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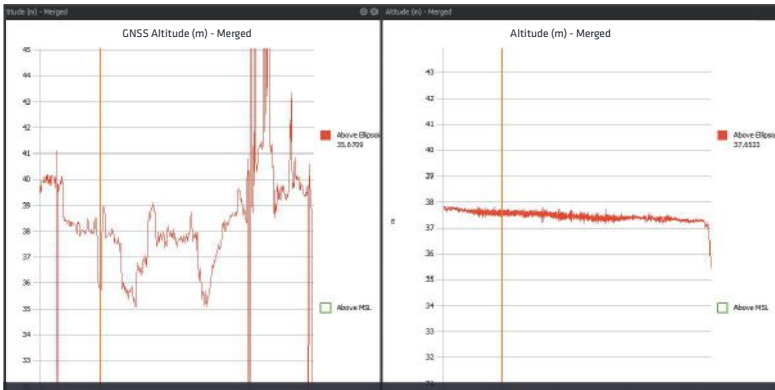

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****U.S. HYDRO 2019,** March 18-21, Biloxi, MS
****Ocean Business,** April 9-11, Southampton, U.K.

MARCH
Electronic Charting/Vessel Management/Ports & Harbors/Dredging/Homeland Security
****AUVSI XPONENTIAL 2019,** April 29-May 2, Chicago, IL

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Offshore Technology/Alternative Energy & Ocean Engineering
****Offshore Technology Conference,** May 6-9, Houston, TX
****UDT 2019,** May 13-15, Stockholm, Sweden

MAY
Communications, Telemetry, Data Processing
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****Oceans '19 MTS/IEEE Marseille,** June 17-20, Marseille, France
****CLEAN PACIFIC 2019,** June 18-20, Vancouver, Canada

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Seafloor Mapping/Sonar Systems/Vessels

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Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST
Geophysical Exploration/Seafloor Engineering
****SEG 2019,** September 15-20, San Antonio, TX
****OceanObs'19,** September 16-20, Honolulu, HI

SEPTEMBER
Ocean Resources Development & Coastal Zone Management
****Offshore Energy 2019,** October 7-9, Amsterdam, The Netherlands
****CLEAN GULF 2019,** October 28-30, New Orleans, LA
****OCEANS 2019 Seattle,** October 28-31, Seattle, WA

OCTOBER
Environmental Monitoring, Remote Sensing & Pollution Control
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NOVEMBER
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Diving, Underwater Vehicles & Imaging
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COVER IMAGE
The team from École de Technologie Supérieure checks their sub, Omer 11, for seaworthiness before submerging for their race at the International Submarine Races in June. See story in this issue. (Credit: U.S. Navy)

NEXT MONTH
In-situ observation system for gelatinous zooplankton … High-precision temperature readings for deep-sea sampling equipment … Coastal monitoring system … Remote observation of phytoplankton bloom in Black Sea … Conference preview: International Water Conference.

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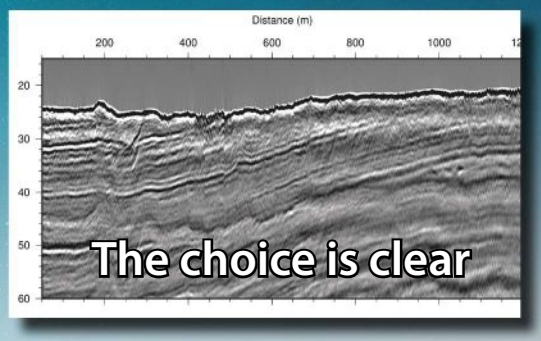

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editorial

Dr. David B. Diamond, *Deputy Associate Director, USGS*

Comprehensive Approach to Marine Minerals Research

High-technology applications—from computers to electric vehicles to fighter jets—rely on an expanding variety of minerals. Moreover, the U.S. relies on other countries completely for more than 20 minerals vital to our economy and security. A December 2017 Executive Order called on federal agencies to develop a strategy to reduce the nation's susceptibility to critical mineral supply disruptions. In May of 2018, the Department of the Interior took the first step in the strategy, releasing a list of 35 minerals deemed critical to the U.S. economy and security, based on a methodology by the National Science and Technology Council and using U.S. Geological Survey (USGS) and Energy Information Administration data. This list in turn was incorporated into "A Federal Strategy to Ensure a Reliable Supply of Critical Minerals," released in June 2019. An important part of that strategy is identifying new critical mineral resources, and many of the critical minerals on the list are present in concentrations of interest in marine mineral deposits.

The USGS has studied seafloor resources in the U.S. Exclusive Economic Zone (EEZ) and globally since the 1970s to understand both how and where mineral-rich deposits form in the ocean and the potential environmental impacts of seafloor mining. Seafloor ferromanganese crusts adsorb metals and other elements from seawater and are especially enriched in manganese, cobalt, nickel, copper, rare earth elements, rare metals such as tellurium, and precious metals such as platinum. In 2017, USGS scientists published a landmark study on seafloor crusts in the Arctic, finding that these formations are particularly enriched with the critical mineral scandium. Polymetallic manganese nodules sit atop sediment covering the vast abyssal plains of the global ocean and are attractive for mining in that they can be mined directly from the ocean floor and are composed almost entirely of valuable minerals, including nickel, copper, cobalt, manganese and lithium. Seafloor massive sulfides form at hydrothermal vents where hot water from beneath the ocean floor mixes with cold seawater, forming copper-, zinc-, gold- and silver-rich sulfide mineral deposits. Marine phosphorites occur along continental margins where upwelling of cold nutrient-rich deep waters is strong, including the Blake-Bahamas Plateau off the southeast U.S. They are sources of phosphate, phosphoric acid and heavy rare earth elements.

These marine mineral deposit types occur in complex and sensitive seafloor ecosystems that must be considered in any mining operation. Environmental impacts for different types of extractions might include sediment, oxide or sulfide mineral plumes; removal of substrate and abyssal fauna; and local metal release or acidification. USGS collaborates with academia, industry and scientists from other government agencies to consider how impactful these issues may be and, if necessary, how to address them. For example, USGS, the Bureau of Ocean Energy Management and NOAA have discussed partnering on a potential study using an ROV to explore the Escanaba Trough, off Northern California, one of the few known massive sulfide systems in the US EEZ. In addition to determining the extent and mineral content of the deposit, the proposed study would also help characterize the local ecosystem, including microbes and megafauna inhabiting the trough, as well as interactions among life, the metal sulfide minerals, and the hydrothermal and oceanic environments.

The potential findings of this, and similar studies, can help the federal government understand its ocean-minerals wealth; help industry determine which regions and deposits might be worth exploring; and help stakeholders understand the effects of mining on the marine environment. By applying USGS technical expertise and resources through cooperative planning and execution with other federal agency and academic partners, we ensure that our research responds to the application needs of our partners and maximizes the value resulting from complex and expensive marine field programs. **ST**

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)) International Assessment of Ocean Energy Jobs. For decision makers, the assessment of the number of jobs related to the development of the ocean energy sector is of utmost importance. Various roadmaps have advanced figures for the 2025, 2030 and even 2050 horizons, but these roadmaps have become outdated as numerous ocean energy technologies have been designed, tested and implemented in pilot farms. A new project will update the assessment of the total number of existing jobs directly related to the sector and validate an approach to assess jobs creation to update projections for the 2030/2050 horizons. This project, commissioned by Ocean Energy Systems (OES), will run for one year and will be conducted by a consortium comprising LOC Renewables (including Innosea), France Energies Marines and the Fraser of Allander Institute from the University of Strathclyde. The consortium will engage with all OES country members and representatives from the Joint Research Centre of the European Commission and the U.S. National Renewable Energy Laboratory. The study is intended to help motivate governments, corporations and agencies to further support the ocean energy sector.

)) Ambitious Targets to Cut UK Shipping Emissions. All new ships for U.K. waters ordered from 2025 should be designed with zero-emission-capable technologies as part of ambitious plans set out by the U.K. government to cut pollution from the country's maritime sector. The commitment is set out in the Clean Maritime Plan. The government is also looking at ways to incentivize the transition to zero-emission shipping and will consult on this next year. The plan includes a £1 million competition to find innovative ways to reduce maritime emissions and is published alongside a call for evidence to reduce emissions on U.K. waterways and domestic vessels. The Clean Maritime Plan is part of the government's Clean Air Strategy, which aims to cut down air pollution across all sectors. It will help deliver the U.K.'s commitment to be net zero on greenhouse gases by 2050. The Clean Maritime Plan is part of the government's Maritime 2050 long-term strategy to keep the U.K. a world leader in the maritime sector.

)) Winning Bid Chosen for New York Offshore Wind. Equinor's Empire Wind has won New York state's first large-scale competitive offshore wind solicitation. The 816-MW offshore wind project will bring renewable energy to New York consumers, contribute to the state's ambitious renewable energy development goals, and provide significant economic benefits to New York. New York has a goal of 9,000 MW of offshore wind by 2035. The project is expected to be developed with 60 to 80 wind turbines, with an installed capacity of more than 10 MW each. The project will be able to power more than 500,000 homes in New York, with an expected start up in late 2024. It should create approximately 800 local jobs during construction and operation, including through the creation of locally manufactured turbine foundations in New York's Capital Region. More broadly, Equinor is committed to developing the nation's first offshore wind supply chain to support the construction, installation and operation of offshore wind projects.

)) Career Support for Young Professionals. The National Marine Electronics Association (NMEA) has started a Young Professionals Group (YPG) to bring together industry personnel under the age of 40 from diverse backgrounds in marine electronics. The new group's goal is to attract, retain and promote diversity in the next generation of NMEA leaders and help ensure their success. NMEA membership is not required to be part of the YPG. The YPG will offer both online and offline environments to facilitate networking. Industry veterans will serve as mentors.

)) NOAA Reports Sustainable Fish Stocks. NOAA has released the Status of U.S. Fisheries Annual Report to Congress, which details the status of 479 federally managed stocks or stock complexes in the U.S. to identify which stocks are subject to overfishing, are overfished or are rebuilt to sustainable levels. Building upon the trend of the past few years, the report notes that the vast majority of U.S. fish stocks were at sustainable population levels in 2018, and the number of U.S. fish stocks subject to overfishing remains at a near-all-time low. The total number of rebuilt U.S. marine fish stocks amounts to 45 since the year 2000.

)) 3D Modeling of US WWII Sub's Wreckage. Aberdeen-based Viewport3 has been collaborating with international explorer Tim Taylor to process pioneering underwater 3D scans on the bow and stern of a U.S. submarine lost in 1942. Viewport3 was contracted by Taylor, CEO of New-York based Tiburon Subsea Services and founder of Ocean Outreach Inc., as part of his ongoing Lost 52 Project responsible for discovery and mapping of four out of eight of the U.S. WWII submarines located to date. The Lost 52 Project thoroughly mapped and filmed the site of the USS *Grunion* at the end of last year. The team located the missing bow section a quarter of a mile away, 300 ft. above the main wreckage, off the island of Kiska, Alaska. The discovery completes the mission undertaken by the sons of the submarine's captain, Mannert L. Abele, 12 years ago. Viewport3 fused 3D data with side scan sonar to show the relative locations of both parts of the wreck and the slide made by the stern as it slid down the side of an underwater mountain. Viewport3 has been working with Taylor to process and develop technical-grade 3D data sets of the USS *Grunion*'s bow for use in virtual- and augmented-reality outreach, educational programs and applications. **ST**

International Submarine Races

By Charles D. Behrle

Twenty-one human powered submarines and more than 400 team members gathered on June 23, 2019 for the 15th International Submarine Races (ISR 15). It was the beginning of a great race week at the David Taylor Model Basin at Naval Surface Warfare Center, Carderock Division, in West Bethesda, Maryland. As the teams staked out their operations base for race week at the east end of the basin, you could feel the excitement grow as the participants walked among the boats and silently measured what the competition would bring this year.

Some participants arrived with the goal of setting new speed records; others arrived with a more modest goal of completing a successful run down the 100-m course. Still others arrived to develop and renew friendships and sustain a comradery among like minds. At the conclusion of the races, all would be part of a growing group who count themselves as ISR veterans.

(Credit: U.S. Navy, Edwin Hernandez)

The University of Washington team makes boat modifications in hopes of improving performance on their boat, the Underdawg.

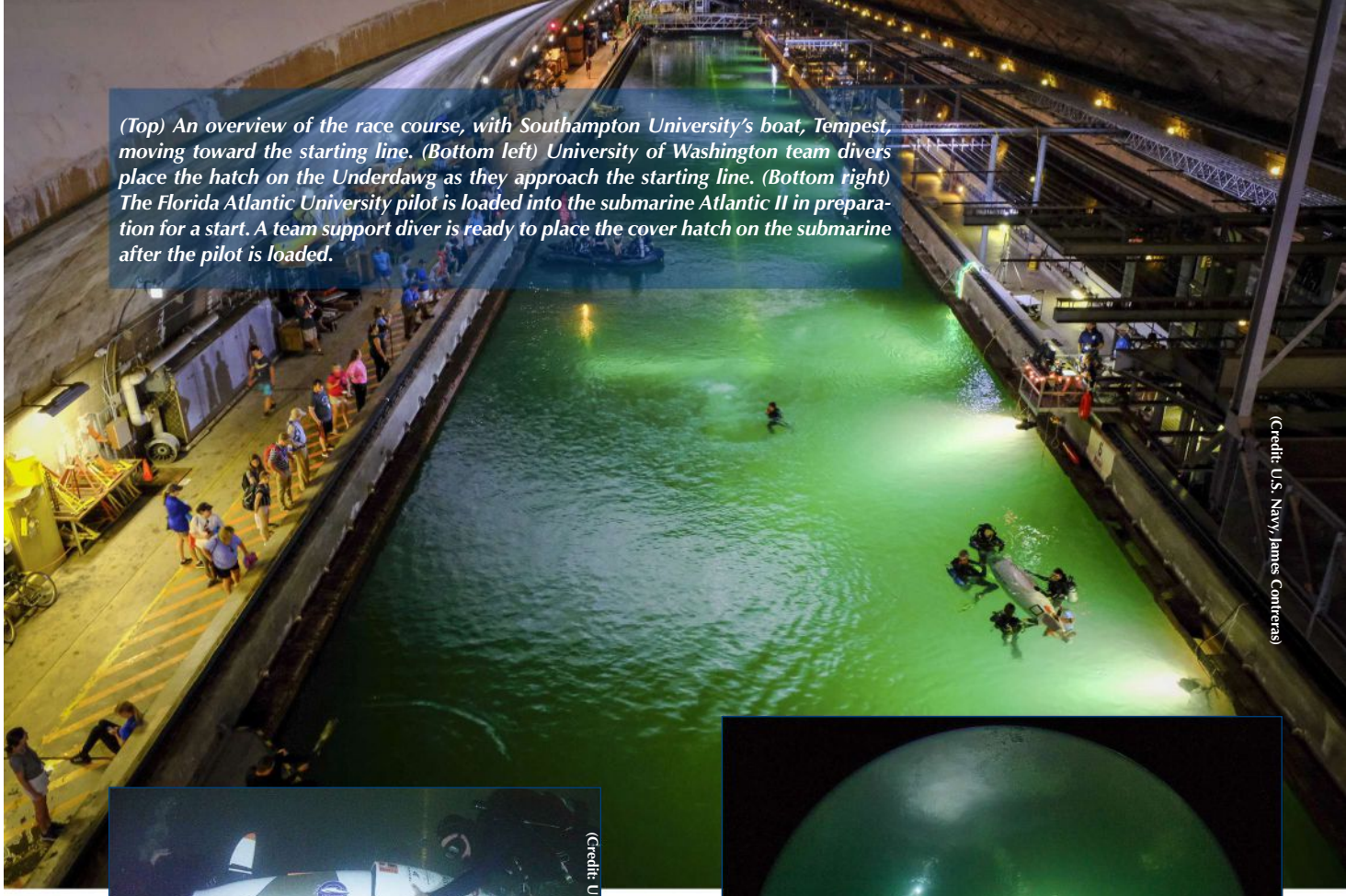
Sponsored by the Foundation for Underwater Research and Education (FURE), the goal of ISR is to provide students a premier capstone science, technical, engineering and math (STEM) event that combines the student's learning in the classroom, lessons from laboratory experiments and small-scale testing results to design, build, test and operate a submerged human-powered submarine that must traverse a 100-m course.

Race week quickly reveals that real life happens: things break, the design doesn't deliver what it was supposed to, or the technology they were depending on overpromised and underdelivered. These circumstances provide an opportunity for team members to think in the "now," seeking solutions that will not be found in a textbook. They seek out other racers to discuss their challenges, and the solution to the problem becomes a learning experience for all, regardless of team boundaries. Racers help racers—whether it be with knowledge, experience or parts. Everyone is more than willing to share successes and failures. As race week progresses, teams band together to ensure all participants get the opportunity to succeed by getting their boat in the water.

History

This year's event marked 30 years of racing human-powered submarines. It was a milestone not lost upon participants and support volunteers. Many wondered if the original race enthusiasts from Florida Atlantic University's Department of Ocean Engineering and the H.A. Perry Foundation ever thought their dream and creation would survive 30 years. Not only has it survived—it has thrived.

ISR history reveals that there are three important factors for a successful race experience and, more importantly, a successful life experience at the race. The first factor is the students themselves, who join a team for a variety of reasons but rarely know what they are getting themselves into. Teamwork, excellence, exploring the unknown and thinking "outside the box" are all hall-



(Credit: U.S. Navy, James Contreras)

(Top) An overview of the race course, with Southampton University's boat, Tempest, moving toward the starting line. (Bottom left) University of Washington team divers place the hatch on the Underdawg as they approach the starting line. (Bottom right) The Florida Atlantic University pilot is loaded into the submarine Atlantic II in preparation for a start. A team support diver is ready to place the cover hatch on the submarine after the pilot is loaded.

(Credit: U.S. Navy, Kevin A. Meier)

(Credit: U.S. Navy, Kevin A. Meier)

marks of successful team members. Verena Oettzmann, a previous team lead from the University of Warwick, summed up her ISR experience in this way: "In addition to all the challenges that we women in engineering face, being the female leader of an otherwise all-male team was a demanding but very rewarding role. The lessons I have learnt throughout my time, coupled with the many skills procured along the way, have been invaluable as preparation for working life after university. Despite being the most difficult venture that I have undertaken at university, it is certainly among the most enjoyable, rewarding and memorable experiences I have ever had."

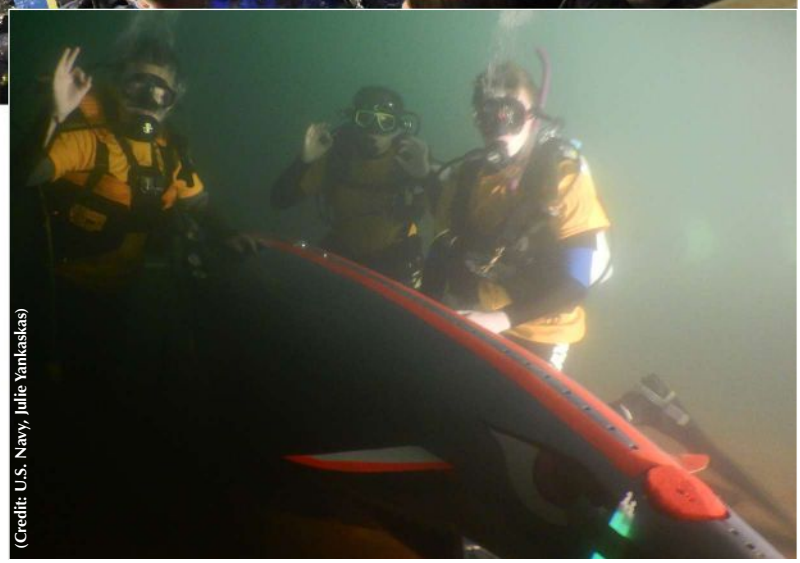
The second factor of a successful race experience is that strong support groups offer assistance when necessary. These support groups may consist of educators, parents, industry members, team advisors or fellow students. Paola Carts, a team adviser with the Kids Into Discovering Science (KIDS) team, explained why she continues to support ISR participation: "ISR offers a unique opportunity for our youth to be creative, solve problems, learn about manufacturing methods and materials, work over an extended time line, push the envelope of what they can do, all while having fun and building friendships. The skills they develop through designing, building and racing a human-powered submarine will last them a lifetime. I am inspired to participate in ISR over and over again because of the joy of discovery that our youth experience so often during their involvement in the program. As a retired design engineer, I know, too, that the hands-on experience they get through the program will be an invaluable asset to them should they pursue careers in science or engineering."

Another example of strong support comes from Dr. Ian Tursely of the University of Warwick. Tursely has served as the Godiva Team Academic Project Director since 2013. He is a strong advocate of the races and has made several presentations, including presentations to the United Kingdom's Higher Education Academy, regarding the value of the ISR experience.

"It is clear that our students who are fortunate enough to be involved in the ISR competition enjoy the experience immensely and value the additional benefits that this unique opportunity provides them," he said. "How-

(Top) Submarines line up in the basin as they prepare to race and await further direction from the race starter. (Bottom) The team from Frederick County Career and Technology Center gives the "okay" signal, indicating that their pilot is loaded and their boat CLS Mako is ready to race.

(Credit: U.S. Navy, James Contreras)



(Credit: U.S. Navy, Julie Yankaskas)

ever, from the point of view of an educator, in addition to the excellent experience, there is tangible empirical evidence that the necessary enforcement of real-world deadlines and constraints focuses their work and personal development on areas that more traditional college learning is not easily able to deliver. Yet these are exactly the skills and behaviors that are most highly valued by potential employers."

The third factor for race success is FURE volunteers who provide structure and manage race operations. While safety is always the top concern, this group of volunteers is a very experienced group, with many of them having more than 10 races of experience. When asked why he continues to support these races after 26 years, Jim Corry, race starter, responded that he attended his first ISR "in 1993 out of curiosity. I came to realize the significant impact this event and its preparation have on the futures of the contestants. I cannot fathom not supporting such an influential event that has been a pivotal and life-changing experience for so many young individuals' futures."

ISR 15 Teams

These three factors—outstanding participants, strong support groups and an organized and ready group of FURE volunteers—combined for a successful race week at ISR 15. A strong field of participants represented 20 teams with 21 boats from around the world and across the academic spectrum. Canada, Netherlands, the United Kingdom and the United States were represented by teams from 15 universities, four high schools and one independent group.

Participating universities included: the Polytechnique Montréal from Montreal, Canada, with Archemede VIII; Florida Atlantic University with Atlantic II; University of Michigan with Bluefin; University of Victoria from British Columbia, Canada, with Chinook II; University of Waterloo from Ontario, Canada, with Claire; Gulf Coast State College from Panama City, Florida, with Commodore; University of Warwick from Coventry, U.K., with Godiva III Mod I; École de Technologie Supérieure from Montreal, Canada, with Omer 11; Virginia Polytechnic Institute and State University with Phantom 8 and Trident; University of California San Diego with Santiana; University of British Columbia from Vancouver, Canada, with Skookumchuck MK V; University of Southampton from Hampshire, U.K., with Tempest; Texas A&M University with the 12th Manatee; University of Washington with

the Underdawg; and Delft University of Technology from Delft, Netherlands, with Wasub IX.

High-school teams included Frederick County Career and Technology Center from Frederick, Maryland, with CLS Mako; Dover Area High School of Dover, Pennsylvania, with Cormorant; Son of Trigonus, sponsored by the Gulf Coast State College; and Sussex County Technical School from Sparta, New Jersey, with Umptysquatch 9.

One independent team also participated: Kids Into Discovering Science (KIDS) from Accokeek, Maryland, with Maryland Mako.

The race was again hosted by Naval Surface Warfare Center, Carderock Division, the U.S. Office of Naval Research, and Program Executive Officer (PEO), Submarines. The race and teams enjoyed visits from senior Navy officials, including RAdm. Lorin Selby, Deputy Commander for Ship Design, Integration and Engineering; RAdm. Eric Ver Hage, Commander, NAVSEA Warfare Centers; and Michael McClatchy, a member of the Senior Executive Service and the Executive Director of Undersea Integration, PEO Submarines. Also visiting the race was Lieutenant Governor of Maryland Boyd Rutherford, who spoke with many students about their accomplishments and future plans.

Industry and professional organizations provided significant financial support to the races. Platinum-level sponsors included Booz Allen Hamilton and Poseidon International. Silver-level sponsors included American Systems, Gryphon Technologies and the Naval Submarine League. Bronze-level sponsors included AECOM, Behrle & Associates, BMT Designers & Planners Inc., DeepSea Power & Light, ELS Inc., Noise Control Engineering, NTIVA, Patrona Corp. and Thor Solutions LLC.

Awards

The very competitive week concluded with an awards ceremony on Friday afternoon. The guest speaker was RAdm. Michael Jabaley (U.S. Navy, retired), who was a former Program Executive Officer of Submarines and responsible for the United States Navy's submarine new construction portfolio. Jabaley's message to the participants was clear: Future technological leaps need to include a breakthrough in nonpropeller propulsion—a challenge he presented to the participants. Jabaley was delighted with the participants' positive "can-do" attitude and is convinced that these young men and women are our future designers and operators.

The award for Overall Performance, including a trophy and $1,000 sponsored by Booz Allen Hamilton, was determined by quantifying 17 weighted parameters to determine the figure of merit (FOM) for each boat. The FOM analysis includes aspects of other awards and the team's attitude, persistence and resourcefulness. The winning team was Team Omer from École de Technologie Supérieure for its one-person, propeller- and nonpropeller-driven submarine, Omer 11.

The Overall Performance Runner-up team was recognized with a plaque and a $500 award, which went to

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"Future technological leaps need to include a breakthrough in nonpropeller propulsion..."

the Wasub team from the Delft University of Technology with its one-person, propeller submarine Wasub IX.

The Innovation Award was won by École de Technologie Supérieure with Omer 11, which has three modes of propulsion: a mirage drive, conventional two-bladed propeller and a mono-blade propeller. In addition, the mirage drive has springs that ensured even power impulses provided by the fins. The propeller-mode functionality also allowed for adjustable propeller pitch control during operation.

For ISR 15, the Woods Hole Oceanographic Institution Center for Marine Robotics provided an award of free attendance to two team members of the Innovation Award winning team to attend the sixth annual Entrepreneurs Showcase and Leadership Forum in July 2020 in Woods Hole, Massachusetts. The Center for Marine Robotics was created to speed development of marine robotic technologies. The goal of the center is to collaborate with industry, academia and government agencies to change the way people and machines work together in the marine environment.

The judges also recognized two additional boats for innovation. First honorable mention went to Umptysquatch 9 from Sussex County Technical School. This high-school team designed and installed an integrated ballast and trim system, with integral structural tanks, pumps and vents that maintained neutral buoyancy and trim during runs down the tank. Second honorable mention for innovation went to Trident from Virginia Tech. This team completely changed management systems, resulting in a more efficient and effective design approach and, ultimately, improved race performance. The Virginia Tech team's testing plans included a bollard-pull test, an ISR first.

ISR 15 was the first time the Best Use of Technology Award was presented, sponsored by American Systems. It includes a plaque and $1,000 for the team in any design category that exhibits the best and most successful use of technology to support their vessel's design, construction and/or performance. The winner was Chinook II from the University of Victoria for use of existing technology to implement an autonomous depth-control system, as well as use of a four-piece modular hull design that facilitated shipping the submarine to the race. Chinook II also used tubercles on the fin leading edges to delay flow separation and reduce the associated wing drag.

The Absolute Speed winner was Omer 11, a one-person, propeller-driven submarine from École de Technologie Supérieure, with a speed of 6.85 kt.

The Best Design Outline Report Award was won by Delft University of Technology's Wasub IX.

The Smooth Operator Award is awarded to a team in recognition of their efficiency in staging for the race course, racing the course, troubleshooting as necessary and otherwise preparing for their next run. The winner was Godiva III Mod I from the University of Warwick.

The Spirit of the Race Award, in memory of the late ISR contestant Steve Barton of team Sublime, is selected by the contestants themselves and recognizes the team that displays the best gusto, fortitude, support for other teams and overall best spirit. This year, vote by the teams resulted in a tie, with École de Technologie Supérieure Omer 11 and KIDS Maryland Makos teams both receiving the award.

The fastest speed awards are awarded for a combination of: one- or two-person boats; propeller or nonpropeller boats; and independent, high-school and college-level teams. The winner of the one-person, propeller, college category was Omer 11/École de Technologie Supérieure, with a speed of 6.85 kt. The winner of the one-person, propeller, high-school category was CLS Mako/Frederick County Career & Technology Center, with a speed of 3.29 kt. The one-person, propeller, independent-team winner was Maryland Mako/KIDS, with a speed of 2.34 kt. The winner of the one-person, nonpropeller, college category was Omer 11/École de Technologie Supérieure, with a speed of 4.78 kt.

Conclusion

A very successful week was had by all. The contestants departed satisfied and tired and, most importantly, with a feeling of success, new knowledge and experiences, new friends, positive memories and a new challenge. Many were already discussing ISR 16.

Additional race results and photos from ISR 15 can be found at internationalsubmarineraces.org.

The 16th ISR is scheduled for June 20 to 25, 2021 at the David Taylor Model Basin. **ST**

Charles D. Behrle is the president and chairman of the Foundation for Underwater Research and Education (FURE).

Crowd-Sourced Bathymetry

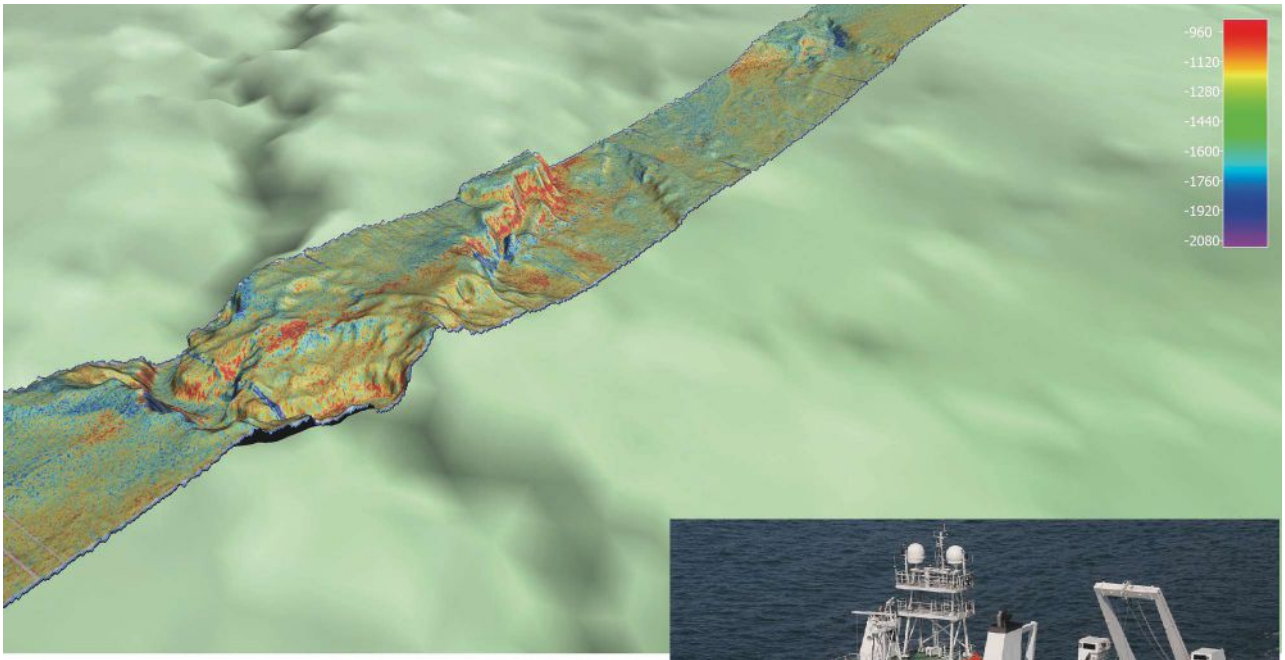
Fugro Supports Global Seabed Mapping, Ocean Science Initiatives

By David Millar • Dr. Kelley Brumley

This past May, nearly 250 thought leaders, champions and key stakeholders from the international ocean community gathered in Copenhagen, Denmark, to participate in the First Global Planning Meeting of the United Nations Decade of Ocean Science for Sustainable Development. The Decade kicks off in 2021, and the aim is to "support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean."

Attendees in the three-day event were diverse in culture and background. They included representatives from ocean science and technology; ocean policy and sustainable development; business and industry; non-governmental organizations and civil society; as well as donors and foundations. With a shared belief that sci-

A look into the First Global Planning Meeting for the United Nations Decade of Ocean Science for Sustainable Development. (Above) Fugro's David Millar participating in the Working Group Session on "A Healthy and Resilient Ocean" at the meeting.



(Above) Transit multibeam data collected by Fugro in support of Seabed 2030 with backscatter and bathymetry data overlaying the existing low-resolution bathymetry. (Right) The **Fugro Brasilis***, one of the vessels participating in Fugro's crowd-sourced bathymetry program, is a highly advanced DP1 survey vessel, suited to perform geophysical surveys.*

ence-based solutions are required to ensure the health of the world's oceans, their work at the meeting focused on defining objectives, prioritizing scientific questions, understanding complementary initiatives and increasing program outreach.

Fugro was among the participants in a panel about innovative funding and partnerships. The company partners with The Nippon Foundation-GEBCO Seabed 2030 project, an initiative that complements the UN Decadal goals for the ocean.

Seabed 2030

Seabed 2030 is a collaborative project between The Nippon Foundation and the General Bathymetric Chart of the Oceans (GEBCO) to inspire the complete mapping of the world's ocean by 2030 and to compile all bathymetric data into the freely available GEBCO Ocean Map. A wholly mapped ocean will inform global policy, improve sustainable use and advance scientific research.

Currently, less than 15 percent of the world's oceans are mapped to modern survey standards. Knowing the depth and shape of the seafloor is fundamental to applications such as safe navigation, disaster management, weather prediction, habitat studies and resource development, among many others.

With 85 percent of the ocean left unmapped, a significant gap remains in our understanding of the ocean and its processes, forcing decisions to be made based on assumptions rather than science. The results can prove dire. The United Nations First Global Integrated Marine Assessment reports that much of the ocean is seriously degraded, and stressors are projected to increase as the human population continues to grow.

The effort toward an improved global bathymetric database began three years ago at the Forum for Future Ocean Floor Mapping in Monaco that was jointly organized by The Nippon Foundation and GEBCO. There, approximately 150 senior representatives, scientists and scholars from major ocean-related and international organizations endorsed the objectives of Seabed 2030.

It's an ambitious project that will require cross-sector collaboration worldwide. The hope is that existing high-resolution bathymetric data, which have been collected and archived by industry as well as academia, will be donated to the project. The unsurveyed portion of the seafloor will be mapped in part by utilizing crowd-sourced bathymetric data.

The International Hydrographic Office defines crowd-sourced bathymetry as: "the collection of depth measurements from vessels, using standard navigation instruments, while engaged in routine maritime operations." Every vessel with a sonar could potentially contribute data to help reach the goal of mapping the entire seafloor by the year 2030.

In addition to working with clients to investigate potential data-sharing opportunities, Fugro has initiated its own large-scale crowd-sourced bathymetry campaign.

Fugro's Contribution

Fugro's crowd-sourced bathymetry solution provides highly automated collection of high-resolution multibeam echosounder data during vessel transits. The program began in 2016 from one vessel in the Americas region, with a goal of developing the systems and processes needed to support remote command and control of data acquisition, as well as remote data upload and transfer. Once workflows were established, the program was expanded to other survey vessels.

A key component of Fugro's process is its Office Assisted Remote Services (OARS), a proprietary technology that enables safe and efficient data acquisition without the need for dedicated survey staff on board the survey vessel. OARS is supported by three command centers strategically located around the globe, operating 24/7, 365 days a year. The technology makes it possible for valuable data to be collected from transiting vessels with minimal effect on Fugro's standard operating procedures.

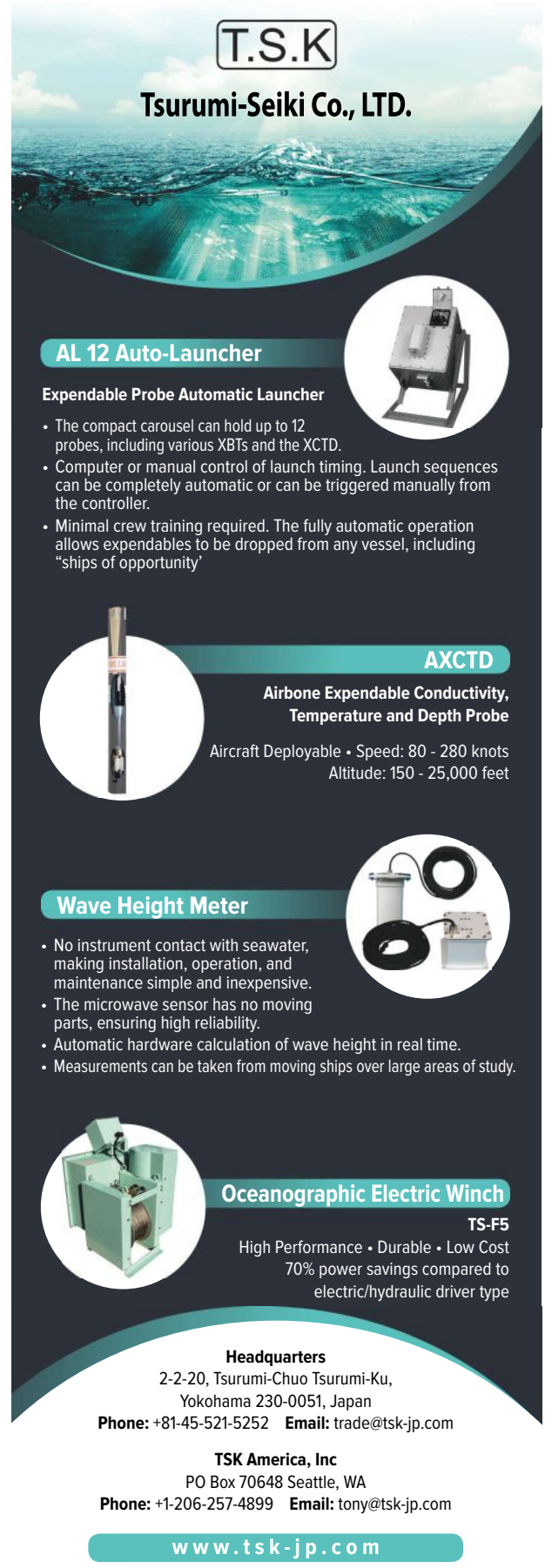
Over the past two years, Fugro has grown its crowd-sourced bathymetry program to include seven multibeam-equipped vessels, contributing approximately 500,000 sq. km of high-resolution bathymetry to Seabed 2030. The company ultimately plans to expand its in-transit collection capability across its entire global survey fleet for even greater impact to the project.

Additional Benefits, Opportunities

While the impetus for Fugro's Seabed 2030 contributions was to help build a publicly available global database, the work has also benefited regionally focused programs. One such project is the Atlantic Ocean Research Alliance (AORA). AORA was formed under the 2013 Galway Statement on Atlantic Ocean Cooperation between the European Union, the United States of America and Canada. With a goal of improving knowledge about the Atlantic Ocean to support a prosperous and sustainable blue economy, AORA has identified seabed mapping as a priority area of collaboration. Over the past two-and-a-half years, Fugro's bathymetric data contributions to Seabed 2030 in this region have totaled approximately 278,000 sq. km. These data, which were provided to AORA's Atlantic Seabed Mapping International Working Group, cover an area about the size of Iceland.

In many cases, the multibeam data contributed by Fugro has included backscatter and water column data along with the bathymetry. Modern multibeam sensors can acquire all three data types simultaneously. Together, they provide significant information for characterizing the seafloor and water column, all of which is of great interest to key priority areas of the UN's Decadal ocean goals and to ocean science in general.

Crowd-sourced bathymetry does not always involve multibeam sonars and multibeam data, however. Single-beam sonars have tremendous utility and potential when the power of the crowd is employed. One can easily imagine what is possible when depth measurements are acquired from cruise ships, commercial shipping vessels, fishing vessels and private yachts as they are engaged in their routine maritime operations.



A Fugro OARS Data Center, which enables safe and efficient data acquisition without the need for dedicated survey staff on board the survey vessel. OARS is used on Fugro projects throughout the world and supports the company's crowd-sourced bathymetry program.

The crowd-sourced approach can also be applied to the collection and contribution of other ocean observation data. Examples include temperature, salinity, currents, and marine mammal and bird observations, to name a few. In the United States, for example, NOAA has implemented a Voluntary Observing Ship (VOS) program for contributing weather information at the volunteer's location. If this program were expanded and/or adapted to include other oceanographic data, crowd-sourced ocean observation could flourish. Similar procedures currently utilized by Fugro to remotely command and control multibeam systems could also be used to help coordinate a global effort of seafloor mapping and ocean observations.

Get Involved

Understanding our oceans is essential to predictions that will help guide our adaptation to inevitable change. Cooperation and collaboration is key, with success dependent upon participation from stakeholders, defined as international organizations, universities, nongovernmental organizations, maritime industries, youth organizations and citizens. These stakeholders can work together to either consolidate existing data, share data that are currently not in the public domain, help map areas where no data exist, or just help get the message out that these data are needed.

The Decade of Ocean Science will rely on an inclusive and participatory stakeholder process to facilitate global communication and shared learning across the stakeholder communities. Gatherings of members from all sectors will be held in 2019 and 2020 to identify priority areas for the Decade, and to define the ocean science needed to achieve sustainable development goals. This series of meetings will also include an official Stakeholder Forum that will continue to collect relevant inputs into the design of the Decade.

It is necessary that local and regional desired outcomes are clearly defined, so that the formulation of scientific products can help guide sustainable-use policies. Incorporating and leveraging existing international programs such as AORA and Seabed 2030 allows for a "bottom-up" collaborative approach to this work.

Over the next year, there will be opportunities for all stakeholders to share, learn and collaborate as an implementation plan for the Decade is developed. Collectively, the community can help ensure that every bit of data collected and every ocean observation shared adds to the greater good. Only by working together will we realize the end-goal of exploring the ocean, sustainably utilizing its bounty and protecting its health for a safe and livable world. **ST**

David Millar is Fugro's government accounts director for the Americas region, based in the Washington, D.C. area. He is a member of the GEBCO Guiding Committee and on the Seabed 2030 Establishment Team. Millar has 30 years of ocean mapping, marine geophysical and hydrographic survey experience and has been with Fugro since 2003.

Dr. Kelley Brumley is Fugro's science manager of ocean mapping for the Americas region, based in the Houston, Texas, office. Brumley is a marine geologist with 13 years of ocean mapping, sample collection and survey experience and has been with Fugro since 2014.

In-Situ Aquaculture Monitoring

Fluorometers Can Help Industry Stay Ahead of Algae, Bacteria Blooms

By Sam Kirby

An algal bloom is believed to have killed thousands of Atlantic salmon at a finfish aquaculture site in Scotland earlier this year. According to a spokesperson for The Scottish Salmon Co., warmer water temperatures are suspected to have been the cause of the bloom in Loch Fyne, the BBC reported (tinyurl.com/y27gbmtq).

This is a story we hear time and time again in the news with regard to salmon farming.

Algal blooms are a phenomenon caused by increases in water temperature and nutrient availability, either through anthropogenic inputs or natural environmental fluctuation. However, it is not always a local event, as blooms are regularly transported by ocean currents and wind.

Most recently, aquaculture operators off the coast of Norway have experienced mass mortalities of salmon due to a prolonged algal bloom. Algal blooms can cause problems for fish producers in a number of ways. The most prominent issue in the news is that of harmful algal blooms: blooms of algal species, such as *Karenia mikimotoi*, that produce toxins that directly affect fish.

It is not only the harmful algae that are a problem. Chain-forming, spiny diatoms, such as *Chaetoceros*, can actually block and damage the gills of fish, reducing their ability to cope with oxygen stress. In certain areas such as Scotland, where Amoebic Gill Disease (AGD) can be a problem, algal blooms can exacerbate the issue. As algae respire through the night, oxygen levels can become

In-situ continuous monitoring is more effective than weekly or monthly monitoring to stay ahead of algae and bacteria blooms in the aquaculture industry.

severely depleted. Coupled with gill damage, either from these chain-forming algae or from the damage caused by the amoebae, this can lead to suffocation.

Algal Monitoring

So, what is being done to minimize the impact of algal blooms in finfish culture?

Normally, depending on the location and regulatory body, water samples are required every one to two weeks to assess levels of toxic algae in the water. Other initiatives are also in place, such as remote sensing using satellite data to give an early warning of the onset of an algal bloom.

Early warning of algal blooms is crucial to farm operators as it allows them to employ management practices to minimize the effect of algal blooms. For example, if a bloom is suspected, operators can increase the aeration in the farm to help avoid suffocation or can cease feeding to allow the fish to "settle" further down in the water column and minimize contact with the algae at the surface.

Although these initiatives are certain to help in the early detection of algal blooms and the identification of toxic species, they still have their limitations. Diurnal variation in algal populations will be poorly understood from weekly sampling, and an algal bloom could easily be missed through this routine. Additionally, satellite measurements rely on clear skies, and measurements can be intermittent.

(Top) Multiparameter algal fluorometers, such as the Chelsea TriLux, are useful for monitoring the levels of different algal groups. (Bottom) The Chelsea UviLux is an in-situ, single-channel UV fluorometer configured to detect and quantify tryptophan.

Continuous, in-situ algal monitoring is crucial to understanding diurnal, seasonal and environmental variability at culture sites and could significantly contribute to the early detection of algal blooms. Coupled with local hydrographic models, sensors can be placed in strategic areas to continuously monitor for any incoming blooms, allowing operators to employ management practices to minimize the risk to their livestock. In addition, long-term, continuous data sets could be used to improve current understanding and models of the biology at these sites and may help to predict future blooms.

Algal monitoring is not only useful for offshore monitoring applications. In coastal waters, algal blooms can cause significant issues. Normally, the growth-limiting factor for algae is nutrients such as nitrogen and phosphorus, rather than sunlight or CO_2. In coastal waters, agricultural runoff containing high levels of these nutrients is known to contribute to the sudden explosion of algae populations. Of course, wind-driven transport of blooms from offshore is also a contributing factor.

These coastal algal blooms can be a hazard to human health. Toxic algae can infect bathing waters and shellfish. Filter-feeding molluscs, such as oysters, can take up these toxins while feeding on the algae. In areas where shellfish are cultured or harvested for human consumption, the toxins can make their way into the human diet. Perhaps the most well known case of this is that of the dinoflagellate *Alexandrium* sp. This algae is responsible for "red tides" and can cause paralytic shellfish poisoning (PSP) in humans.

Multiparameter algal fluorometers, such as the Chelsea TriLux—already in wide use for oceanographic and environmental applications, such as the SITES AquaNet mesocosm project in Sweden—are useful for monitoring the levels of different algal groups. Typical parameters include chlorophyll-a, phycocerythrin, phycocyanin and turbidity. Phycoerythrin and phycocyanin are photosynthetic pigments, like chlorophyll, that are normally found in blue-green algae, or cyanobacteria. There are a number of toxic species of cyanobacteria, and there is interspecies variation in the dominant pigments they contain. Therefore, characterization of typical algal species in a given location (or the risk of the occurrence of certain species of toxic cyanobacteria) is important in identifying which pigment to monitor.

In-situ species identification can be incredibly tricky, but sensors installed on site would be able to detect any rise in algal pigments and could prompt samples to be taken and species identified either by trained personnel or other means of technology. The compact design and low cost of the sensor make it ideal for mass deployments, and low power consumption coupled with a wide choice of data outputs and anti-biofouling options allows for long-term remote deployments.

With the apparent increase in algal bloom incidence and severity, possibly due to rising water temperatures and increased anthropogenic inputs, the need for improved forecasting and mitigation of algal blooms is more relevant than ever. With a rising global population and the increased demand for protein from developing countries, solving these issues will be crucial to ensuring future global food security.

Bacterial Monitoring

Phytoplankton is not the only biological parameter worth measuring in coastal waters. Sewage outfall can

pollute coastal waters and similarly affect water quality in bathing areas and around coastal shellfisheries. Pathogens such as *E. coli* and *Streptococcus* are typically present in wastewater and, should a wastewater treatment facility fail, can affect humans through similar vectors to toxic algae.

In some areas of the U.K., it is mandatory that harvested shellfish go through a "depuration" process, during which they are allowed to cleanse themselves in a highly controlled environment for 48 hr. However, this is not always the case globally, and bacterial contamination can actually be very costly for producers. Further up the supply chain, samples of shellfish can be routinely tested for levels of harmful bacteria. If the levels are found to be above a threshold deemed safe for consumption, the entire batch could be discarded; a safety measure that comes at a high cost.

Again, regular sampling programs of coastal waters are in place in some areas to assess levels of harmful bacteria. However, these sampling programs offer the same limitations as they do for algae—a significant pollution event can be missed by weekly or monthly sampling.

Tryptophan is an amino acid that occurs as a by-product of bacterial respiration and is a useful indicator of bacterial contamination. Long-term monitoring of tryptophan in coastal waters is useful for understanding background levels and temporal variations of the amino acid, as well as detecting significant pollution events. This is useful to both producers and consumers as, in the case of a pollution event, farmers can defer harvesting or take the appropriate purification measures to ensure that their product is not rejected and is safe for human consumption. In-situ fluorometers, such as the Chelsea UviLux single-channel UV fluorometer, are configured to detect and quantify tryptophan. For example, CEFAS uses a combination of UviLuxs targeted for tryptophan and colored dissolved organic matter to help inform on water quality around shellfish sites on the south coast of the U.K.

Looking to the Future

As the industry moves toward long-term, data-driven solutions for optimizing business processes and minimizing environmental impact, continuous monitoring of environmental parameters such as algae and harmful bacteria will play a critical role in sustainability. With a growing global demand for protein from fish and shellfish, mitigating stock losses and environmental impacts are key to securing sustainable future food sources for a growing world population. **ST**

Sam Kirby is the marine sales manager for Chelsea Technologies Ltd. Kirby has an M.S. in marine biology from Southampton University, specializing in aquaculture and parasitology, and has previous experience in the Australian oyster aquaculture industry. His primary interests are using technology to ensure sustainability and food security. He can be contacted at skirby@chelsea.co.uk.

Hadal Manned Submersible

Five Deeps Expedition Explores Deepest Point in Every Ocean

By Dr. Alan J. Jamieson • John Ramsey • Patrick Lahey

The very deepest parts of the world's oceans are seldom explored. Four of our five oceans extend to depths exceeding 6,000 m, putting them beyond the reach of most commercially available technologies and certainly beyond all human-occupied vehicles currently in operation.

Scientific interest in these ultradeep ecosystems has greatly increased over the last decade, but technological limitations have favored the use of simple static lander vehicles over remotely operated or human-occupied exploratory vehicles.

The Five Deeps Expedition (FDE) is changing all that. In 2015, Victor Vescovo, an American private-equity investor and explorer and founder of Caladan Oceanic, approached Triton Submarines in Florida with a vision to design, engineer, build, test and support a full-ocean-depth-capable and independently accredited two-person manned submersible, which he intended to dive to the deepest point in each of the five oceans over the course of a year-long expedition.

In a little over three years, this vision became reality. In December 2018, Vescovo performed his first solo dive in a two-person, full-ocean-depth submersible to 8,376 m in the Puerto Rico Trench, and the expedition is now more than halfway through its journey.

The FDE is supported by an international team of scientists, engineers, filmmakers and operational crew (both ship and submersible).

By the end of 2019, the Five Deeps Expedition, supported by a dedicated research vessel, will have also sent the new submersible and supporting landers to the South Sandwich Trench (approximately 7,400 m; Southern Ocean); Java Trench (approximately 7,200 m; Indian Ocean); Mariana Trench (approximately 10,900 m; Pacific Ocean); and the Molloy Deep (approximately 5,600 m; Arctic Ocean). In addition, the expedition will explore and sample a number of other deep locations along the way. The FDE will be the first time in history when an individual dives to the deepest point in each ocean.

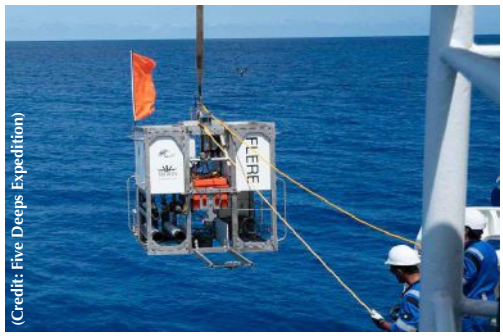
(Credit: Five Deeps Expedition)

The DSV Limiting Factor (Triton 36,000/2) being deployed for testing in the Bahamas in 2018.

Using a state-of-the-art multibeam echosounder, the first modern bathymetric charts of these deepest and most remote ocean trenches will be produced.

In addition to the production of new charts, scientists will have an opportunity to collect samples and conduct research in these remote points, in some cases for the first time ever.

(Credit: Five Deeps Expedition)



(Credit: Five Deeps Expedition)

(Top) The DSSV **Pressure Drop***, the full-ocean-depth-submersible support vessel and multibeam platform. (Bottom) One of the three full-ocean-depth landers being deployed to 8,376 m, the deepest point in the Atlantic Ocean.*

DSV Limiting Factor

The deep-submergence vehicle (DSV) Limiting Factor, designed and built by Triton Submarines for Caladan Oceanic, is one of the most uniquely capable, piloted vehicles in seafaring history. Also known as the Triton 36,000/2 or Full-Ocean-Depth (FOD) Triton, the "LF," as it is more commonly known, is rated to 11,000 m (36,000 ft.) and is capable of carrying two people to any depth in the world's oceans.

The submersible is operated from the deep-submergence support vessel (DSSV) *Pressure Drop* and supported by a number of small surface craft and three full-ocean-depth-rated lander systems, all owned by Caladan Oceanic and collectively known as the hadal exploration system. (The term "hadal" refers to the deepest biozone of the oceans at depths greater than 6,000 m.) The names "Limiting Factor" and "Pressure Drop" and lander names "Skaff," "Closp" and "Flere" are an homage to the late science fiction author Iain M. Banks's Culture Series.

Compared to other ultradeep-capable submersibles (e.g., Shinkai, Trieste, Jiaolong, Archimede), the LF is relatively compact (4.6 by 1.9 by 3.7 m) and lightweight (11.4 metric tonnes). Unlike typical human-occupied submersibles with predominantly forward trajectory, the Limiting Factor's movements are primarily descent and ascent, so its configuration is optimized for vertical travel through the water column to get it to the seafloor quickly; it can descend at speeds up to 3.5 kt. through the water column and 2 to 3 kt. laterally at depth.

Sub Interior

The two-person submersible carries a comfortable space for a pilot and passenger. The sphere—1.5-m (59-in.) internal diameter, 90 mm (3.5 in.) thick and machined to less than 1 mm of variance across its near-perfect spherical shape—is constructed of Grade 23 Titanium (Ti-6Al-4V ELI). The sphere also features three acrylic viewports to observe outside the vehicle.

The exterior is equipped with four high-definition video cameras (IP Multi SeaCam 3105, DeepSea Power & Light) used to record footage of the surrounding seafloor and four wide-angle standard-definition cameras (Super Wide-i SeaCam 4060, DeepSea Power & Light) for situational awareness. The submersible's exterior is illuminated by 10 15,500-lumen LED lights (LED-1153-A3-SUS, Teledyne Bowtech).

Operation and Navigation

The vehicle initiates descent by flooding a 600-liter trunking and four 375-liter main ballast tanks (2,100 liters total) aided by a pair of electromagnetically released steel ballast weights (freeboard and surfacing), with a combined total of up to 500 kg, depending on depth and specific gravity. On approach to the seafloor, the net buoyancy of the vehicle is trimmed in 5-kg increments using a pair of electromagnetically released variable ballast control tubes, each containing up to 50 kg (10 each) of steel ballast weights. Transiting and maneuvering is undertaken via two sets of five thrusters (three lateral, two vertical) on either side of the vehicle.

At the end of the dive, the surfacing weight is jettisoned and ascent is initiated by virtue of the approximately 7.5 cubic meters of syntactic foam (TG39/11,500, Trelleborg Applied Technologies). On approach to the surface, the freeboard weight is jettisoned. Upon surfacing, the ballast tanks are emptied to bring the submersible approximately 1 m above the water line. Locating the vehicle on the surface is aided by a large flag, VHF radio (MMB-7500, NOVATECH), Iridium satellite beacon (iBCN, NOVATECH) and, for low-light conditions, a Xenon strobe (MMF-7500, NOVATECH). In the unlikely event of surfacing far from the support vessel, the submersible has a satellite telephone communication suite that allows for nearly seamless transmission of verbal contact between the pilot and the support ship.

Precise underwater navigation is achieved via a system of underwater modems (GPM300 acoustic modem, L3 Oceania). The LF is equipped with two modems that are tracked using another two surface modems installed on the support vessel and a support boat, which can then triangulate from at least two of the three landers that are deployed prior to the submersible dive. Two CTD probes (SBE 49 FastCAT, Sea-Bird Scientific) record pressure, temperature and depth during the descent and can transmit data to the ship during the dive via the modems. These dual-redundant modems also allow verbal

"The FDE will be the first time in history when an individual dives to the deepest point in each ocean."

and text communication between the LF and the surface throughout a dive.

Scientific Capabilities

The scientific capabilities of the vehicle comprise a combination of the submersible itself, vessel-mounted equipment and the support landers. The support vessel *Pressure Drop* is equipped with a full-ocean-depth multibeam echosounder (MBES EM 124, Kongsberg), which maps the dive site prior to subsea operations. Once the target site is located, the landers are deployed in freefall and are then followed down by the submersible.

The LF's primary science capability is the array of HD video cameras on the exterior to observe the geomorphology, habitat type and associated biological communities of the seafloor. It is also equipped with a Raptor hydraulic manipulator arm (Kraft TeleRobotics). With support from the surface and a submersible-mounted side scan sonar (1171 Series, Kongsberg Mesotech), the LF is directed to the closest lander. The manipulator arm can be used to operate six push cores mounted on the lander to collect sediment cores. The arm can also be used to operate a sample scoop, attached to the lander to deposit any surface-dwelling animals or geological samples into a closable sample box, also mounted on the lander. In addition to the submersible-interfaced operations, the landers perform autonomous scientific tasks with baited HD cameras, large and small baited traps, a 10-liter Niskin water sampler and another CTD sensor.

Safety and Accreditation

The sphere and every component of the vehicle have been successfully cycled in hydrostatic pressure test chambers to 120 percent of full ocean depth (1,400 bar). The LF has an endurance of 16 hr., plus an emergency-life-support time of 96 hr., made possible by 148-VDC, 10/36-kWh bespoke lithium battery units (ICTINEU).

The LF has also been accredited by a third-party certification agency, DNV GL. The DNV GL certification essentially makes the LF the first commercially viable submersible designed for repeated use to full ocean depth. It is currently believed to be the most capable deep-diving active submersible in the world according to design limit and will have a life expectancy measured in decades and thousands of dives to the hadal depths.

Trials, Latest Update

The LF underwent sea trials in August and September of 2018 in the vicinity of the Bahamas and reached a depth of 4,950 m in the Abaco Canyon. From there, it went to the Puerto Rico Trench to dive the deepest point in the Atlantic Ocean. On December 19, 2018, the submersible reached that point, a depth of 8,376 m, without incident, proving unequivocally that the LF is currently the deepest-diving submersible in the world.

The LF and *Pressure Drop* then went on to map and dive the deepest point in the Southern Ocean (7,433 m), the Indian Ocean (7,192 m) and completed five dives to the bottom of the Mariana Trench (max depth 10,928 m).

At the time of writing, the expedition is heading through the Pacific Ocean to map, dive and sample the second deepest point in the world, Horizon Deep in the Tonga Trench, before heading back to the Atlantic to complete the Five Deeps Expedition in the Arctic Ocean in September this year.

Acknowledgments

We would like to thank everyone involved in the Five Deeps Expedition, especially Victor Vescovo (Caladan Oceanic), Captain Stuart Buckle and his crew on the DSSV *Pressure Drop*, Rob McCallum and Karen Horlick (EYOS Expeditions), and especially everyone from Triton Submarines, and all those who have taken part in and contributed to the expedition. **ST**

Dr. Alan J. Jamieson is a senior lecturer in marine ecology and specializes in the explorations of the hadal zone. He has participated in more than 50 deep-sea expeditions and published a book on the hadal zone and more than 80 papers on deep-sea biology and technology.

John Ramsey, the principal design engineer at Triton Submarines, is responsible for the design and creation of every new Triton sub. He has been a lead engineer on 17 newbuild submersibles, including both military and commercial projects and vehicles built to ABS, Lloyds and DNV GL classification.

Patrick Lahey, the co-founder and president of Triton Submarines, began diving in 1975 and has more than 30 years of commercial diving and underwater experience. During his career, he has participated in the design, engineering, manufacture and testing of numerous underwater vehicles and systems, including more than 50 manned submersibles.

Offshore Energy

OFFSHORE ENERGY 19
EXHIBITION & CONFERENCE
(7), 8 & 9 OCTOBER 2019
AMSTERDAM | THE NETHERLANDS

Offshore Energy Exhibition & Conference (OEEC) will be held October 7 to 9 in Amsterdam in the Netherlands. It will attract more than 10,000 offshore professionals and more than 550 exhibiting companies.

Offshore Energy is unique in bringing together the various offshore industries—oil and gas, offshore wind and marine energy—and, as such, serves as a hub to aid the energy transition from fossil fuels to renewables. A focus on the energy transition is reflected in the 22,500 m^2 exhibition floor and the conference, which comprises six 2-hr. sessions, Offshore Wind Conference and Marine Energy Event.

Knowledge Sharing

Offshore Wind Conference will take place October 7 and 8 and will concentrate on how the offshore wind industry will play its part in the energy transition.

Five sessions, which will range in topic from the global potential of wind to future pioneers to linking the grids, will take delegates on a journey to current and future challenges and achievements.

Confirmed speakers include: Manon van Beek, CEO, TenneT; Huub den Rooijen, director, Energy, Minerals and Infrastructure, The Crown Estate; and Andries Hofman, project manager, GustoMSC.

During Offshore Energy, visitors will have the chance to attend conference sessions on: the International Energy Outlook; Future Offshore Energy Systems; Cross-Industry Game-Changing Technologies; and the Energy Transition Debate.

Marine Energy Event 2019 will be held on October 9, and it will focus on how marine energy can lead Europe in the energy transition from traditional sources based on fossil fuels to renewable sources of energy.

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"Offshore Energy...serves as a hub to aid the energy transition from fossil fuels to renewables."

Highlights

A fascinating mix of leaders from business (buyers, investors), engineering and other interested parties within the offshore energy sector will get the opportunity to meet each other at OEEC, and it is precisely this balance between supply and demand that brings a unique mix of exhibitors and visitors to Offshore Energy each year.

Energy Plaza, a new feature on the exhibition floor, will combine many strong concepts in one spot, such as the Startup Zone, the Stage, Matchmaking and the Premium Lounge.

Offshore Energy Awards

After a grueling pitch round followed by an individual score from the respective juries, the three nominees per award for Offshore Energy 2019 have been narrowed down to: Public Outreach Award—DOB-Academy, Dutch Wavemakers and Nexstep; Young Engineer Award—Jesper Elzinga (Van Oord), Tom Ashley (Royal IHC) and Travis Anthony (Shell); and Best Innovation Award—Pulse (IHC IQIP), Electrical Thermal Energy Storage (Siemens Gamesa Renewable Energy GmbH & Co. KG) and CIS System (DEME Offshore).

The Offshore Energy Awards attract many international applicants and a global audience. This year, applicants hailed from Germany, the U.K. and the U.S., just to name a few examples. Two of these international applicants journeyed to the Netherlands to pitch in person, showing their resolve to win a place among the nominees.

Take Part in the Energy Transition

More information on Offshore Energy Exhibition & Conference can be found on the website offshore-energy.biz, where you can register, book conference tickets and find out more about the conference program and all other events related to Offshore Energy.

If you would like to become part of Offshore Energy, limited stands are available, as well as many sponsoring opportunities. You can also take part in the Offshore Energy Opening Gala Dinner and Awards Show. **ST**

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BOEM Addresses OCS Sediment Resource Needs For Increasing Coastal Restoration Projects

The U.S. Bureau of Ocean Energy Management (BOEM) Marine Minerals Program (MMP) has seen an increase in both the number of requests and volume of Outer Continental Shelf (OCS) sediment for coastal restoration projects. This is largely driven by diminishing resources in state waters, the frequency and magnitude of storms along the Atlantic and Gulf of Mexico coasts, and new infrastructure projects.

To help meet future sand resource needs out to about 2027, MMP funded a study entitled "Projected OCS Sand Resource Needs and Effort." The report outlines several possible scenarios to help estimate future need and the research required to meet the demand.

The report reached three major conclusions: more states will turn to OCS sediment resources as in-state resources become scarcer; the volumes requested will be larger to support increasing coastal resilience measures; and there is a critical need for BOEM to continue identifying additional OCS sand resources.

The report will support BOEM's development of a National Offshore Sand Inventory.

Potential follow-on studies would attempt to close data gaps and refine the forecast to improve its usefulness to coastal managers.

US House Passes Four Bills Tackling Ocean Acidification

The U.S. House of Representatives passed H.R. 1237, the COAST Research Act of 2019; H.R. 1716, the Coastal Communities Ocean Acidification Act of 2019; H.R. 1921, the "Ocean Acidification Innovation Act of 2019"; and H.R. 988, the "NEAR Act of 2019."

These four bills address ocean acidification, the gradual decrease in oceanic pH due primarily to the absorption of excess atmospheric carbon dioxide by seawater, by reauthorizing and updating the Federal Ocean Acidification Research and Monitoring Act and by providing avenues to address its impacts through vulnerability assessments, prize competitions and a National Academies study.

Acidification is occurring faster in some U.S. coastal regions as a result of local factors such as upwelling of naturally low-pH water, changes in freshwater inputs and high-nutrient inputs.

The activities directed by this legislation would enhance the ongoing ocean acidification work currently conducted by NOAA and other federal agencies and help address some of the knowledge gaps in this field.

Hands-Free Mooring Tech Now Operational in St. Lawrence Seaway

The U.S. Department of Transportation's Saint Lawrence Seaway Development Corp. (SLSDC) has announced that hands-free mooring (HFM) technology is fully deployed throughout the Saint Lawrence Seaway.

The new technology revolutionizes the method for locking vessels through the seaway and is the most important technological advance since the seaway's opening in 1959. It will enhance workplace safety, lower operating costs for carriers, and decrease vessel transit times through the locks.

The SLSDC invested $23 million to install HFM technology in the U.S. Snell Lock and the U.S. Eisenhower Lock. The HFM project is the first use of this technology for an inland waterway.

The HFM system uses vacuum pads, each of which provides up to 20 tons of holding force. The vacuum pads are mounted on vertical rails inside the lock chamber wall to secure the ship during the lockage process as it is raised or lowered while keeping it a fixed distance from the lock wall. The last step in the lockage operation consists of releasing the vacuum and retracting the pads so that the vessel can sail safely out of the lock.

The full implementation of this new technology is important to the Saint Lawrence Seaway's operations. Last year, there was a 7 percent increase in vessels transiting the seaway, moving 41 million tons of cargo through the binational waterway. The increase in shipping in the seaway is the highest cargo total since 2007.

MARAD Awards Nearly $20 Million in Grants For Small Shipyards

The U.S. Department of Transportation's Maritime Administration (MARAD) announced $19.6 million in grants to support capital improvements at 28 U.S. small shipyards as a part of its Small Shipyard Grant program. The funding supports employee training and related improvements that foster increased efficiency and economic growth.

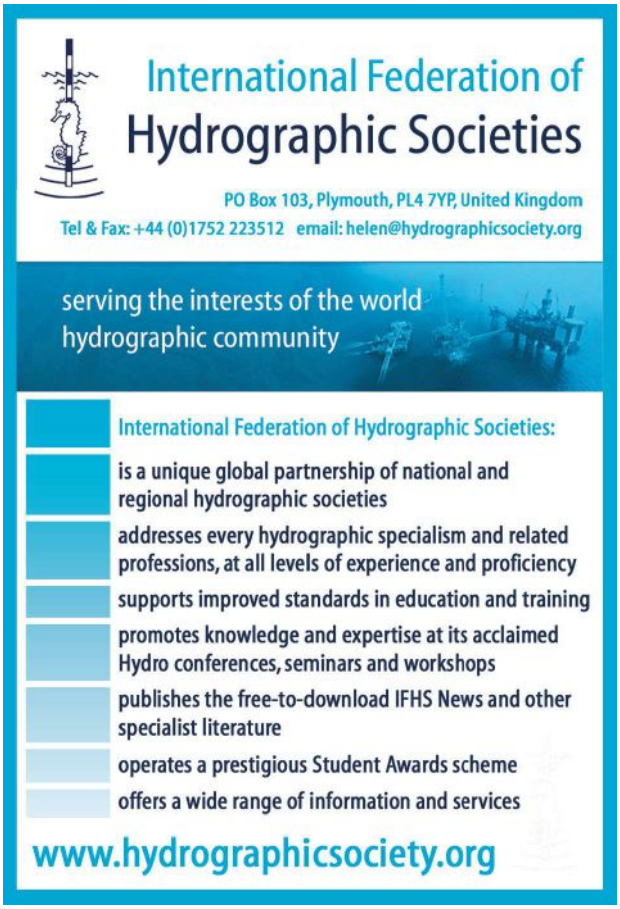
In 2013, U.S. shipbuilders produced $37.3 billion in gross domestic product. Typically family owned and employing less than 1,200 workers, small shipyards play a critical role in contributing to the U.S. economy, supporting more than 400,000 jobs.

BLUE GLOBE Act Now Introduced In Both Houses of Congress

U.S. Reps. Suzanne Bonamici (D-Ore.) and Don Young (R-Alaska), co-chairs of the House Oceans Caucus, have introduced the Bolstering Long-Term Understanding and Exploration of the Great Lakes, Oceans, Bays, and Estuaries (BLUE GLOBE) Act to strengthen ocean data collection and monitoring efforts and improve the coordination of current federal and international programs.

The bill would create an Interagency Ocean Exploration Committee, assess the potential for an Advanced Research Project Agency–Oceans (ARPA-O), establish an innovation prize, and strengthen federal innovation efforts to expand ocean data and monitoring technologies.

Sens. Sheldon Whitehouse (D-R.I.) and Lisa Murkowski (R-Alaska), co-chairs of the Senate Oceans Caucus, introduced the BLUE GLOBE Act in the Senate earlier this year. **ST**



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Ship Design Competition for Schoolchildren

The winning ship of the Design Your Ship for the Future competition held by MARIN (Netherlands Maritime Research Institute) has the shape of a sailfish, a retractable sail, a frictionless shark skin and a flexible moving tail. It was tested in one of MARIN's model basins.

Almost 100 participants were involved in the competition. Ideas came in the form of drawings and short videos, including ships with solar panels, sails, wind turbines and hydrogen engines for clean propulsion; floating hospitals for marine animals; and self-navigating ships with cameras and radars.

MARIN brought together the best ideas and combined them into the winning design.

Common Structural Rules Software Updated

Common Structural Rules Software LLC, a joint venture company formed by Lloyd's Register (LR) and ABS, has released updates to its software products to simplify compliance with existing and future IACS Common Structural Rules (CSR). Both LR and ABS will use these tools to evaluate new designs against the CSR.

CSR Prescriptive Analysis and CSR FE Analysis have been updated to reflect new rule changes that came into force in July.

Sonar to Protect Eastern European Waterside Energy Facility

Underwater intruder detection technology from Sonardyne International Ltd. has been chosen to secure the coastal perimeter of a critical national energy infrastructure facility in Eastern Europe.

The Sentinel Intruder Detection Sonar (IDS) will be deployed to detect unauthorized divers and subsurface vehicles approaching the facility from the water. The installation, at an undisclosed location, is the first phase of a site-wide project led by MARSS Group to enhance security at the facility with its NiDAR long-range air, land and underwater situational awareness system.

WOC Adds Members

Worldwide Project Consortium (WWPC), Priority Cargo Network and Cargo Equipment Experts (CEE), comprising hundreds of individual companies, have joined the World Ocean Council (WOC) in support of ocean sustainable development.

"Maritime transport and cargo logistics are central to the global economy, moving 90 percent of international trade—and are thus fundamental to the future of the ocean," WOC CEO Paul Holthus said.

New Application for Blade Air Emission Tech

Kongsberg Maritime has successfully adapted a propeller concept used in naval applications and is now offering the same operational and environmental benefits to commercial shipping customers. The naval sector has been using Kongsberg Blade Air Emission technology for

a number of years, with several navies deploying it to limit vessel signature, and the process is now being applied to commercial ship propellers to reduce the effect of underwater radiated noise on marine life.

Acteon Expands Claxton Brand

Subsea services group Acteon is adding subsea cutting expertise to its Claxton brand with the acquisition of Proserv's international Field Technology Services and Survey business units.

The Field Technology Services business offers cutting, friction stud welding and pipeline maintenance services from bases in Stavanger (Norway), Houma (U.S.), Singapore and Aberdeen (U.K.). These additional services and facilities will be integrated into Acteon under the Claxton brand, enabling rapid globalization of Claxton's complementary well decommissioning, riser and conductor and surface pressure control offerings.

The Survey business unit will join Acteon's existing UTEC Survey business.

SBG Surveys Hamburg Port

SBG Systems put all its inertial navigation systems (INS) to the test during a three-day hydrographic survey in Hamburg, Germany.

Test results took the form of interactive maps so hydrographers could select a product and compare its performance through seafloor maps.

SBG Systems and local partner MacArtney GmbH tested three grades of their MEMS INS (Ellipse, Ekinox, Apogee) with their FOG INS coupled with a multibeam echosounder. SBG FOG-based INS Horizon was post-processed within Qinertia PPK software to be used as a reference.

New London Office for Consultancy

Brookes Bell, a multidisciplinary marine, scientific and technical consultancy, has opened a new office in London, providing expertise across a range of sectors, including casualty investigation, forensic analysis, technical dispute resolution and expert-witness work.

Brookes Bell also operates in Liverpool, Glasgow, Sidcup, Singapore, Shanghai and Hong Kong.

JFD Trials for TechnipFMC

JFD, part of James Fisher and Sons plc, has successfully completed rigorous mating trials of its latest Portable Hyperbaric Reception Facility (PHRF) for TechnipFMC.

The trials were conducted with two of TechnipFMC's vessels.

LR Approves DSME Smart Ship Solution

Daewoo Shipbuilding & Marine Engineering Co. Ltd. (DSME) has received approval in principle (AiP) from Lloyd's Register (LR) for its Smart Ship Solution (DS4).

DS4 is a fleet monitoring smart ECDIS and surveillance system. It has been granted the descriptive note "Digital AL3 SAFE SECURITY," confirming that the system is in accordance with LR's Digital Ships ShipRight Procedure. **ST**

oceanbusiness

USCG Approves Evac BWMS

The Evac Evolution Ballast Water Management System (BWMS) has received type approval from the U.S. Coast Guard (USCG).

The system is manufactured by Cathelco, now part of the Evac Group, which attained USCG Alternate Management Systems (AMS) acceptance for its original BWMS more than four years ago.

Hyper-bb Development

Sequoia Scientific Inc. Scientist Dr. Wayne Slade has developed a hyperspectral backscattering instrument (Hyper-bb) through a NASA Phase II SBIR (Small Business Innovation Research) grant. A prototype has been delivered to NASA for testing. This is Slade's and Sequoia's second SBIR-funded development and delivery in 2019.

The Hyper-bb product is expected to be available for order in the first quarter of 2020.

MTS, SUT Join Forces

The Marine Technology Society (MTS) and the Society for Underwater Technology (SUT) have entered into a three-year memorandum of agreement to explore ways to work together to the benefit of their collective membership. Both SUT and MTS focus on the facilitation, development and application of marine science and technology for purposes of exploration, understanding and sustainable use of the ocean and its resources.

Canada's Ocean Supercluster Commits Funding To Kraken's OceanVision Project

Kraken Robotics Inc.'s wholly owned subsidiary, Kraken Robotic Systems Inc., has been conditionally approved by the Ocean Supercluster to move forward with its OceanVision project.

OceanVision is a three-year, $20 million project to develop new marine technologies and products to enable an underwater-robotics-data-acquisition- and data-analytics-as-a-service business for ultrahigh-definition seafloor imaging, mapping and analytics.

The Ocean Supercluster will provide an investment up to a maximum of $5.9 million to the OceanVision project.

Funding for Marine Firefighting Rescue Vessel

The Canaveral Port Authority will receive $1.5 million from the state of Florida to support the acquisition of a specialized fireboat to provide marine firefighting and rescue capabilities for Port Canaveral and the surrounding communities.

The Marine Firefighting Rescue Vessel (MFRV) will offer the area enhanced fire protection and response-time capabilities to serve the port's growing maritime operations.

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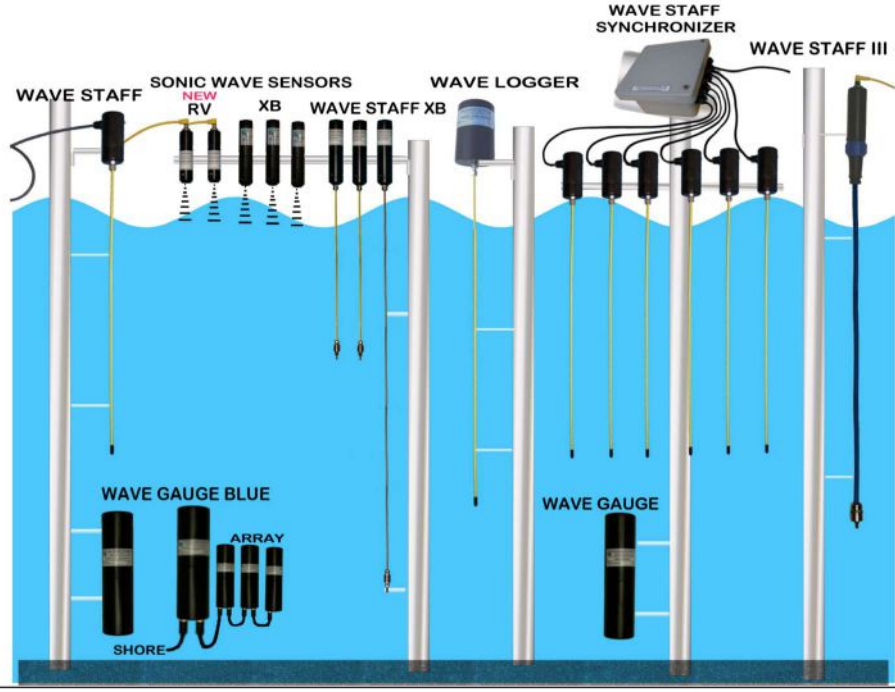

TTI to Stock SEACON Products

TE Connectivity will begin stocking six of its high-demand SEACON product lines for the marine, oil and gas market with TTI Inc., a specialty distributor of electronic components and one of TE's largest global distribution partners. The SEACON product lines that customers will be able to buy through TTI are: 55 Series, All-Wet, HUMMER, Micro WET-CON, Rubber Molded Connectors and WET-CON.

L3Harris Arises from Merger

L3Harris Technologies Inc. is merging with Harris Corp. to create an agile global aerospace and defense technology company uniquely positioned to deliver innovative, affordable mission solutions that can be rapidly fielded. The new company is called L3Harris.

WFS Expands

WFS Technologies, specializing in Subsea Internet of Things (SIOT) devices for asset-integrity management, has expanded into Houston and Brazil as it continues to meet growth objectives for 2019. Molly Reyes joins the WFS senior leadership team to lead the new office and explore opportunities in the growing energy sectors of the Gulf of Mexico and North American territories.

Quiet Ship Workshop Results

Acentech, a Cambridge, Massachusetts-based noise, vibration and acoustical consulting firm, has issued its final report to Transport Canada concerning the Quiet Ship Workshop held at the International Maritime Headquarters (IMO) in London this past January and February.

Among the key policy and research recommendations from the event include: biological underwater radiated noise (URN) limits are not available at this time, so ship-based URN limits should be studied; noise mitigation measures should align with efforts to improve energy efficiency and reduction of greenhouse gas emissions; vessel URN data should continue to be gathered to understand issues and validate modeling; research on shipboard noise control technologies should be advanced; a comprehensive framework of international standards for URN measurement should be developed; and there should be an increase in education/outreach to shipowners, designers and builders, and machinery and equipment manufacturers.

Port of Cartagena Invites More Traffic

Cartagena Port in Colombia is becoming increasingly important as a regional transportation hub. Last year, Panalpina set up the first ocean freight hub in Cartagena for Central and South American LCL (less than container load) cargo. The Port of Cartagena had the fourth highest throughput of all container gateways in Latin America and the Caribbean in 2018, according to the UN's Economic Commission for Latin America and the Caribbean. The port handled 2.9 million TEU in 2018, 6.9 percent more than in 2017. **ST**

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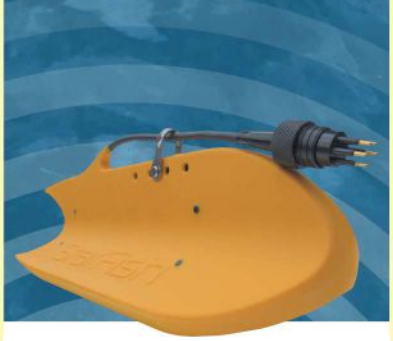
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Anti-Fouling Coating

Containing the barnacle-repellent active agent Selektope, SEA PREMIER 3000 PLUS is a self-polishing coating based on silyl polymer technology. It delivers excellent slime and algal resistance with the combined power of Selektope and cuprous oxide for superior hard-fouling prevention. Chugoku Marine Paints Ltd.

Software Update

Pertaining to NavNet TZtouch2, this update enables the use of the popular CMOR seafloor maps, with bathymetric bottom images that help navigators identify suitable locations for fishing and diving, overlaid on top of NavNet's conventional vector, raster or fishing charts. Furuno USA.

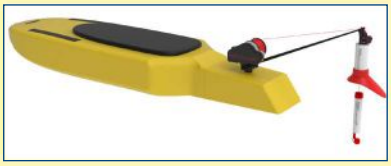
Hydrographic Support

Hydrographic Production Database (HPD) 4.0 supports the new S-100 Universal Hydrographic Data Model. Users of HPD 4.0 will be able to augment their existing production environment to support both the S-101 and S-57 Electronic Navigational Chart (ENC) production from the same source database. Teledyne CARIS.

DNA-Based Monitoring

GeneCount comprises DNA-based monitoring tools that complement ATP measurement kits. While ATP kits determine total micro-organism quantity and can confirm water treatment efficacy, GeneCount reveals the specific species found and what these organisms are doing. LuminUltra Technologies Ltd.

Autonomous Profiling Winch



Intended for use on small research boats, vessels of opportunity, ASVs and dockside, the compact RBR*glissando* enables vertical profile data to be automatically downloaded from the CTD logger to the winch via Wi-Fi and stored on the winch, telemetered directly via Iridium or GSM, or passed to the vehicle controller. RBR Ltd.

GPS/INS Antenna Receiver

This single-antenna receiver enables robust centimeter positioning and 3D attitude (heading, roll, pitch) while keeping weight and power consumption to a minimum. Positioning is based on multifrequency, multiconstellation GNSS (GPS, GLONASS, Galileo, BeiDou, QZSS) technology. Septentrio N.V.

Underwater Bonding

Whether below the waterline or undercarriage, Fix15 delivers massive holding strength. The adhesive sealant bonds underwater and is paintable. Fix15 uses an MS polymer base and is suitable for sheet, carbon and stainless steel; aluminum; fiberglass; composite; glass; non-oily wood; mirrors; PVC; rubber; and PU foam. FixTech LLC.

Cloud-Based Software

The a3 Agency System reduces paperwork and streamlines workflows across a ship-agency business. Simplifying the management of documentation and actions required in port calls into a unified system reduces administrative overheads and enhances service quality. Wallem Group Ltd.

Micro-AUV

Small (less than 1 m long) and easy to carry and launch (less than 20 lb., including payload), NemoSens can host any payload, be it a CTD probe, side scan sonar or other sensors. Thanks to an open LINUX architecture, it can be programmed from a ROS or MOOS interface to complete various missions. RTsys.

Smaller ROV

Half the size of the Outland ROV-1000, the ROV-500's smaller frame allows for access into smaller spaces while maintaining a high thrust-to-weight ratio. The hand controller includes depth, heading (compass or gyro), cruise controls and altimeter depth control. Outland Technology Inc.

Compass

An analog compass comes in handy when there's no power. The HF-743 Helmsman Flush Mount CombiDial displays an actual heading. The polished dome has 45° lubber lines for easy reference. Integrated compensators adjust for deviation. Ritchie Navigation.

Virtual-Reality Training

"Wall Wash Test - Protecting Your Cargo" trains ship operators to avoid potential claims that could amount up to millions of pounds due to cargo damage caused by insufficient tank cleaning on board chemical tankers. The user gets a 360° simulation with haptic motion controllers. Videotel Marine International.

Small GPS Tracker

Ready to use out of the box, the Spytrack Nano is an ideal solution for tracking portable assets in the shipping industry. It can be set to report its location up to every 15 to 30 sec. Rewire Security.

Climbing Robots

Capable of remote operation, these robots can inspect and clean hulls, remove coatings and marine growth, perform spot repairs, and deploy a welding head for remote welding. They are made of DragonPlate carbon-fiber-reinforced plastic components. International Climbing Machines.

Water-Quality Monitoring

The FlowCam 5000 is ideal for general and process-specific monitoring applications. It is also a suitable tool for aquatic research and educational institutions. Using flow-imaging microscopy, the FlowCam 5000 provides digital images that allow for rapid count and measurement of organisms in a liquid sample. Fluid Imaging Technologies Inc.

INS with DVL

TOGSNAV has three model options: 0.1°, 0.3° and 0.5°. It comes with 4,000-m-rated housing; 600- or 300-kHz DVL; and a single ROV connection, plus connections for sensor inputs. Teledyne TSS Ltd.

Environmentally Friendly Cleaner

Bio-based Safe-T-Solve is a fast-acting, industrial-strength cleaner and degreaser that can be used on all surfaces. It's strong enough to use in a parts cleaning system and has no harmful volatile organic compounds. Iosso Products.

Rack-Mount Computers

The industrial-grade RM-1200 series offers redundant power and dual PCIe x8 expansion in a <400-mm 1U enclosure. It is powered by the latest-generation (8 core) Intel Core (RM-1200-CL) and Xeon E series (RM-1200-XE) processors. Steatite Ltd. **ST**

RBR Measurements for Great Lakes Study

RBR has recently delivered hundreds of scientific instruments to meet the critical requirements of the Real-time Aquatic Ecosystem Observation Network (RAEON). RAEON will support comprehensive and multidisciplinary research to understand and manage the Great Lakes and will be a reference for researchers worldwide who are investigating freshwater ecosystems. This collaborative hub will enable researchers to join forces in understanding freshwater ecosystems.

RAEON will help reinforce Canada's position as a leader in environmental stewardship.

Four-hundred RBR*solo*³ T loggers (internally recording and powered temperature instruments) will be used in conjunction with acoustic telemetry arrays in Lake Ontario for long-term monitoring of temperature in the lake over annual and interannual time scales. The RBR*solo*³ T temperature measurement is required to measure and resolve the small changes in the vertical structure of lake temperature that drive seasonal circulation and track long-term changes.

More than 20 RBR*maestro*³ CTD multiparameter data loggers were delivered to identify the baseline health of the Great Lakes. The loggers will be used to measure a variety of key environmental factors, such as temperature, salinity, depth, pH, turbidity, dissolved oxygen, carbon dioxide and multiple wavelengths of fluorescence. The combination of these sensors on one logger enables the researchers to measure all parameters on the same time scale, which is important to get a baseline water quality level of the lakes for long-term lake monitoring. The RBR*maestro*³ CTDs will be used for vertical-profiling studies on small research boats, as well as moored for long-term interannual studies.

MacArtney Supports Deep-Sea Observatory off France

MacArtney France continues to supply Teledyne Oil & Gas connectivity solutions to the pioneering MEUST-NUMerEnv observatory project located 40 km offshore Toulon, France.

Over the last two decades, MacArtney France has provided connectors to ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch) and the MEUST (Mediterranean Eurocentre for Underwater Sciences and Technologies), a permanent deep-sea observatory deployed at 2,500-m depth.

The NUMerEnv (Neutrino Mer Environnement) project, the second phase of the MEUST project, is a technologically advanced cabled infrastructure hosting the neutrino telescope of the KM3NeT Collaboration and deep-sea observatory,

EMSO (European Multidisciplinary Seafloor Observatory).

Cabled observatories, connected to land by electro-optical cables, provide continuous data transmission and offer unique opportunities for the study of the neutrino, the most mysterious of the elementary particles, and for monitoring deep-sea phenomena.

MacArtney's scope of supply to this ongoing project includes a continuing tender for Teledyne Oil & Gas connectors, interlinks, Y cables, jumpers, battery and sensor links.

DO Loggers Reveal Eutrophic Lake's Diurnal Dynamics

Dissolved oxygen (DO) concentrations and their fluctuations are vital to the aquatic health of eutrophic lakes. As oxygen production through aquatic plant-based photosynthesis is largely dependent on the sun, DO concentrations, especially in the upper water column, vary significantly over a 24-hr. period. Because of these variations, spot measurements, if taken on a daily or weekly interval, could be misleading depending on where the measurement occurs in the diurnal cycle.

Last year, Rob Bowen of Diversified Scientific Solutions deployed one of ASL Environmental Sciences' DO loggers to examine the finer details of the DO diurnal cycle at Swan Lake in Victoria, British Columbia, Canada. This 9-hectare lake in an urban landscape is subject to algal blooms and fish kill due to hypoxia.

This year, Bowen is using two ASL DO loggers from the ASL lease pool to examine DO levels in an area where a bubbler system was installed.

Satellite Data Enhances Arctic Bathymetry Map

Scientists from DTU Space, Denmark's national space research institute, have published a paper that reveals the first Arctic bathymetry map using marine gravity.

The surface of the ocean is not flat. Because of gravitational pull, the height of the ocean surface mimics the rise and fall of the ocean floor. Areas of greater mass such as underwater mountains have a higher gravity, attracting more water and creating a rise in the sea surface.

Fine-tuning the relationship between bathymetry and gravity in the Arctic Ocean has enabled scientists to calculate seafloor bathymetry from satellite gravity measurements.

By using ERS-1 and ERS-2, Envisat and seven years of CryoSat data, an altimetric gravity model has been developed by DTU Space. This has been combined with the existing IBCAO bathymetry map to create a new and improved hybrid bathymetry map of the Arctic Ocean. The existing IBCAO bathymetry map of the Arctic Ocean is based on ship soundings, assisted by digital depth contours. Combining IBCAO bathymetry with altimetry-derived marine gravity has yielded a more accurate Arctic bathymetry map. **ST**

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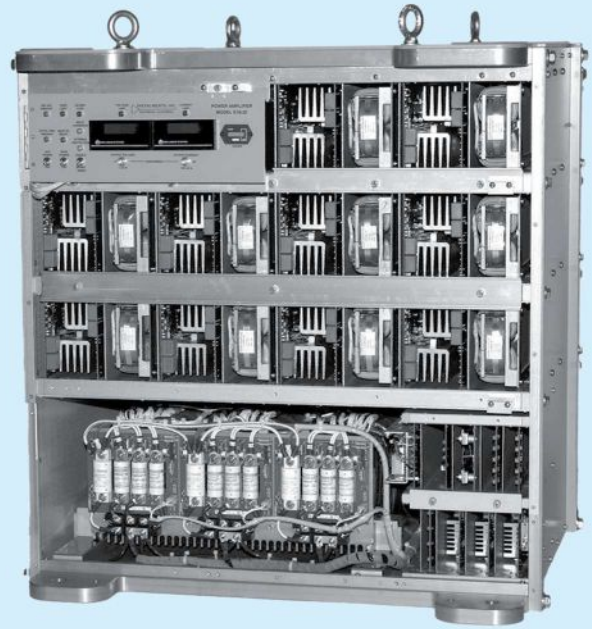

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October 2-3—OilComm, Houston, Texas. 484-869-2378, dmuirhead@accessintel.com or www.oilcomm.com.

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

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

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

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

October 11—Maritime Economy Forum, Gdynia, Poland. www.forum.gdynia.pl.

October 15-17—RECSO Enviro-Spill Conference & Exhibition, Abu Dhabi, United Arab Emirates. +973 3905 7872, vishak@iconex.in or www.recsoenvirospill.org.

October 27-31—OCEANS 2019 Seattle, Seattle, Washington. info@oceans19mtsieeeseattle.org or https://seattle19.oceansconference.org.

October 28-31—CLEAN GULF Conference & Exhibition, New Orleans, Louisiana. www.cleangulf.org.

October 29-31—Challenge of Science Leadership Training Course, Oban, Scotland. info@scienceleadership.co.uk or www.scienceleadership.co.uk.

October 30-November 1—SNAME Maritime Convention, Tacoma, Washington. 703-997-6701, events@sname.org or https://snameconvention.com.

NOVEMBER

November 4-6—Oceans in Action, Gulport, Mississippi. laurie.jugan@usm.edu or www.mtsociety.org/oceans-in-action.

November 5-7—International Conference on Marine Engineering and Technology Oman, Muscat, Oman. +44 (0)20 7382 2656, marketing@imarest.org or www.icmetoman.com.

November 6—OPITO Global, Kuala Lumpur, Malaysia. www.opito.com/events/opito-global.

November 6-7—ASNE Design Sciences Series Workshop: Digital Engineering: Digital Twin, Washington, D.C. 703-836-6727, asnehq@navalengineers.org or www.navalengineers.org/Symposia/Design-Sciences-Series-Digital-Engineering-Digital-Twin-2019.

November 10-14—International Water Conference, Orlando, Florida. 412-261-0710 ext. 13, t.bombalski@eswp.com or www.eswp.com/water.

November 18-22—BlueTech Week, San Diego, California. mbjones@themaritimealliance.org or www.bluetechweek.org.

November 20-21—Combat Systems Symposium, Arlington, Virginia. 703-836-6727, asnehq@navalengineers.org or www.navalengineers.org/Symposia/Combat-Systems-Symposium-2019.

November 20-22—Sustainable Ocean Summit, Paris, France. info@oceancouncil.org or www.oceancouncil.org.

November 21-23—Pacific Marine Expo, Seattle, Washington. 207-842-5666, cdimmerling@divcom.com or www.pacificmarineexpo.com.

November 28-30—International WorkBoat Show, New Orleans, Louisiana. 508-743-8567, info@workboatshow.com or www.workboatshow.com.

DECEMBER

December 3-6—Marintec China, Shanghai, China. marintecchina@126.com or www.marintecchina.com.

December 4-5—Maritime Security & Coastal Surveillance, Singapore. +65 6722 9388, KunLim.Lau@iqpc.com.sg or https://bit.ly/2XqMeIu.

December 4-5—West Coast Small Business Defense Contracting Summit, San Diego, California. 202-552-0179, info@defenseleadershipforum.org or https://tinyurl.com/y3z9jvmj.

December 10-12—Chesapeake Technology's Annual Training Workshop, Savannah, Georgia. 650-967-2045 or workshop@chesapeaketech.com.

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JANUARY

January 14-16—Blue Innovation Symposium, Newport, Rhode Island. 401-847-6650 or https://salve.edu/blue-innovation-symposium.

FEBRUARY

February 4-6—EUROMARITIME, Marseille, France. +33 1 56 59 15 07, anne-charlotte.micca@gican.asso.fr or www.euromaritime.fr.

February 4-6—Underwater Intervention, New Orleans, Louisiana. ui@naylor.com or www.underwaterintervention.com.

MARCH

March 23-25—International Lidar Mapping Forum, Washington, D.C. 800-803-5804, customerservice@divcom.com or www.lidarmap.org.

APRIL

April 13-16—MTS Buoy Workshop, Wilmington, North Carolina. rickcole@rdsea.com or www.mtsociety.org/mts-buoy-workshop-2020.

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

contracts

Wild Well Control Inc., Houston, Texas, has a new contract for the provision of BOP intervention skids and test units for inclusion in its Subsea Response Kit. As part of the WellCONTAINED subsea capping stack program, the new 450/150 Mark 3 BOP intervention skids will replace the existing equipment in inventory. Fugro.

Penguin International Ltd., Singapore, has selected an electronic fuel monitoring system (EFMS) solution provider for its Flex Fighter range of armored multi-role security boats and on its own fleet of Flex-42X Executive Fast Crew Boats. FUEL-TRAX.

BIO-UV Group, Lunel, France, has secured a contract to retrofit a BIO-SEA ballast water treatment system to the cruiseship *Europa*. A modular BIO-SEA B01-0085 system with an 85 m^3/h flow rate will replace a competitor's first-generation UV-type ballast water system currently installed on the 28,890-gt vessel. Columbia Cruise Services.

ABB, Zurich, Switzerland, has won a contract to supply ABB Ability Remote Diagnostic Systems for Marine to 11 vessels operating in the Arctic and Russia's Far East. Sovcomflot.

MacGregor, part of Cargotec, Helsinki, Finland, has signed a framework purchasing agreement to support MacGregor spare parts and service of equipment installed on a fleet of more than 1,000 ships operating worldwide. COSCO Shipping.

Sea Machines Robotics, Boston, Massachusetts, entered into a cooperative agreement to demonstrate the ability of Sea Machines' autonomous technology to increase the safety, response time and productivity of marine oil-spill response operations. The demo was to be conducted in August in Portland, Maine. U.S. Department of Transportation's Maritime Administration and Marine Spill Response Corp.

N-Sea, Zierikzee, Netherlands, was awarded three contracts in the Middle East entailing completion of a pipeline repair and pigging campaign, air-diving campaigns and a saturation-diving campaign for spool, clamp and riser installations. Undisclosed.

TechnipFMC, London, England, has been awarded a major engineering, procurement and construction (EPC) contract for the Arctic LNG 2 project located in the Gydan peninsula in West Siberia, Russia. It will cover the EPC of three LNG trains and associated topsides. Novatek and partners.

Next Geosolutions, London, England, has been awarded three marine survey contracts from three different clients for onshore, nearshore and offshore activities, to be done primarily via ROV-mounted sensors and tools. Undisclosed. **ST**

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How to Get the Next Generation into STEM—*Al Leszczynski*

Al Leszczynski is a science interpreter at the Franklin Institute in Philadelphia, Pennsylvania, with a background in environmental science from Temple University and a passion for the marine sciences and malacology. Leszczynski has served as a science communication fellow with the Ocean Exploration Trust aboard the EV Nautilus *for the 2018 and 2019 field seasons, helping to conduct research in the Pacific Ocean.*

If you're reading this magazine, it's probably safe to say that you understand the value and opportunities in the fields of sea technology and marine sciences. But how did you end up valuing those things?

For many, the love for science is not found in a classroom, but, instead, through informal experiences. It might be playing in the puddles during a rainstorm, watching a relative tinker with a car engine, or simply being guided to scientifically observe the world around us. These experiences can set the course for a life full of excitement through learning and participating in science and engineering.

I have always been known as a "science kid," but no one is just born this way. A curiosity for the world and a love for science and inquiry must be fostered in and out of school for children of all ages.

GSK Science in the Summer, a free national program administered in partnership with the Franklin Institute, aims to do just that.

Each year, the education team at the Franklin Institute, along with leaders and scientists from GSK, work together to create interactive, engaging and accessible science curricula for students nationwide. This year's theme is "The Science of Me: an exploration of human biology, anatomy and the health sciences as a whole." GSK Science in the Summer serves students going into grades second through sixth. This age group is targeted specifically because studies have shown—and my personal experience as an all-ages educator suggests—that confidence in the STEM fields is often most fortified, or sadly diminished, at these times in a child's growth and development.

For many, science and engineering is not "for them," but what experiences cause that thinking? How can the presentation of STEM in childhood and adolescence garner a different result?

The GSK Science in the Summer program follows an approach of localizing and personalizing experiences, drawing science connections to the larger world, and building upon dimensions of science capital such as science literacy, unstructured science experiences and awareness of the transferability of STEM-based skills.

In Philadelphia, the program partners with the Free Library system, which includes many neighborhood libraries that host the program in their spaces. By utilizing the local library system, we are able to bring these experiences closer to the audiences that want them and need them, lessening the negative impact of transportation costs on low-income families. This also allows learners to familiarize themselves with their local libraries and all that they offer, maximizing the likelihood that they will return and feel comfortable using the learning resources that are available to them in these accessible places.

In a 2016 study, Louise Archer and Jennifer DeWitt discuss the strong correlation between a student's personal connection with someone who works in STEM and their confidence and engagement with the sciences.

The GSK Science in the Summer program hires certified teachers, many of whom have a focus on the sciences, to serve as the program educators. Additionally, the program highlights the many varying career paths that can be found through the sciences. For each lesson and activity, educators have the chance to connect students with real-life job opportunities. This is incredibly important because the perceived utility of science courses and extended science learning for career paths strongly predicted a student's choice to continue pursuing math and physics beyond compulsory science courses, as highlighted by a 2014 paper by Tamjid Mujtaba and Michael Reiss.

One of my most impactful science moments took place in the basement of the Northeast Regional branch of the Free Library of Philadelphia back in 2002. I was 11 years old, and my mom had secured me a spot into the oceanography week of GSK's free Science in the Summer program. Wearing a tiny lab coat and safety goggles, just like a real scientist, I was able to view a drop of pond water through a microscope for the very first time. I spent only a total of 6 hr. in the program for that week—but its impact has been lifelong.

To this day, I have my program workbook on display at my desk at the Franklin Institute, full of microscope illustrations of sponge spicules and algae. That's why I am proud to be a marine scientist who continues to work with the Science in the Summer program as a full-time science educator at the Franklin Institute, and through my years as a science communication fellow with the Ocean Exploration Trust and Nautilus Live.

Whether growing up on the California coast, in a Midwestern town or in an urban center like Philadelphia, all children deserve access to programs like GSK Science in the Summer.

They are the future of sea technology and marine sciences—we just have to give them the tools. **ST**

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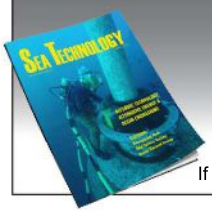

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