populations of marine species at the Great Barrier Reef.

In another example, the rapidly melting Kaskawulsh Glacier has changed the river flow of Kluane Lake, located in a World Heritage site in Canada and the U.S., and this change is depleting fish populations.

Project to Produce Hydrogen From Offshore Wind

Equinor has joined Europe's biggest green hydrogen project, the North₂ project, which aims to produce green hydrogen using renewable electricity from offshore wind off the coast of the Netherlands. The rapid growth in offshore wind is well suited to developing a green hydrogen value chain.

North₂ was launched in February 2020, with Shell, Groningen Seaports Gasunie and the province of Groningen. The project will complete a feasibility study by 2021. Development activities are expected to start in the second half of 2021. The project will have a capacity of 1 GW in 2027, 4 GW by 2030 and 10+ GW by 2040 for electrolysis. This equates to 0.4 million tonnes of green hydrogen production in 2030 and 1 million tonnes green hydrogen production by 2040. This can abate 8 to 10 million tonnes of CO₂ emissions.

Scotland Aquaculture Targets Sea Lice Problem

Sea lice infestation is a major issue facing aquaculture in Scotland, an industry that contributes £1.8 billion annually to the Scottish economy. Traditional treatment methods are costly and can have a detrimental impact on the marine environment.

Supported by Scottish Sea Farms, Marine Scotland Science, Aquatera and the Scottish Environment Protection Agency, BMT will deliver a feasibility study using innovative approaches and its AquaDEEP software to model biologically active sea lice dispersion, infection risk to farmed fish, sea lice response to bath treatment, and its environmental impacts. This will help farmers make informed decisions on site selection and operational management practices. **ST**

AZFP for Baleen Whale Study

University of Victoria Ph.D. candidate Rhonda Reidy has received funding for her project “Modifying an acoustic zooplankton and fish profiler for quantitative spatial sampling of baleen whale prey in British Columbia.” Reidy studies baleen whale foraging dynamics.

North Pacific humpback whales, in particular, are increasing in abundance and, in British Columbia, are increasingly struck by vessels and entangled in fishing gear. New tools are required to observe their interactions, including collecting data on the humpback whale diet. Reidy and ASL Environmental Sciences (ASL) will collaborate on a modified ASL acoustic zooplankton and fish profiler (AZFP) for use on small boats.

The project will evaluate the AZFP’s utility for collecting high-resolution prey data near feeding baleen whales. The AZFP will be in a vessel-mounted, downward-looking orientation from the sea surface, which requires modifying the AZFP’s external hardware and developing custom software.

Dead Fish at Ocean Depths Are Hidden Sources of Carbon

Fish that die naturally in the ocean sink to the depths, taking with them all the carbon they contain. When a fish is caught, most of this carbon is released into the atmosphere as CO₂.

An international research consortium, including scientists from UC Santa Barbara, has estimated that because of this overlooked phenomenon, carbon emissions from fishing are actually 25 percent higher than what up to now was considered from fuel consumption alone. What’s more, part of the carbon extracted from the oceans comes from areas where fishing is not economically profitable in the absence of government subsidies.

Carbon is a major component in the molecules that make up living tissue. Large fish like tuna, sharks and swordfish are composed of 10

to 15 percent carbon. When they die, they quickly sink to the deep sea. As a result, most of the carbon they contain is locked away for thousands or even millions of years. They are, therefore, literal carbon sinks, the size of which has never been estimated before.

Sensors for Hadal Carbon Degradation Research

A new international collaboration aims to better understand the ultradeep sea through innovative adaptation of sensors to withstand the crushing pressures at depths down to 11,000 m.

Funded through the NERC Global Partnerships Seedcorn Fund, the project will bring together experts from the U.K. National Oceanography Centre (NOC) and researchers from the newly created center of excellence for ultradeep-sea research, the Danish Center for Hadal Research at the University of Southern Denmark, to improve knowledge about the processes governing organic carbon degradation in deep-sea trenches.

The hadal, or hadopelagic zone, is at depths of 6,000 to 11,000 m (20,000 to 36,000 ft.). It is the deepest region of the ocean, lying within oceanic trenches. It accounts for nearly half of the ocean’s depth range and has only recently been recognized as a potential hotspot for organic carbon turnover and microbial activity.

Carbon recycling in sediments can have critical implications for ocean chemistry, redox conditions and nutrient availability, impacting life in the oceans.

The project will support knowledge exchange and a collaborative design between partners to adapt the innovative sensor technology required to study the ocean at these extreme depths.

The sensors will be provided by the NOC’s Ocean Technology and Engineering team and rigorously tested in the pressure-testing facilities of the Danish Center for Hadal Research before being deployed

during joint field work in a deep-sea trench off Japan in 2022.

Roly Polies Transfer Mercury

New research finds that steelhead trout in a stream on the California coast accumulate mercury in their bodies when the fish eat roly polies and similar terrestrial bugs that fall into local waterways. The new study corroborates earlier findings that mercury can make its way to the top of the food chain in coastal California.

The results show for the first time that roly polies and other bugs are transferring high levels of the toxic metal to fish in an otherwise pristine watershed where environmental contaminants are not known to be a concern, according to the researchers. This research is the first step in identifying mercury as a potential stressor on these populations.

It is unclear whether mercury accumulation in steelhead and other species would affect humans, but the findings suggest mercury can move between connected ecosystems and affect threatened or endangered species in unsuspecting ways, according to the researchers.

eDNA Offers Rough Estimate Of Fish Biomass

Scientists report in a new study that environmental DNA (eDNA) found in small water samples reveals the relative biomass of fish in the sea roughly as well as a “gold standard” U.S. state government trawl with nets.

The researchers drew seawater samples during New Jersey government fish trawls and tested the water for fish DNA. Water analysis revealed the relative abundance of fish with a 70 percent match in results between the two sampling methods. The study found that each sampling method yielded information missed by the other.

eDNA has been proven before as a reliable way to determine the variety of fish in an area of water, and the new study is the first to show that bits of eDNA floating in seawater also disclose the relative abundance of the species swimming through it. **ST**

meetings

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

MARCH

March 1-5—World Ocean Summit, Virtual. <https://events.economist.com/events-conferences/emea/world-ocean-summit>.

APRIL

April 28-30—Waterpower Week (WPW) 2021 and the International Conference on Ocean Energy (ICOE) 2021, Virtual. <https://waterpowerweek.com> and <https://icoe2021.org>.

MAY

May 18-20—Aquaculture UK, Aviemore, Scotland. +44 (0)1453 836363, carvonio@divcom.co.uk or www.aquacultureuk.com.

JUNE

June 1-4—Nor-Shipping, Oslo, Norway. www.nor-shipping.com.

June 15-17—Seawork and Marine & Coastal Civil Engineering Expo, Southampton, England. www.seawork.com and www.mcceexpo.com.

June 28-29—Floating Wind Solutions, Houston, Texas. <https://floatingwindsolutions.com>.

June 29-July 1—UDT, Rostock, Germany. www.udt-global.com.

JULY

July 6-8—Ocean Business, Southampton, U.K. www.oceanbusiness.com.

AUGUST

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

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

SEPTEMBER

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

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

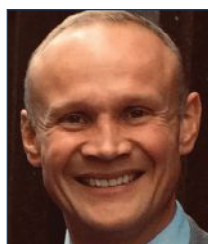
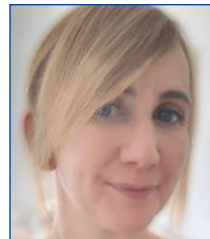
September 20-22—Oi Middle East, Abu Dhabi, United Arab Emirates. www.oceanologyinternationalmiddleeast.com.

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

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

people

Katy Womersley, former general manager of Clyde Marine Training (CMT), will take up the role of operations director at Stream Marine Careers. She has extensive experience in the maritime industry, beginning as a deck cadet before working in the offshore and short sea trade. She helped to grow CMT from 300 officer cadets to a peak of over 1,000 while also managing the recruitment company and introducing foundation apprentices into the CMT office.



Global Energy Group has appointed **Iain Sinclair** to the newly created role of executive director of renewables and energy transition, with plans to launch a new operation in Edinburgh. The former professional rugby player, who has over 18 years' experience in senior energy and infrastructure roles, will develop opportunities in offshore wind, green and blue hydrogen, and sustainable infrastructure.

President and CEO of Consortium for Ocean Leadership (COL) **RAdm. Jonathan W. White**, U.S. Navy (retired), will retire this spring. He led COL for five years, after a 32-year Navy career.

Motive Offshore Group has appointed **Declan Slattery** as chief financial officer. Slattery, who co-led Enpro Subsea through its recent acquisition by energy group Hunting plc, joins Motive as it implements its domestic and international growth strategy to become a £20 million EBITDA business by 2024. He has 12 years of financial experience with oil-field service providers.

Dr. Cheryl Burgess has joined the Society for Underwater Technology as chief executive, bringing over three decades of experience in the energy industry, including oil and gas, renewables, and utilities. She takes over from **Steve Hall**.

Morten Hasås will join Kongsberg Digital as senior vice president for maritime simulation. Previously CEO of Scantech Industries, he has held top management positions at ScanSense, Scanmar and Kongsberg Maritime. **ST**

professional services directory

An effective medium reserved for listing professional and consulting services. Size: 3-3/16" wide x 1" deep, to a maximum depth of 3". Rates: \$95 per one-inch insertion for 1-6 times; \$90 each for 7-12 consecutive times. Payment terms: net 30 days. Discounts: 10% for advance payment for 6 or more insertions without copy change; no agency commissions. No charge for typesetting. Send your electronic file or text and images (300 dpi) to seatechads@sea-technology.com by the 10th of the month preceding insertion month.

Relax.
We can take the pressure.



Subsea Instrumentation Housings and Junction Boxes
Contact us for a FREE Brochure

10,000 N. Technology Drive, Fountain Hills, AZ 85268
877-3PREVCO (Toll-Free) 480-837-0100 480-718-7723 (Fax)
noleaks@prevco.com www.prevco.com

SONOTRONICS
MARK YOUR EQUIPMENT



Mark your underwater equipment for later recovery in case of loss. With *close to 50 years* of experience in the manufacture of sonic pingers, hydrophones, and receivers, SONOTRONICS can provide equipment for your underwater tracking needs.

www.sonotronics.com
(520)746-3322

MetOcean Equipment Leasing

ADCPs, CTDs, Water Quality Loggers (Tu, DO etc),
Acoustic Releases, Ice & Zooplankton Profilers,
Mooring Frames & Cages, Pingers, etc.

Reliable Rentals at Reasonable Rates

ASL

www.ASLNAV.com

GALVANIC TIMED RELEASES

Cost-effective electrochemically degraded links available in durations ranging from one minute to 100 days. Trigger closure mechanisms, open escape panels, release cable support buoys or subsurface instrument locator floats. Stock and custom-designed releases available from:

International Fishing Devices, Inc.
18246 134th Way N., Jupiter, FL 33478
Ph: (954) 574-9517

André LaBonté
P.O. Box 60, Waipu, New Zealand 0545
Ph/Fax: 011-64-9-432-0645

underseareleases.com



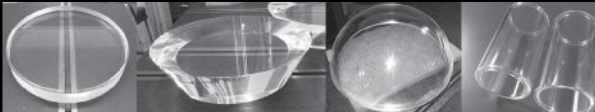
SEA CATCH
TOGGLE RELEASE

McMillan DESIGN, INC.
9816 Jacobsen Lane
Gig Harbor, WA 98332
USA

Tel: 253-858-1985 Fax: 253-858-1986
Email: jmcmillan@seacatch.com

WWW.SEACATCH.COM

HYDROSPACE Group
PVHO Windows and Acrylic Pressure Vessels



**Fabrication – Certification – Engineering – Repair
Replacement – Hydrostatic Testing – Custom Design**

Contact: Michael Azer Tel + (909) 989-7773 - pvho@HydrospaceGroup.com
www.HydrospaceGroup.com

Sea Technology magazine

Since 1963, Sea Technology has been the industry's recognized authority in providing information in design, engineering and application of equipment and services in the global ocean community.

Let Sea Technology work for you by providing published editorial content to validate your marketing initiatives.

Electronic Reprints
Digital versions of ST articles in high-resolution PDF format can be posted directly on your company's website.

For additional information, please contact:
Compass Publications, Inc.
T 703.524.3136 • F 703.841.0852
seatechads@sea-technology.com • sea-technology.com

Current Meters: New Models!



hs engineers
www.hs-engineers.de

Rugged instruments for adverse conditions;
analog sensors or smart multi-parameter probes

How Deep-Sea Tourism Can Help Science—Dr. Edith Widder

Dr. Edith Widder is a MacArthur fellow and deep-sea biologist best known for capturing the first video of the giant squid *Architeuthis* filmed in the deep sea (*Sea Technology*, August 2013). She is also the founder and CEO of the Ocean Research & Conservation Association (ORCA), a 501(c)3 focused on science-based solutions to ocean conservation challenges. Learn more at: www.teamorca.org.



Despite impressive technological advances, ocean exploration is still in its infancy, and opportunities for studying the amazing life in this realm are exceedingly rare. As the anthropogenic impact on the planet accelerates, there is an urgent need to expand exploration and monitoring capabilities to better track, understand and hopefully reverse declining ecosystem health.

The greatest obstacle toward advancing ocean exploration is chronic underfunding. There is an enormous disparity between government support for space exploration compared to ocean exploration. In 2011, the cost of one Space Shuttle launch was upward of \$1 billion, which could have financed two deep-submersible dives a day (\$25,000), every day, for 110 years. That's a colossal imbalance—and goes a long way to explaining our woeful ignorance about the ocean-dominated ecosystem that sustains life on our planet.

The Ocean Exploration Act of 2009 established the only national ocean exploration program in the U.S. Since it was created, NOAA's Office of Ocean Exploration and Research's operating budget has remained at about \$20 million per year, a meager sum that faces increasing demands to maintain aging ships and infrastructure.

To stimulate innovation and greatly broaden the reach of ocean

exploration, NOAA would do well to follow NASA's example by turning to the private sector to help take up the slack. For space exploration, private contractors have stepped in with commercially competitive infrastructure, such as launch vehicles capable of flying passengers and cargo to the International Space Station. Free-market competition results in greater efficiency and lower costs than projects managed solely by government agencies.

There is also a focus in some sectors on a different funding stream, i.e., an emerging market in space tourism projected to be valued at \$3 billion in private funding by 2030. The realm of suborbital tourism by companies like Blue Origin or Virgin Galactic offers passengers a 60-mi.-high view of Earth and a few minutes floating in microgravity for an estimated cost per person of about \$250,000. Alternatively, orbital tourism by companies like SpaceX promise to go higher and stay longer, spending days in orbit or ferrying tourists to the International Space Station for an estimated cost of about \$50 million per person. This is obviously a very small customer pool, with questionable long-term profitability.

Deep-sea tourism, on the other hand, could be a far more robust market while expanding much-needed ocean exploration. Recent advances in submersible technology have revolutionized tools for exploration with larger, deeper diving, more inexpensive platforms. For only \$2 million to \$5 million, the owners of \$100 million superyachts see a three-person bubble sub that can dive nearly three-quarters of a mile (3,280 ft.) deep as a worthwhile luxury investment that promises high adventure. And larger, deeper diving versions are now being developed for use by luxury cruise ships.

The opportunity to observe the breathtaking fireworks display that

is deep-sea bioluminescence, to possibly see a giant squid or discover some animal never seen before, represents a powerful draw that could lead to greatly expanded access to the deep sea without the requirement of massive government funding.

However, without scientific guidance and oversight, most of these valuable observations will go undocumented. NOAA could take advantage of this trend by investing in an expanded version of an existing program: sending NOAA-trained data managers to sea with NOAA-funded expeditions to facilitate “end-to-end” (E2E) data management. Specifically, E2E incorporates cruise planning, data management tools, ISO metadata record keeping and data management metrics, all of which are then curated by the NOAA Central Library and provided to scientists, resource managers and the public through online open access. The key feature of this “private sector” E2E approach would involve offering to fund the inclusion of a NOAA rep, with a science background and data management training, to ensure that the video and image data collected during an expedition are properly curated and uploaded to the NOAA Central Library.

Trained naturalist guides are a major asset to any expedition. By offering them to help plan and execute expeditions and provide on-board educational commentary in return for access to dive data, the observations and recordings made during privately funded deep-sea dives could be retained and contribute significantly to the overall scientific database.

Additionally, this approach would make a valuable contribution to conservation efforts by providing transformative natural-world experiences that will foster more informed appreciation and decision making for ocean discovery. **ST**

february advertiser index

Blueprint Subsea	33
www.blueprintsubsea.com	
*EvoLogics GmbH.....	11
www.evologics.de	
General Oceanics, Inc.	29
www.generaloceanics.com	
*Instruments, Inc.	31
www.instrumentsinc.com	
RBR Ltd.....	2
www.rbr-global.com	
*RJE International, Inc.	13
www.rjeint.com	
Saab Seaeye Limited.....	22
www.seaeye.com	
SubConn	41
www.macartney.com	
SubCtech GmbH.....	27
www.subCtech.com	
*Subsalve USA Division	13
www.subsalve.com	
R.M. Young Company.....	27
www.youngusa.com	

*For more information, consult the digital 2020 *Sea Technology Buyers Guide/Directory*:
<https://lsc-pagepro.mydigitalpublication.com/publication/?i=649355>

SEA TECHNOLOGY

Available free of charge to qualified individuals (those involved in the marine industry) – in digital format.



www.sea-technology.com/subscribe-free

Also available, at no charge: our bi-weekly e-newsletter, *Sea Tech e-News*. Sign up here:

<https://sea-technology.com/enews>

If you prefer a more personal touch, please contact us at +703 524 3136 or seatechads@sea-technology.com.

MISSION STATEMENT

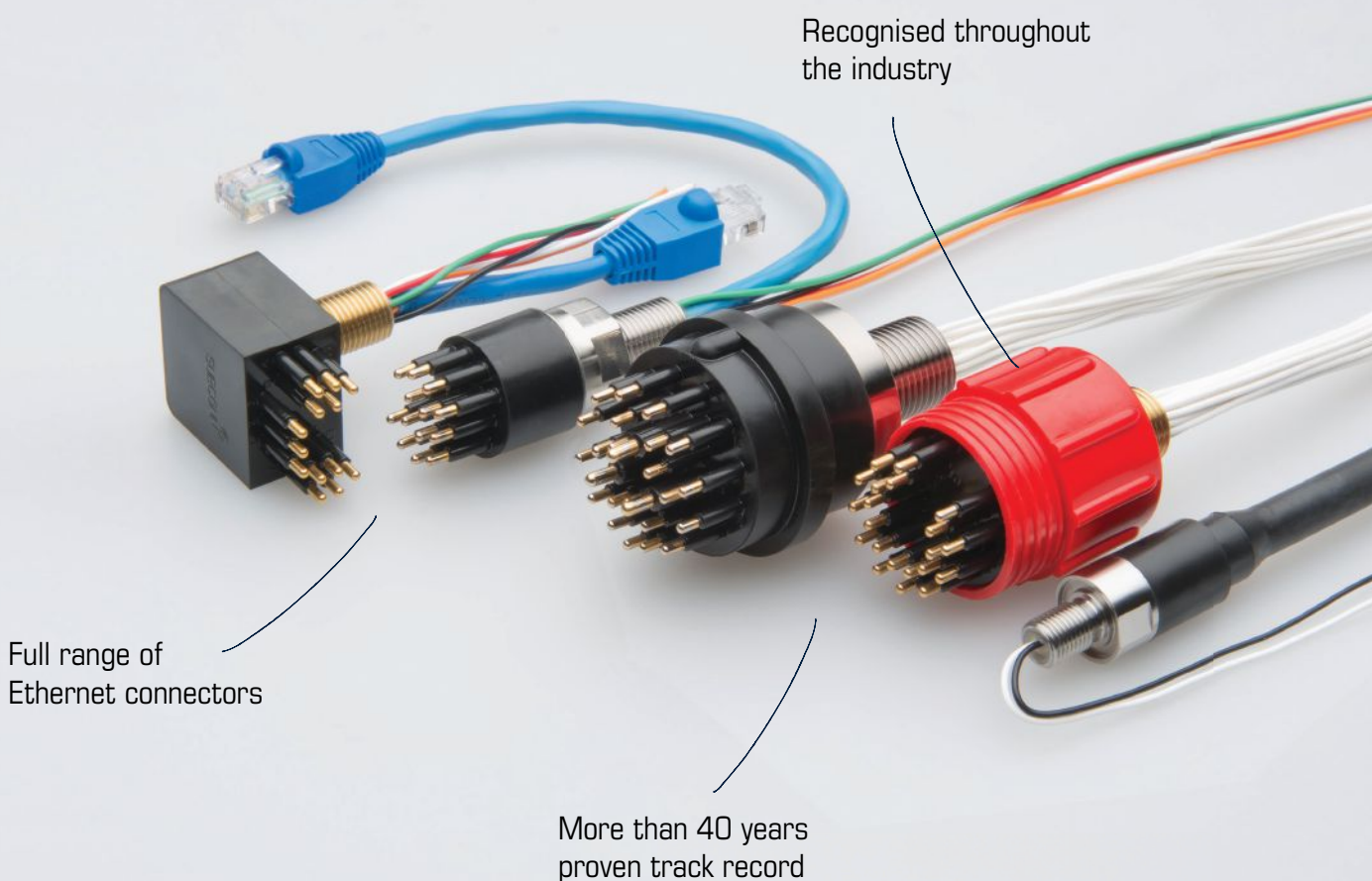
Sea Technology is the worldwide information leader for marine business, science & engineering. Our goal is to provide our global audience with current information on the various segments of the worldwide marine/ocean industry through state-of-the-art and application articles, news columns, and staff reports; and to provide our advertisers with a cost-effective, valuable, and useful vehicle by which to promote their products and services.

For permission to photocopy portions of *Sea Technology*, please contact the Copyright Clearance Center • 222 Rosewood Dr. • Danvers, MA 01923 • Phone (978) 750-8400 • FAX (978) 750-4470

Sea Technology news magazine, including Underwater Engineering, UnderSea Technology, Oceanology International Offshore Technology, and its website, is edited for executives, scientists, engineering and technical personnel in industry, government, and education engaged in the field of undersea defense, oceanography, anti-submarine warfare, marine sciences, underwater exploration, diving and construction, drilling, and mining. While effort is made to verify material published, opinions of authors are not necessarily those of the publisher, and the publication accepts no responsibility in connection with any liability that might occur as a result of published material.



Wet-mate connectors



Available worldwide

Denmark | Norway | Sweden | Finland | United Kingdom
Netherlands | Germany | Poland | France | Spain | Portugal
Italy | UAE | Israel | Turkey | South Africa | USA | Canada | Mexico
Colombia | Chile | Brazil | Singapore | China | India | Pakistan
Russia | Belarus | South Korea | Japan | Taiwan | Australia

