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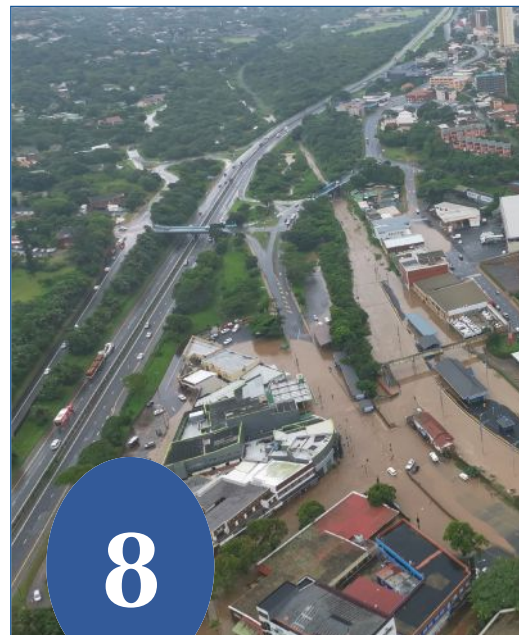
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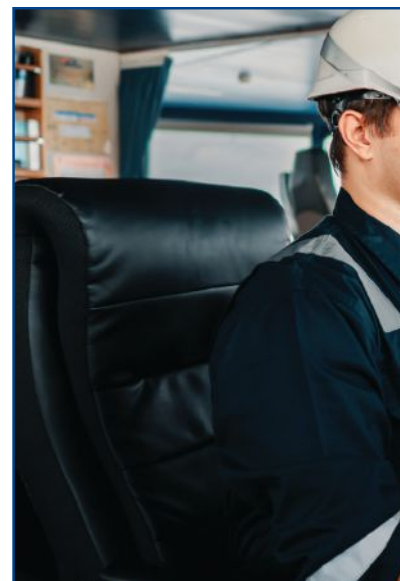


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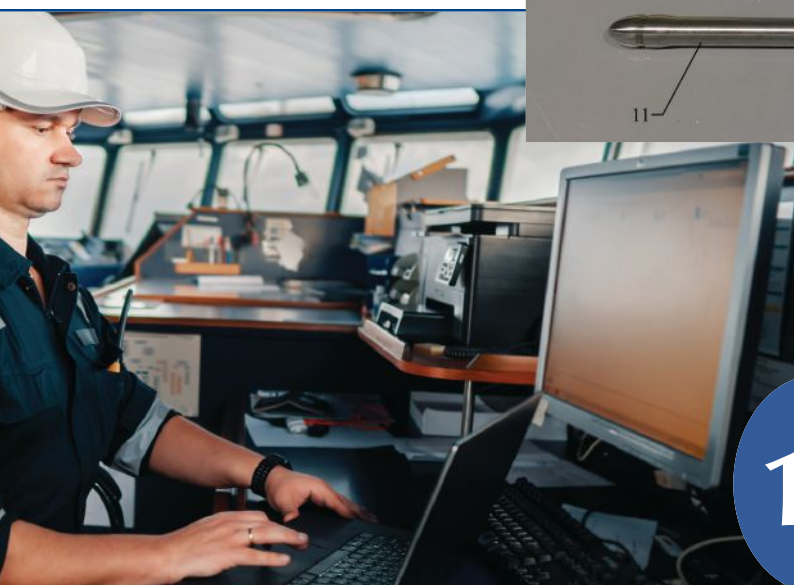
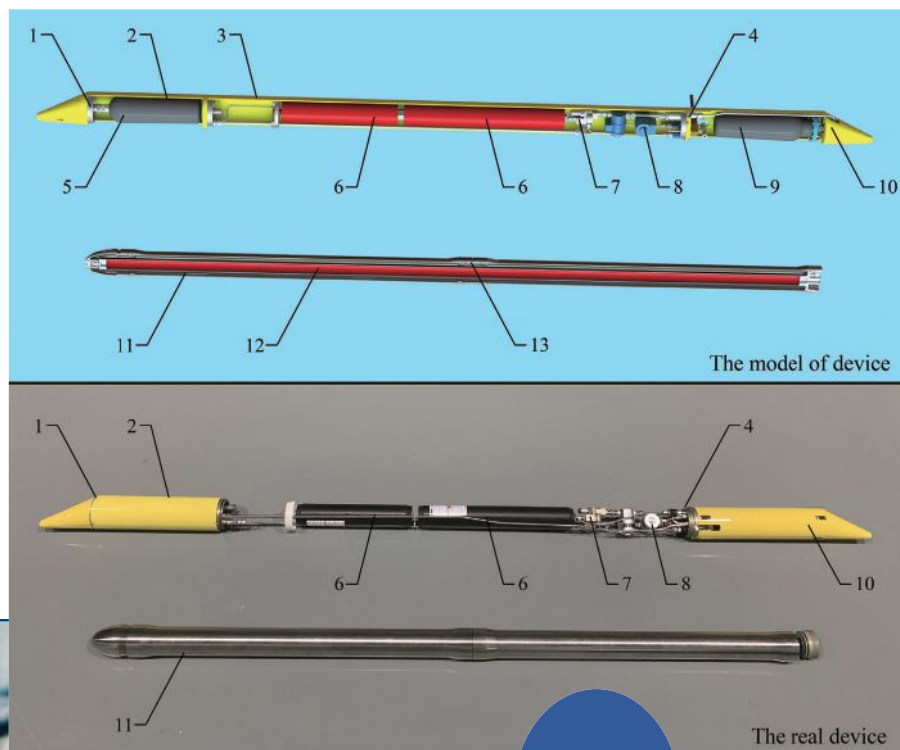
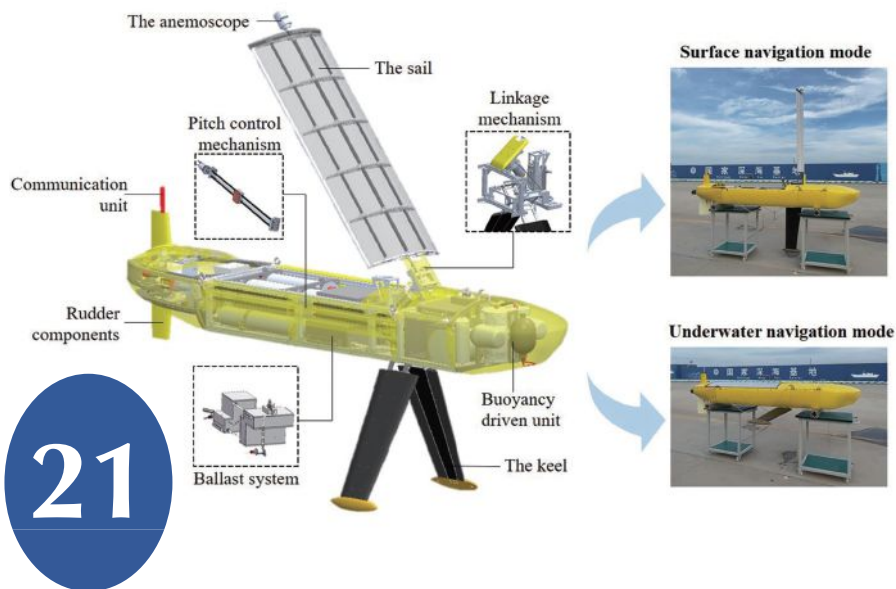
The Boundary Pass Underwater Listening Station deployed by JASCO Applied Sciences in May 2020. Commissioned by Transport Canada, the station records the noise emissions of shipping vessels and transmits the data to shore along 2.8 km of fiber-optic cable to be immediately processed and made available online. Learn more about the project at: www.jasco.com/boundary-pass-uls. (Credit: Christopher Whitt, JASCO Applied Sciences)

NEXT MONTH

Automated target recognition options for Teledyne Gavia vehicles ... Wind turbine installation vessels ... Phase-measuring bathymetric sonar to survey hydroelectric dam ... New satellite-derived bathymetry processes ... Company Profile: Massa.



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)) Funding for World's First Net Zero Industrial Cluster by 2040. All three of Equinor's projects to deliver deep cuts in emissions from industries and support clean growth on the U.K.'s east coast have received public funding from U.K. authorities. With a combination of private and public funding, Equinor and its partners will now progress these projects in order to create the world's first net zero industrial cluster by 2040. Zero Carbon Humber (ZCH), is a 12-company partnership to turn the U.K.'s largest industrial cluster net zero through the step-wise deployment of low-carbon hydrogen, carbon capture and negative emissions being delivered at sites across the Humber Estuary. The first project is the Equinor-led H2H Saltend low-carbon hydrogen facility and a hydrogen and carbon dioxide pipeline network across Humber industrial sites developed by National Grid Ventures. Net Zero Teesside (NZT) is a five-company partnership to decarbonize the Teesside industrial cluster with carbon capture and build a new gas-fired power station with state-of-the-art carbon capture technology. Northern Endurance Partnership (NEP) is a six-company partnership (with ENI, National Grid, Shell, Total and operator bp) to develop offshore carbon dioxide transport and storage infrastructure in the U.K. North Sea that will serve both ZCH and NZT. The three successful bids amount to GBP 229 million in private and public funding, with Equinor and its partners contributing more than two-thirds of the total.

)) Risk Assessment of Autonomous Ships. ClassNK has begun joint investigative research with Sompō Japan Insurance Inc. on risk assessment of autonomous ships. Global efforts are accelerating toward the practical use of technology for autonomous operation in the field of ships, as this may be a promising way to improve safety by preventing human error related to ship maneuvering and working conditions by reducing the work load of crew members. With the implementation of demonstration projects and development of the guidelines led by the government, the framework for safety evaluation is in progress in Japan. As a verification body for ensuring ship safety, ClassNK conducts research and development for the safety evaluation and setting standards for autonomous operation technology and is involved in efforts by the government, research institutes, corporations, etc. related to such technology from a safety and technology standpoint. Risk assessment research began in February 2021, and results will be released in 2022.

)) Biden Advances Offshore Wind. The Biden Administration is taking coordinated steps to support rapid offshore wind deployment and job creation, specifically: advancing ambitious wind energy projects to create jobs; investing in American infrastructure to strengthen the domestic supply chain and deploy offshore wind energy; and supporting critical research and development and data sharing. The Bureau of Ocean Energy Management (BOEM) has announced a new priority Wind Energy Area in the New York Bight—an area of shallow waters between Long Island and the New Jersey coast—which a recent study from Wood Mackenzie shows can support up to 25,000 development and construction jobs from 2022 to 2030, as well as an additional 7,000 jobs in communities supported by this development. BOEM will publish a Proposed Sale Notice, followed by a formal public comment period and a lease sale in late 2021 or early 2022. The administration has set a target of employing tens of thousands of workers to deploy 30 GW (30,000 MW) of offshore wind by 2030. There will be investment in port infrastructure to support offshore wind, and offshore wind will receive R&D funding through the National Offshore Wind R&D Consortium.

)) \$230 Million Available in US Port Infrastructure Development Grants. The U.S. Department of Transportation's Maritime Administration has announced a Notice of Funding Opportunity encouraging states and port authorities to apply for \$230 million in discretionary grant funding for port and intermodal infrastructure-related projects through the Port Infrastructure Development Program (PIDP). Previous grants have supported projects such as infrastructure resiliency and shore-side improvements to facilitate wind energy projects. The Consolidated Appropriations Act 2021 made \$230 million available for the Port Infrastructure Development Program, with \$205 million reserved for grants to coastal seaports and Great Lakes ports. The minimum award size is \$1 million, with a federal cost-share not to exceed 80 percent. The federal cost share can be higher for certain categories of projects. Technical assistance will be available via webinars during the Port Infrastructure Development Program grant application process (www.transportation.gov/portgrants). The deadline to submit an application for PIDP is July 30, 2021. For more information, visit: www.maritime.dot.gov/PIDPgrants or email: PIDPgrants@dot.gov.

)) Nominations Open for Walter Munk Scholar Award. Nominations for the Walter Munk Scholar Award are now open and will close on May 31. The award, which is jointly sponsored and awarded by the Walter Munk Foundation for the Oceans (WMFO) and the Marine Technology Society (MTS), is presented annually to a scholar currently enrolled in an undergraduate, graduate or postdoctoral program. Nomination forms are available at: www.mtsociety.org/awards-and-honors. Walter Munk was dubbed the "Einstein of the Oceans" and spent his 80-year career at Scripps Institution of Oceanography, where he made significant contributions, including: pioneering work on predicting wave and surf conditions used for the successful landings at Normandy on D-Day, underwater sound propagation and the development of acoustic tomography, internal waves, and large-scale ocean circulation. **ST**

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New Age of Ocean Science Communications

Communication and ocean technology are revolutionizing ocean science. This comes at a time when we urgently need progress in understanding, protecting, restoring and sustainably using the global ocean. In January 2021, the United Nations launched a Decade of Ocean Science for Sustainable Development to bring together all nations to address significant environmental challenges, including the climate crisis, and to forge a path forward to a healthy and resilient ocean that supports sustainable economic development.

New tools for communication have enabled innovative ways to share stories from the ocean. The internet, social media and high-definition video transmit important messages instantaneously around the world. Cameras on underwater robots reveal images of unknown seascapes and sea creatures from the deepest, darkest corners of a largely unexplored ocean.

New ocean technologies are being advanced by NOAA and a growing number of our partners, including ocean explorers, philanthropic organizations, research institutes, academia and industry. The technologies, powered by robotics, artificial intelligence and genetic analysis, make it possible and more affordable to scale up exploration, mapping and the characterization of the world's largest ecosystem.

When it comes to communicating about the ocean, "basics matter," said Janet Greenlee, communicator with Vulcan Inc., a private company tackling some of the world's biggest challenges facing oceans, climate, conservation and communities. "Good ocean communications relies on a good story with a purpose," Greenlee said. Key ingredients of a good story are often scientists on the front lines who can convey the excitement and societal value of their research. One such scientist is Dr. Jose Martin Hernandez-Ayon, a Mexican scientist who researches ocean acidification and shares his science with the Mexican government and fishing communities. The Ocean Foundation, dedicated to reversing the trend of destruction of ocean environments worldwide, provides scientists such as Hernandez-Ayon with research support. "We also train scientists to help them increase the impact of their research," said Alexis Valauri-Orton of the Ocean Foundation.

"Partnerships are key," said Emily Crum, communicator for the NOAA Office of Ocean Exploration and Research. "There's so much to do and explore. No one organization can do it alone."

For example, Mattie Rodrigue of OceanX's team recently collaborated with the Haiti Ocean Project to study sharks in the Caribbean, with a view to long-term shark conservation and sustainable fishing. OceanX combines science with compelling media and storytelling to create an engaged global community of explorers, scientists and storytellers.

Dr. Carlie Wiener, director of communications for Schmidt Ocean Institute, helped create the Artist-at-Sea Program to turn science into art that can reach new audiences. "The arts are a great way to engage people who might be intimidated by ocean science," she said.

NOAA and our partners aim to inspire the next generation of ocean scientists, explorers and workers in the growing blue economy. NOAA offers explorer internships, making an effort to involve young people from underserved communities, communities of color and others who live far from the ocean.

Unlike the first age of exploration of the 15th century, this new age of ocean discovery is not about competition among nations for new territory; this time, we know we need everyone to work together to sustainably develop, understand, protect and restore our ocean. **ST**

Rethinking Design for Monitoring

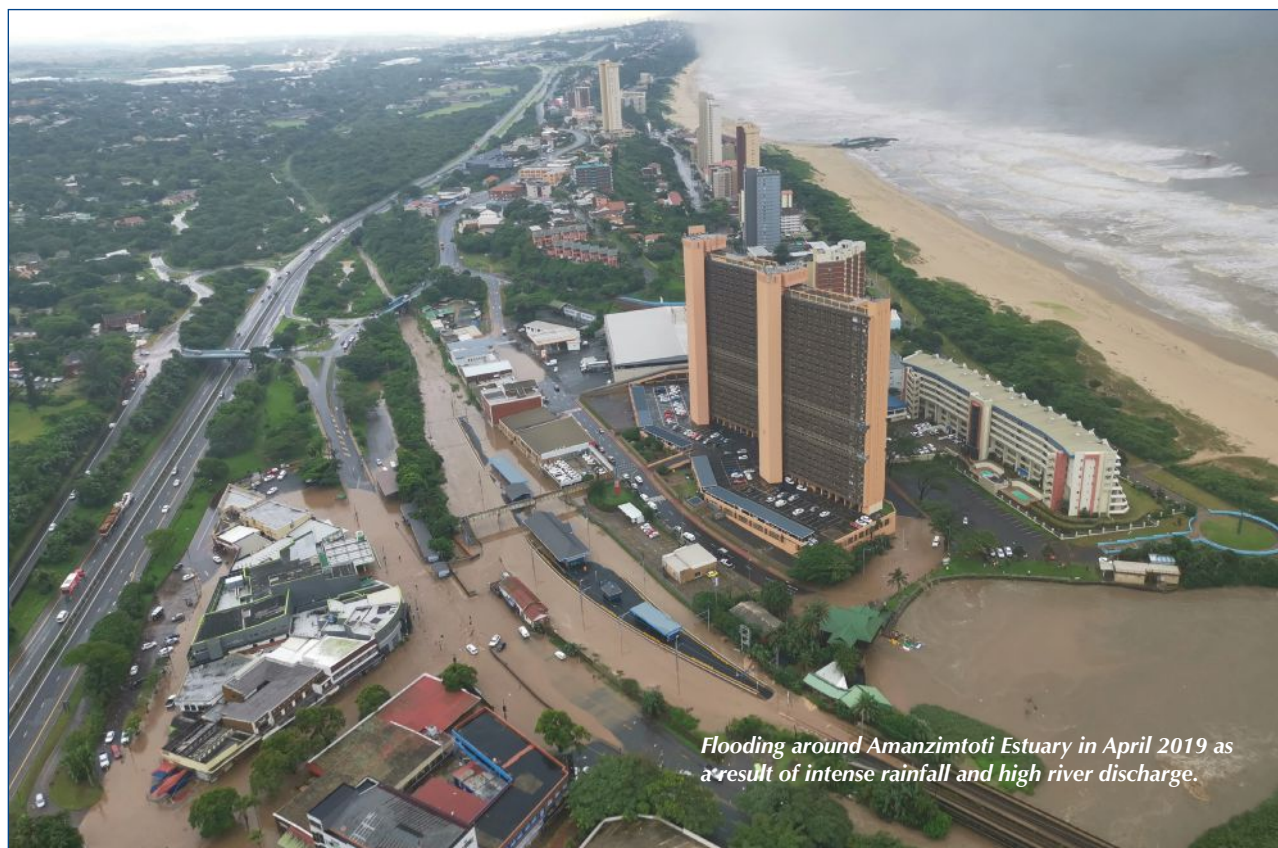
Addressing Coastal Monitoring Challenges in Developing Areas

Dr. Max Radermacher • Zane Thackeray • Godfrey Vella

The majority of the world's population lives in low-lying river deltas. The great fertility and good accessibility of these areas has historically led to the rise of the most important settlements, which have evolved into today's metropolises. Ongoing urbanization adds to this trend. At the same time, these low-lying cities at the mouth of large river systems are prone to natural disasters, mostly originating from their large exposure to water. Storms and heavy rainfall can lead to flooding of

the built environment and result in economic damage, human displacement and loss of life. While this exposure to the forces of nature exists naturally in delta areas, it is aggravated by climate change, accelerated sea level rise and human-induced land subsidence.

Our ability to understand and deal with these threats is undergoing impressive development. Levees and barriers are safeguarding areas that would otherwise suffer from frequent flooding. Sand nourishment schemes



Flooding around Amanzimtoti Estuary in April 2019 as a result of intense rainfall and high river discharge.



The Power & Telemetry Module with a built-in radar sensor makes for a completely wireless, low-maintenance water level gauge. (Below) A wave buoy deployed off the Durban coastline.

create stable coastlines that would otherwise be subject to rapid erosion. Computer models can forecast hazardous conditions multiple days ahead, enabling us to anticipate and take precautions. However, design and construction of flood defenses and the development of accurate forecasting models heavily depend on the availability of environmental observation data. Especially in the developing world, collection of long-term operational environmental data sets receives little attention. Its importance is either overlooked, or it cannot be achieved for various practical and economic reasons.

The highly specialized nature of conventional environmental monitoring equipment leads to a high price level in this market. The number of manufacturers is limited, and the products are the result of a long-running, costly R&D trajectory that, especially in the past, involved highly skilled specialists in the fields of electronics, oceanography, chemistry, etc. Due to the complexity and vulnerability of the equipment, skilled and experienced staff are required to keep it operational in the field over long periods of time. This strongly limits the possibilities to collect environmental data where they are most needed: coastal areas in the developing world.

Obscape, a Netherlands-based environmental monitoring equipment manufacturer, has identified and experienced the issues discussed above during its long-stand-



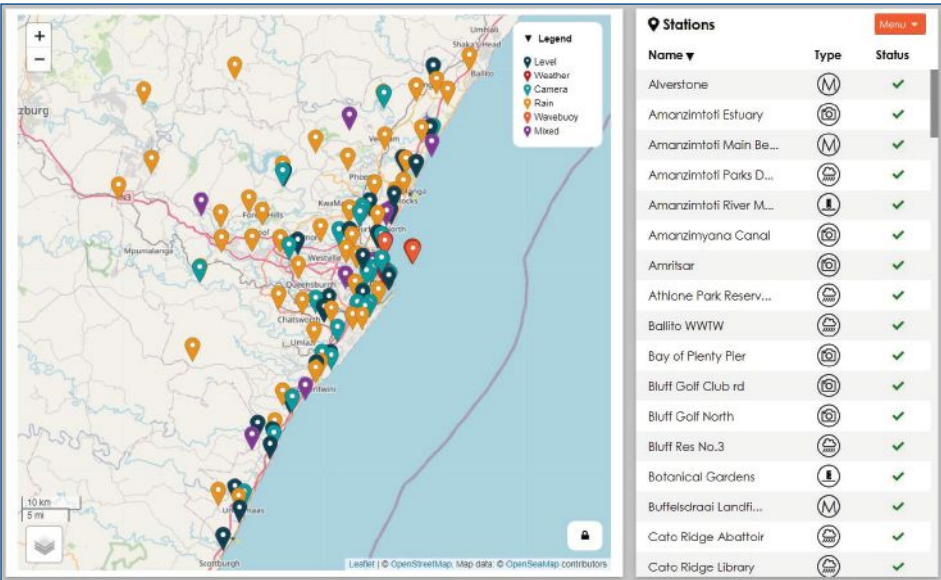
ing collaboration with the eThekweni Municipality (city of Durban) in South Africa. It inspired them to come up with a new design philosophy for their products, which is aimed at the development of affordable, robust and easy-to-use environmental monitoring equipment. The company aims to remove existing barriers for the collection of long-term environmental data sets, making environmental observations available to anyone who needs them.

Challenges of Environmental Monitoring in Durban

Zane Thackeray (co-author of this article) and Rio Leuci started a local survey company in Durban, South Africa, in 2006. Soon after, they were contracted by the eThekweni Municipality to conduct beach surveys in order to keep track of structural erosion of local beaches.



Devices are spray-painted to make them go unnoticed and minimize the risk of theft. (Below) All real-time data are collected into the Obscape Data Portal. The figure shows the current extent of the monitoring network across the eThekweni Municipality.



Coastal erosion is just one out of many complexities that local coastal engineers and water managers are faced with. The city of Durban is set in hilly terrain along

the Indian Ocean coastline. The municipality comprises no less than 17 separate catchment areas, all of which discharge directly into the Indian Ocean. Estuaries with complex morphodynamics have formed at the mouth of each river. Seasonal closing and breaching of the estuaries are associated with flooding and water quality issues. Furthermore, the humid subtropical climate in Durban is associated with intense rainfall events. Given the hilly, paved urban environment, this regularly triggers flash flooding. During these events, river water levels rise rapidly, inundating infrastructure and informal settlements at the riverbanks. Additionally, Durban's beaches are inundated by high swells on a regular basis. Besides eroding the beaches, this has caused damage to properties along the beachfront.

The eThekweni Municipality is responsible for flood defense and disaster management. This task creates a strong need for real-time environmental observations and forecasts. Thackeray and Leuci aimed to expand their activities for the municipality by installing and maintaining a network of monitoring stations. They soon concluded that this could not be done using off-the-shelf equipment, since the budgetary constraints of the project did not allow for the number of sensors required to achieve sufficient spatial coverage.

In addition, they experienced that several practical disadvantages of existing equipment made field operations difficult and time-consuming. First and foremost, theft rates were unacceptably high. Instrumentation is often given a high-tech, aesthetically pleasing look. Solar panels, which in itself are an important feature if one wants to reduce the maintenance level by omitting regular battery swaps, are often placed on an external bracket, making them clearly identifiable. These factors make monitoring equipment look attractive and valuable and therefore substantially increase the risk of theft in many countries. Second, the use of

multi-channel data loggers with several wired external sensors made instrument assembly cumbersome and had an adverse effect on robustness of the system. The latter

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especially holds for the case of submerged equipment, e.g., a pressure sensor-based water level gauge or a water quality sonde.

Finally, data management was far from trivial. Since no single manufacturer offered a full product suite that matched the project's constraints and requirements, data had to be pulled into a central database from different portals with large variations in user-friendliness and functionality. Furthermore, most portals were associated with a substantial license fee after the initial trial period had expired.

A New Design Philosophy

These drawbacks made Thackeray and Leuci realize that they had to start developing their own real-time monitoring equipment. With input and guidance from Godfrey Vella (senior manager of the Coastal Engineering Division of eThekweni Municipality and co-author of this article), they deployed their first prototypes in 2014. This drew the attention of Max Radermacher (co-author of this article), who was looking for affordable sensors to collect field data for his Ph.D. research at Delft University of Technology in the Netherlands. Thackeray's knowledge of electronics and material processing, Leuci's field experience, and Radermacher's software skills and access to the European market were exactly the right ingredients to start an equipment manufacturing company: Obscape.

The company's design philosophy revolves around three core aspects: affordability, robustness and ease of use. This has condensed into the PTM: the Power & Telemetry Module. In essence, it is a single-channel data logger with integrated solar panels, power management, control and telemetry. Shaped like a 1-L milk carton, it is not necessarily the biggest eye-catcher, but that is exactly what its designers wanted to achieve. Three 1-W solar panels are mounted flush on the vertical faces of the PTM, avoiding the typical theft-sensitive solar panel look. Whenever possible, sensors are integrated into the PTM housing, e.g., a camera module (creating a general purpose time-lapse camera) or a radar sensor (creating a water level gauge). This leads to very compact and robust devices without external cables. Real-time telemetry is taken care of by a built-in cellular modem or an optional satellite modem, ensuring worldwide compatibility and coverage. Paired with a global SIM card, the PTM-based products become truly turnkey environmental monitoring solutions: simply press the power button, close the housing, and mount the device to a wall, pole or tree with the versatile mounting bracket.

The intention is to arrive at a broad but coherent PTM-based product range that includes all commonly required equipment for coastal, estuarine and catchment monitoring. This allows the user to work with a single supplier and have all real-time observation data available under one roof. As it currently stands, Obscape offers a radar-based water level gauge (no submerged parts, thus, robust and low maintenance); a time-lapse camera; a weather station; a rain gauge; a conductivity and temperature sensor (toroidal design, limiting biofouling

and maintenance); and a directional wave measurement buoy (lightweight, deployable by hand). While the wave buoy obviously has a different look than the standard PTM, the technical concept and resulting user experience are identical.

Device purchase comes with unlimited access to the Obscape Data Portal, where all real-time data across all different device types are collected and displayed. While most suppliers have made the shift to a business model that revolves around selling periodic data portal licenses, the company has a strong belief that users should not pay for access to their own measurement data. Instead, a freely available portal with extensive functionality for viewing, downloading, managing and analyzing real-time environmental data combined with affordable instrumentation pricing creates a healthy business model with happily returning clients.

Application in Durban

The environmental monitoring network in the eThekweni Municipality currently entails around 125 stations, which will expand to 200 sites over the current contract period. Among others, the network contains four wave buoys, 25 water level gauges, 55 rain gauges, 28 time-lapse cameras and seven weather stations. The large amount of real-time data that are returned by the network are used by the municipality for coastal, stormwater and catchment management purposes.

For example, the aforementioned cycles of estuarine closing and breaching are closely monitored with a combination of a time-lapse camera at the estuary mouth, water level gauges along the course of the river and upstream rain gauges. This yields a complete overview of upstream rainfall causing rising water levels in the river and the closed-off estuary, while the actual breaching event is captured by the camera.

Alongside the monitoring network, the eThekweni Municipality runs an operational forecast model train, which is capable of forecasting potential disasters several days ahead. It consists of atmospheric, oceanic, coastal and riverine models, as well as stormwater runoff models. The existence of the extensive monitoring network is of critical importance for the value of the model forecasts. On the one hand, observation data are used for calibration and validation of the computer models, while on the other hand the real-time observations provide the ground-truth data for the disaster management team during severe storm events.

The design philosophy has proved its value when installing and operating the monitoring equipment. The compact devices require minimal preparation, and installation has been made easy. The radar-based water level gauges are mounted above water, typically on a bridge deck. The lightweight wave buoys are deployed from a RIB. Maintenance has been low since the first PTM-based devices were installed at the start of 2020. None of the devices experienced serious fouling of sensors or solar panels, and data transmission has been stable. Any settings adjustments or firmware upgrades that were needed could be installed over the air via the built-in

cellular modem. Due to the low maintenance level, the field technicians can focus all their attention on further expansion of the network this year.

Future Developments

Over the years to come, the existing product range will expand with a number of new sensors. Based on confirmed requests from existing and potential clients, Obscape has entered into R&D trajectories for water quality monitoring and current monitoring, both buoy-based and mounted to a rigid structure. It is aimed to tackle existing problems in the field of water quality monitoring, such as limiting biofouling and making water quality instrumentation available to projects with a limited budget.

Furthermore, global advances in AI and computer vision are expected to yield a whole new range of applications for the time-lapse camera. Alongside the qualitative time-lapse imagery, this will provide ways to extract all sorts of quantitative information from the images.

Conclusion

In response to practical issues with existing measurement equipment, a new range of instrumentation for environmental observations was developed. The new products were designed to be affordable, robust and easy to use. Deployment of 125 devices across the eThekweni Municipality in South Africa has demonstrated the simplicity of instrument deployment and the robustness of

the equipment when it comes to minimizing the need for maintenance and the risk of theft. These efforts make environmental observations easier to conduct and available to a wider community.

Acknowledgments

We gratefully acknowledge eThekweni Municipality for its continuous support and collaboration, as well as for making its measurement data available for demonstration purposes. **ST**

Dr. Max Radermacher obtained his M.S. in coastal engineering from Delft University of Technology in the Netherlands. While pursuing his Ph.D. with the same institute, he partnered with Zane Thackeray and Rio Leuci to establish Obscape. Radermacher heads the Dutch offices of Obscape and leads software development and sales.

Zane Thackeray obtained his honors degree in geology from the University of Kwazulu-Natal in Durban, South Africa, and is a registered professional natural scientist. Together with Rio Leuci, he established Enviromap, continuing as Obscape after the entry of Max Radermacher. Thackeray heads the Durban offices of Obscape and leads R&D and production.

Godfrey Vella has worked in the coastal engineering field for over 30 years and is a registered professional technologist. As senior manager of the Coastal Engineering branch for the last 17 years at the eThekweni Municipality (city of Durban), Vella is responsible for all coastal engineering design, implementation and maintenance of coastal infrastructure within the 97 km of coastline, as well as for all monitoring of coastal processes together with Obscape, plus numerical modeling.



Ocean Sensor Systems

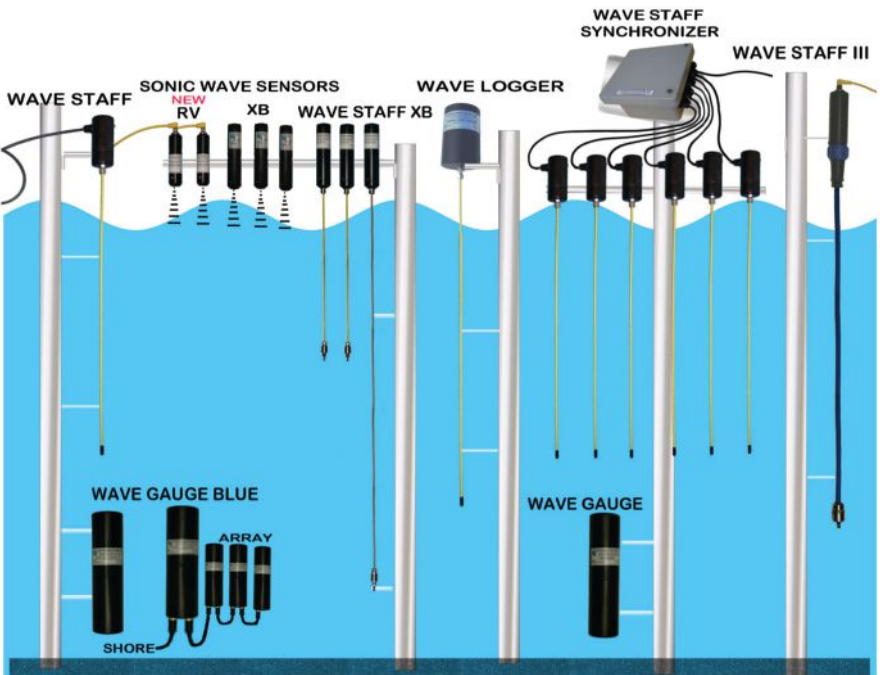
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By Wouter Deknopper



The LT-3100S terminal.

For decades, the Global Maritime Distress and Safety System (GMDSS) has been a mainstay for mariners as an internationally mandated, satellite-enabled communications system dedicated for emergency use. Since its inception, only one provider had been recognized to deliver the service, establishing a monopoly that limited choice for vessel managers and a market that lacked innovation and competition.

This monopoly was challenged in December 2020 when Iridium made maritime history by officially becoming operational as the second-ever recognized GMDSS provider.

This historic moment not only broke the monopoly but has given the GMDSS market a modernized alternative that enhances safety at sea by offering more capabilities,

unprecedented coverage and cost-effective options for vessels of all sizes.

Regarding GMDSS capabilities, there are three services mariners need access to: Distress Alert, Safety Voice and Maritime Safety Information (MSI). With the original GMDSS option, multiple devices are required to equip a ship with all three capabilities. Now with Iridium, GMDSS mariners can install one, small form factor and multi-capable terminal: the LT-3100S, developed by Lars Thrane.

Capability

If an Iridium GMDSS-equipped ship is in distress, help can be instantly reached at the push of a button, regardless of location. When a mariner presses the distress

button, a quick and simple process begins. First, an alert will immediately be sent to a designated Rescue Coordination Center (RCC), and in approximately 10 sec., the terminal will show a notification indicating that Iridium's centralized GMDSS system has received the distress alert. Next, once the RCC acknowledges the alert, the system will show that the alert has been identified, and upon completing this process, the LT-3100S will automatically make a distress call to the RCC, allowing those on board to speak directly with RCC team members. It is important to note that Iridium GMDSS is currently the only satellite system to offer automatic initiation of a distress voice call following a distress alert. The combination of all three GMDSS capabilities allows the crew to give emergency

responders a complete picture of the situation, which can greatly improve overall response efforts and ultimately increase safety for mariners everywhere.

Global Coverage

At the core of the highly capable Iridium GMDSS service is unmatched, truly global coverage, which was previously not available with the original service. Delivered over Iridium's network of 66 cross-linked, low Earth orbit (LEO) satellites, reliable satellite connectivity is available across the entire planet, including the Arctic and Antarctic waters of Sea Area A4, which is outside the coverage of the legacy GMDSS satellite system but where many mariners sail. Iridium's satellite connectivity is delivered over the L-band spectrum, offering a weather-resilient connection even during the most inclement conditions, and the network's location in LEO offers low-latency communications, which is a much-needed capability during emergencies and times of distress. This combination of truly global coverage, weather resiliency and low-latency connectivity makes Iridium's L-band the network of choice for maritime communications, especially for safety services.

Cost

While capability and coverage are key, when it comes to ensuring safety at sea, mariners should never be in a position where safety is sacrificed because of cost. Before the availability of Iridium GMDSS, some ships, such as smaller,



(Top) An artist rendering of the Iridium constellation. (Bottom) The Malik Arctica.





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“If an Iridium GMDSS-equipped ship is in distress, help can be instantly reached at the push of a button, regardless of location.”

non-SOLAS-class vessels, may have passed on installing GMDSS technology because the only option available was too expensive. In addition to its high price tag, the legacy system requires large, cumbersome and difficult to install hardware that can take up valuable real estate that smaller ships cannot spare. The LT-3100S is priced lower than the alternative hardware and offers more services than the single option that has been used by mariners for the last two decades. Additionally, the LT-3100S is smaller, more capable and simple to install, allowing shipowners to streamline overall communications and operations, helping loosen budget restraints and reduce money spent. Iridium's GMDSS offering is available at no additional charge for Iridium subscribers with an Iridium GMDSS terminal and is accessible to ships of all sizes.

Conclusion

Today, Iridium's GMDSS service is available globally, with activations already taking place. The first activation was on board the Norwegian trawler *Trygvason*, with subsequent installations occurring on the *Malik Arctica*, Alaskan ferries, and on board vessels from Denmark, Sweden, Russia and France.

Looking ahead, additional SOLAS (International Convention for the Safety of Life at Sea) and non-SOLAS activations will continue to take place around the world, and plans are in motion to make GMDSS available over Iridium Certus terminals, further simplifying and streamlining shipboard communications for all shipowners. Iridium will continue pushing the boundaries in offering highly capable, reliable and affordable safety services for mariners, no matter where they sail.

For more information about Iridium's GMDSS offerings, visit: www.iridium.com/services/gmdss. **ST**

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Wouter Deknopper is the vice president and general manager of the maritime line of business at Iridium Communications Inc., the only satellite communications company that offers truly global voice and data coverage. In this role, he is responsible for bringing new services and products to market in alignment with Iridium business objectives while being attuned to the needs of the end-users in maritime industries. Deknopper earned a *Diplôme d'études approfondies* (master of advanced study) in European law from the University Jean-Moulin III Lyon and a master's degree in social and political sciences from KU Leuven in Belgium.



Maximizing Digitalization's Benefits

How the Offshore Sector Can Use Data, Expertise to Thrive

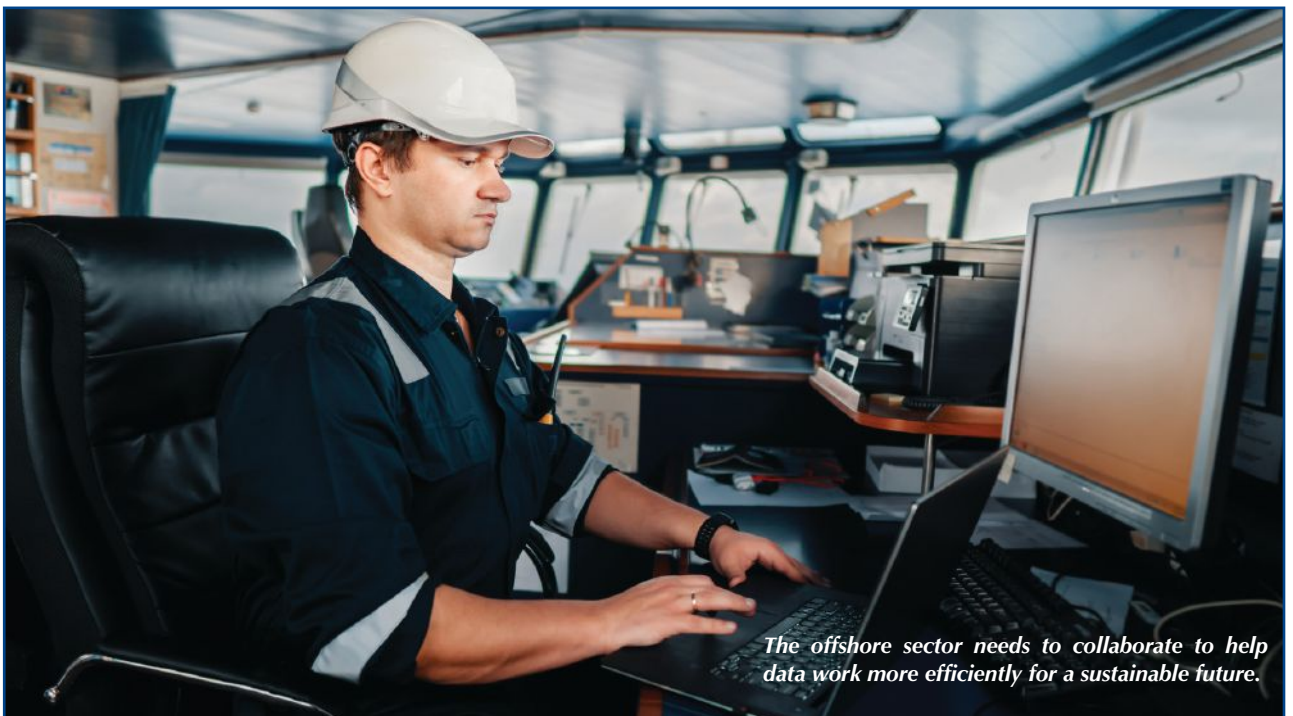
By Arnaud Dianoux

In an era of already slim operating margins, the COVID-19 pandemic has turbocharged the necessity of finding efficiencies in the maritime and offshore sectors. As an industry and as a society, we are confronting the need to deliver a dramatic reduction in greenhouse gas (GHG) emissions while managing an era of profound change.

As the need to decarbonize comes to the fore, a range of different forces are driving change, whether through regulation, such as the International Maritime Organization's ambitious carbon reduction targets for shipping; from the markets, such as the growth in green financing; or wider public sentiment.

An energy transition is inevitable. The question now is how best to navigate this transition and dampen the impact of market volatility on the offshore sector. We've navigated the worst of the pandemic; now, we must build and deliver an operating strategy that can thrive in the next normal.

We already have a primary tool at our disposal: data. The digital revolution has given us access to data on an unprecedented scale. However, it's not a case of just digitalizing your operations. To convert data into actionable intelligence, we face tremendous obstacles daily, ranging from poor connectivity to a lack of digital culture. The data are here, but the question remains: How can we



The offshore sector needs to collaborate to help data work more efficiently for a sustainable future.



Building a digital culture requires buy-in at every level of a company, and the larger industry, to do things differently.

turn the data into meaningful insights to reduce costs, cut carbon, protect margins and improve performance?

Short-Term and Long-Term Success

The sector is at a digital crossroads where mismatched approaches and fragmented data utilization are stunting the offshore sector. As a sector, we need to collaborate to help data work more efficiently to unlock shipping's short- and long-term sustainable future.

The level of data maturity within the industry, combined with the current offshore landscape, makes it difficult for shipowners to invest in additional data sources. However, operators can create immediate value from data collected from multiple sources. Integrating information from weather, positioning, engine data, EFMS (electronic fuel management systems) when available, and more, where applicable, can enhance the effectiveness of systems designed to improve performance.

Frustratingly, the offshore sector faces a siloed, fragmented digital landscape that is not conducive to unleashing the sector's digital potential. Performance management solutions, as opposed to expensive, time-intensive hardware solutions, can bridge the divide. They can offer a clear sense of what's happening on the field with more precision and inform the decision-making processes for logistics and operational teams.

When margins are tight, it is essential that your investment offers tangible improvements. We know that operators cannot afford lengthy lay-ups or technical faults that squeeze already tight margins.

Good performance management solutions, blended with expert insight, can make the difference. Opsealog specializes in performance management, with a particular focus on marine logistics operations for the maritime, offshore oil and gas, and renewable energy sectors. We work with a wide range of exploration and production (E&P) companies, including energy majors and regional

operators, translating their data into intelligence about the deployment of their offshore support vessels.

Through what we describe as "efficiency as a service," our data integration and analysis tools enable vastly improved visibility of vessels to support smarter, better informed decisions, whatever the priorities may be.

Understandably, for many operators, fuel efficiency and carbon reduction is a high priority. Across the global fleet of over 470 vessels that we track and support, we've managed to deliver 80,000 tonnes of CO₂ savings. In 2019, this equated to a 10 percent reduction in emissions from changes in the operational behavior of these vessels by our E&P customers.

How has this been achieved? Better visibility of their vessels informs and supports decision making over operational patterns and vessel deployment to improve performance, cut fuel consumption, and reduce GHG emissions in a verified and measurable way.

Beyond the GHG emissions and reductions, digital solutions can impact an often neglected area of operations: safety. Extensive data on efficiency and emissions provides better monitoring of health, safety, security, and environmental performance and compliance. Data analytics can improve the understanding of environmental risks, and authorities can create more effective regulations and monitoring. What's more, this information is easily accessible through Opsealog's Marinsights web portal, presented in a way that is easy to understand and remains at the fingertips of operators, helping to streamline day-to-day operations.

Adapt to the New Normal

Today's offshore operators, including oilfield service providers and logistics partners, face unprecedented challenges. Digitalization and data insights can enable these businesses to make positive, proactive decisions that will enable them to extend asset life and value and—

in some cases—ensure survival. Opsealog's partnership with an affiliate of a leading energy major illustrates this perfectly. We worked together to build a new solution to support fleet monitoring operations. Its fleet of crew boats suffered from low-quality AIS tracking and poor connectivity. A lack of data and inaccurate reporting prevented the affiliate from having a clear overview of its vessel operations, which inhibited decision making.

The affiliate was able to find other data sources that would complement its fragmented AIS data and build greater data redundancy. The Marinsights platform combined with human insight to process, integrate and visualize data, delivered a single interface to provide a clear, timely picture of the fleet.

The platform provides accurate, timely and actionable information needed to optimize the utilization of vessels to cut fuel consumption, reduce emissions and generate cost control reports. These technologies can enable operators to act with a higher degree of agility that has become the new normal during the pandemic.

As travel restrictions came into force with the pandemic, the sector witnessed a growth in reliance upon data-driven technology sourced from anywhere in the world. For instance, we enabled a European-based customer to remotely manage its offshore support fleet in Nigeria just as effectively as if the customer were in the same location.

Commit to the Digital Journey

It would be naive to think that these are “quick fix” solutions. Though initially plug-and-play by nature, Opsealog's performance management solutions feed into a wider digital transformation, which only succeeds when all stakeholders, from shore-based fleet management to technical support teams to those serving on rigs and offshore vessels, understand the data's importance and buy into the process.

Working with that same affiliate in West Africa, we used our Marinsights service to process, integrate and visualize its data in a single interface with a clear, up-to-date picture of its fleet. The introduction of a platform that unifies and visualizes

data points from across its ecosystem has given the company the accurate insights to optimize vessel utilization by cutting fuel consumption and reducing emissions.

When talking about digital insights, a premium is often placed on real-time reporting, and rightly so, particularly compared to a legacy of daily, weekly or even less frequent reporting. But it's important that your data platform also enables you to take a step back to see the bigger picture. We work collaboratively with our clients through this process, asking the right questions and recommending the most effective way to visualize their data to build a turnkey solution that meets their specific operational needs.

Using the Data You've Got

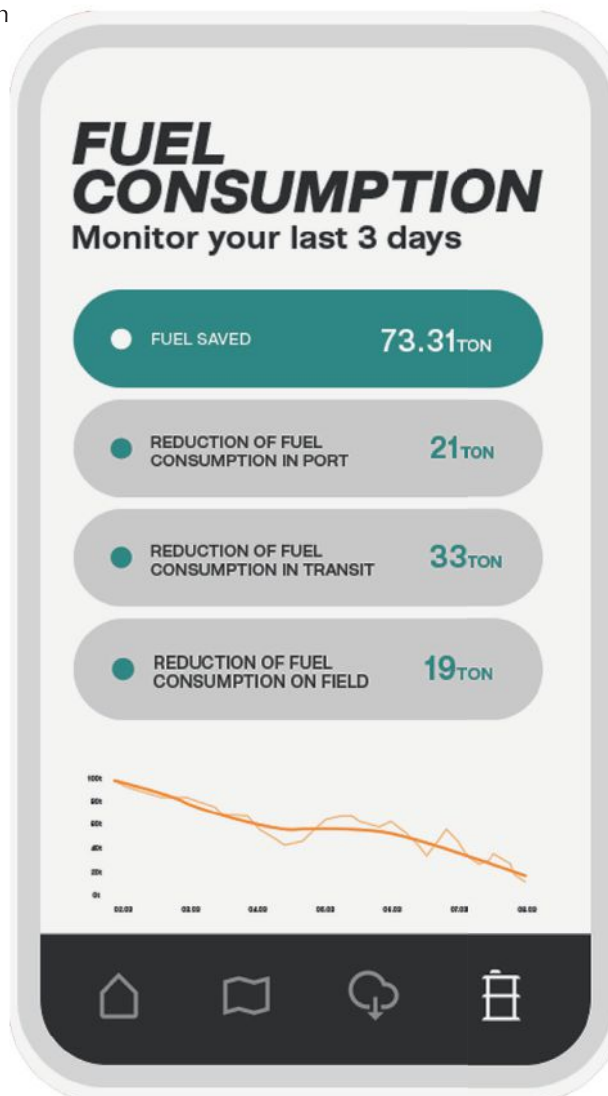
Some firms pause at the digital challenge for several reasons. They worry that it will become too expensive, too time intensive and provide too little value for the money.

In many cases, you can achieve a remarkable amount with the data that many offshore operators already have at their disposal, if they know how to take advantage of the data. That's the case for some clients that operate in locations where there are issues with AIS coverage or other data limitations.

For example, in our work with the same affiliate in West Africa, we were able to address the challenge of fragmented AIS data with other sources of positioning, as well as using other information sources, including EFMS, weather forecasting and onboard reporting software.

Many digital solutions can be deployed now as a proven technology. In our field, there are powerful benefits that we can generate from data that are already available or easily obtained. These data can be obscured by being fragmented or siloed. The sector can achieve a lot by creatively using data from various sources and implementing tailored algorithms to help crosscheck information from these fragmented sources, combining them into one single interface.

Finally, as ship-shore connectivity speeds continue to improve, it makes sense to put in place the data man-



Mobile app of Opsealog's Marinsights platform.

“Good performance management solutions, blended with expert insight, can make the difference.”

agement solutions that are ready to take full advantage of this.

Build the Digital Culture

For any digital effort to succeed, the creation of a robust digital culture is critical. Building a digital culture requires buy-in at every level, from the boardroom to the quayside, the rig and the vessel to do things differently.

When working with our partners and customers in the offshore sector, we know that they need to understand “the why.” If the sector can see how digital tools are driving up performance, reducing costs, tackling emissions and empowering individuals in their roles, the likelihood of a successful deployment of your digital tools will be far greater.

Operators can also learn from other sectors. In our experience, the offshore renewables sector is more digitally minded than its counterparts in oil and gas, from the perspective of their working culture, despite the fact that the renewables market is less mature. An opportunity lies in the fact that the renewables market is embarking on the digital journey while in its infancy, rather than attempting to transform well established processes and thinking. Also, perhaps because of the higher start-up costs facing renewables, those companies are better attuned to the need to operate at the highest efficiency levels.

Clear results must underpin this digital journey. For instance, during a five-month trial period with Opsealog in 2020, ADNOC Logistics & Services achieved a 12 percent reduction in fuel consumption and CO₂ emissions, representing 572 m³ of fuel and 1,519 TEQ of CO₂. Seeing digitalization in action is the most compelling way of showing how data integration and analysis tools,

combined with expert support, can make an immediate impact.

Next Steps

The past year has shed light on the offshore sector’s need to overhaul its manual, legacy solutions to facilitate better decision making at a time when it is needed more than ever.

However, digitalization is not a silver bullet. It takes time, effort and expertise to unlock its profound impacts. For sectors facing financial pressure and tough choices, good data management can provide immediate insights to support revenues and drive down GHG emissions, charting a pathway toward a sustainable industry.

Good data management can also support the strategic choices facing a sector in transition. Wood Mackenzie points out that upstream suppliers must choose whether to ride out the tough times facing oil and gas, or pivot to renewables. This theme is echoed in PwC’s “Time to Choose” report, which describes oilfield service companies at a strategic crossroads. In choosing how best to adapt, good data can play an important part in deciding whether or not assets should be redeployed to alternative uses.

As an industry, we have been quick to describe data as “the new oil.” The smart use of data to improve operational efficiencies has a vital role in helping offshore operations meet the demands placed upon them, delivering profitability and extending asset life and value.

But data, like oil, need to be refined. Only then, with the right analytical tools and a commitment to a digital culture underpinned by human expertise, can the real value be secured. **ST**

French entrepreneur and former Merchant Marine captain Arnaud Dianoux is the managing director of Opsealog. He has over 10 years of experience in the offshore field in multiple regions, including India, China, West Africa and the Black Sea. After pursuing an M.B.A. degree in France and Singapore, he started working on fuel management before focusing on improving global offshore operational efficiency using data analytics and performance management. His passion for data and his maritime experience inspired him to found Opsealog, a company that helps energy clients generate savings by optimizing offshore operations.



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Petrel-Dual

Hybrid Vehicle Navigates On and Under the Water

By Bingxi Liu • Dr. Shuxin Wang • Dr. Yanan Yang

The ocean covers 71 percent of the Earth, yet less than 5 percent of it has been explored. There is a strong demand within the commercial, scientific and government communities for long-term information gathering in the ocean.

Unmanned marine vehicles such as USVs and UUVs have become an indispensable tool for researchers to conduct ocean observation. USVs have high maneuverability and flexibility for surface navigation. UUVs are driven by thruster or buoyancy control to navigate underwater.

In 2018, the underwater vehicle group based at Tianjin University initiated a project to develop a multi-modal unmanned marine vehicle that combines the properties of a USV and a UUV. The result is Petrel-Dual, which features both surface and underwater navigation capabilities.

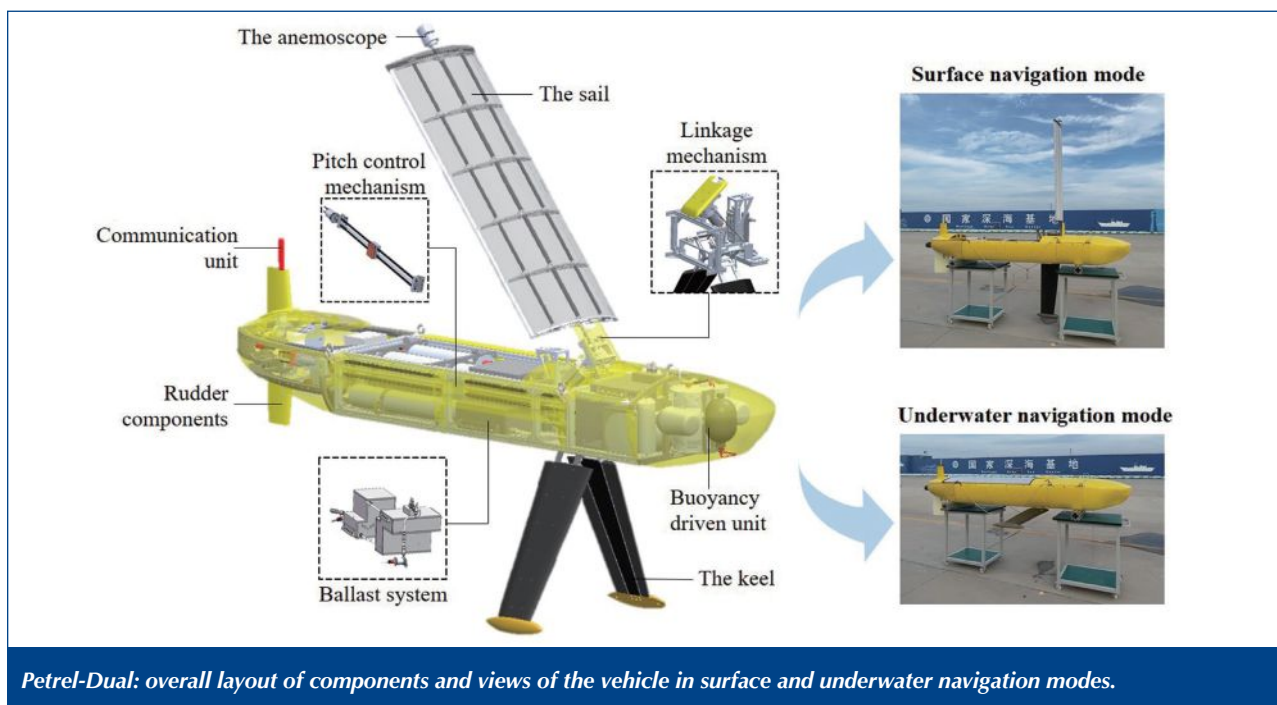
Petrel-Dual is designed to dive to a depth of 200 m.

System Design

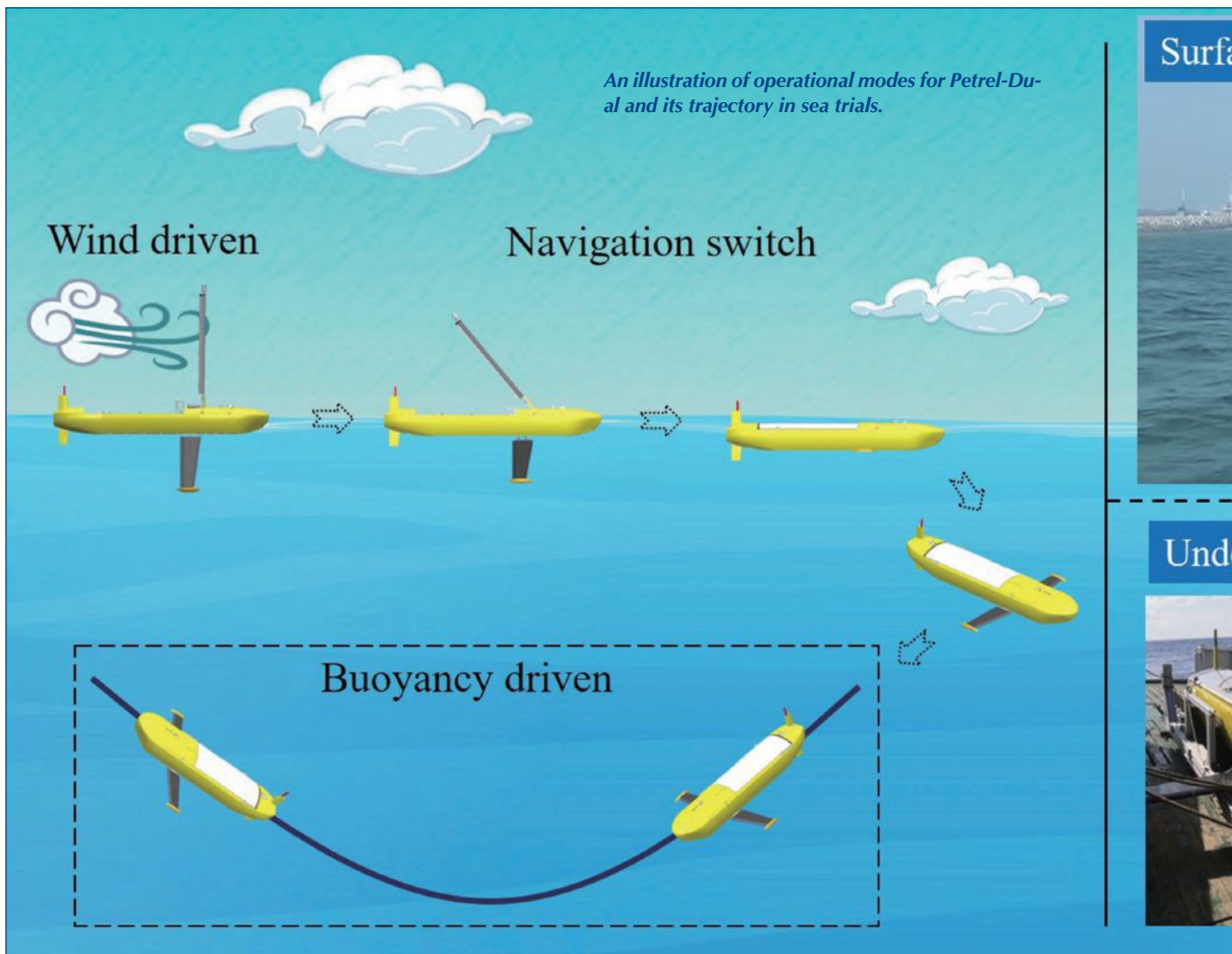
Petrel-Dual is 3.5 m long, 0.7 m wide, 0.5/3 m tall (in underwater mode and surface mode, respectively), and weighs 230 kg. The shape of the vehicle is the typical round bilge hull form.

Petrel-Dual has a distributed layout, which makes it easy to access and maintain its units. The electronics of each unit are installed into separate waterproof chambers, making it possible to contact or mate with the underwater connectors in one chamber without opening the other chambers.

The operating system comprises the following units: wind-driven, buoyancy, navigation switch, navigation control and communication.



An illustration of operational modes for Petrel-Dual and its trajectory in sea trials.



Wind-Driven Unit. This unit contains the sail, the anemoscope and the sail-rotation mechanism. The crescent-shaped sail is 1.4 m high and 0.6 m wide. The outer camber ratio and inner camber ratio are 0.12 and 0.07, respectively, for good aerodynamic performance. The sail has a skin-skeleton structure for enough strength and rigidity with light weight. The skeleton, made of carbon fiber, is used to withstand the shear force, bending moment and torque of wind currents. The skin of the sail covers the skeleton to bear and transfer the aerodynamic load.

The anemoscope, mounted at the top of the sail, obtains data on wind direction and speed with an ultrasonic sensor, which has a wide measuring range, high sensitivity and fast response speed.

The rotation mechanism, located at the bottom of the sail, comprises a motor and a worm gearing. When the mechanism is working, the sail is perpendicular to the hull, and the motor can rotate the sail in all directions along its longitudinal axis through the worm gearing. The sail rotates at a speed of 30° per second.

Buoyancy-Driven Unit. This unit, inside the bow of the hull, uses hydraulic means to enable underwater gliding. It comprises an oil tank, two external bladders, several valves and a hydraulic pump. The oil tank has high-prec-

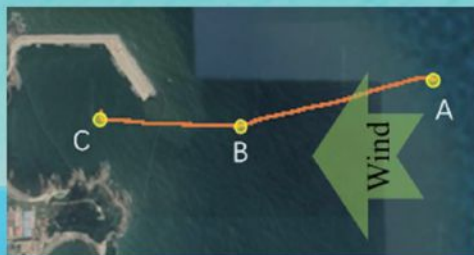
sion oil volume detection capability to precisely control the volume distribution of hydraulic oil in the oil tank and external bladders. The two external bladders are arranged on both sides of the oil tank, on the longitudinal axis of the vehicle. This arrangement reduces deviation of the center of gravity caused by the flow of hydraulic oil and helps to stabilize the attitude of the vehicle.

According to the calculation of hydrodynamic forces during the glide, the oil discharge is set at 4 L. An accumulator improves the speed of oil drain so that the vehicle can complete the switch between diving and climbing faster. The average flow rate of oil drain and return is 0.8 L/min. and 0.4 L/min., respectively.

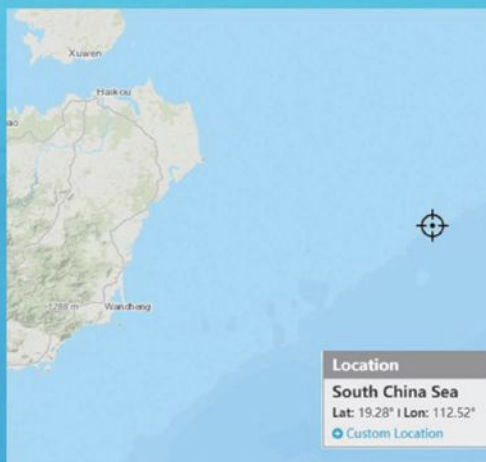
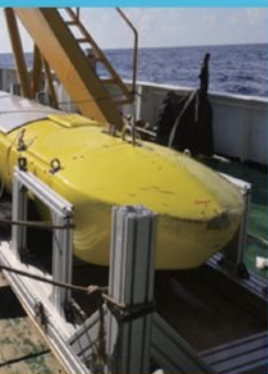
Navigation Switch Unit. This unit contains a sail-keel linkage mechanism and a ballast system. The sail-keel linkage mechanism, located in the middle of the hull, folds and unfolds the sail and keel. The mechanism is driven by a single hydraulic actuator and enables linkage through multiple sets of connecting rods. This mechanism is designed to be compact, and the gravity of the sail and keel counterbalances each other to reduce the force required for driving.

The ballast system rapidly regulates the submerged volume of the vehicle by injecting or draining seawater into and out of the reserve tank. This system, compris-

Surface trial



Underwater trial



Operational Principles

Petrel-Dual has three modes of operation: surface navigation, underwater navigation and navigation switch.

In surface navigation mode, Petrel-Dual can be driven by the wind within a 300° wind range. In a downwind situation, the sail angle is at 0°. For every 30° change in wind direction, the sail angle rotates 18° in the corresponding direction, and the maximum sail angle is 72° in each direction. In an upwind situation, the vehicle must gybe several times and approach the target by zigzag navigation. An algorithm enables the sail to generate and maintain the maximum driven force in the current course autonomously.

By comparing the current course with the target, the rudder components adjust the angle of the rudder in real time to ensure course accuracy. The keel folded under the hull lowers the center of gravity to enhance the stability of the vehicle.

In underwater navigation mode, the keel spreads out on both sides of the hull as wings. Gravity-based buoyancy lowers power requirements. Horizontal translation is realized by the hydrodynamic force on the hull and wings.

The accumulator is pre-charged with 2 Mpa of pressure for a target depth of 200 m. During the dive, the hydraulic pump increases the pressure of the accumulator to 10 Mpa. When the vehicle dives to a pre-set depth, the accumulator releases the hydraulic oil first, and then the hydraulic pump is powered on to move the remaining hydraulic oil from the oil tank to the external bladder.

The pitch control mechanism adjusts the attitude of the vehicle in real time to maintain the target glide angle. Course control, similar to the surface navigation mode, is also realized by the rudder components.

The switch mode controls surface-to-underwater and underwater-to-surface switching. The surface-to-underwater switch has three steps: sail initialization, sail-keel linkage and water injection. In the first step, the sail rotation motor powers on and drives the sail to rotate back to the initial position. In this step, the waterline height is 230 mm from the bottom of the hull. The center of gravity of the vehicle is above the center of buoyancy, and the stability of the vehicle is maintained by the reserve buoyancy generated by the hull above the waterline. In step two, the sail lowers backward 90° to fall on the hull, and the two wings simultaneously pivot upward 90° to the left and right sides of the hull. In this step, the waterline height remains unchanged, and stability is maintained by the reserve buoyancy. In the third step, the injection pump of the ballast system powers on to inject seawater into the front and rear tanks until the water touches the water level probes, which means the tanks are full. In this step, the waterline height is at 360 mm, meaning that the hull is almost entirely submerged. With loss of reserve buoyancy, the center of gravity is lower than the center of buoyancy to maintain vehicle stability. These three steps are reversed for the underwater-to-surface switch.

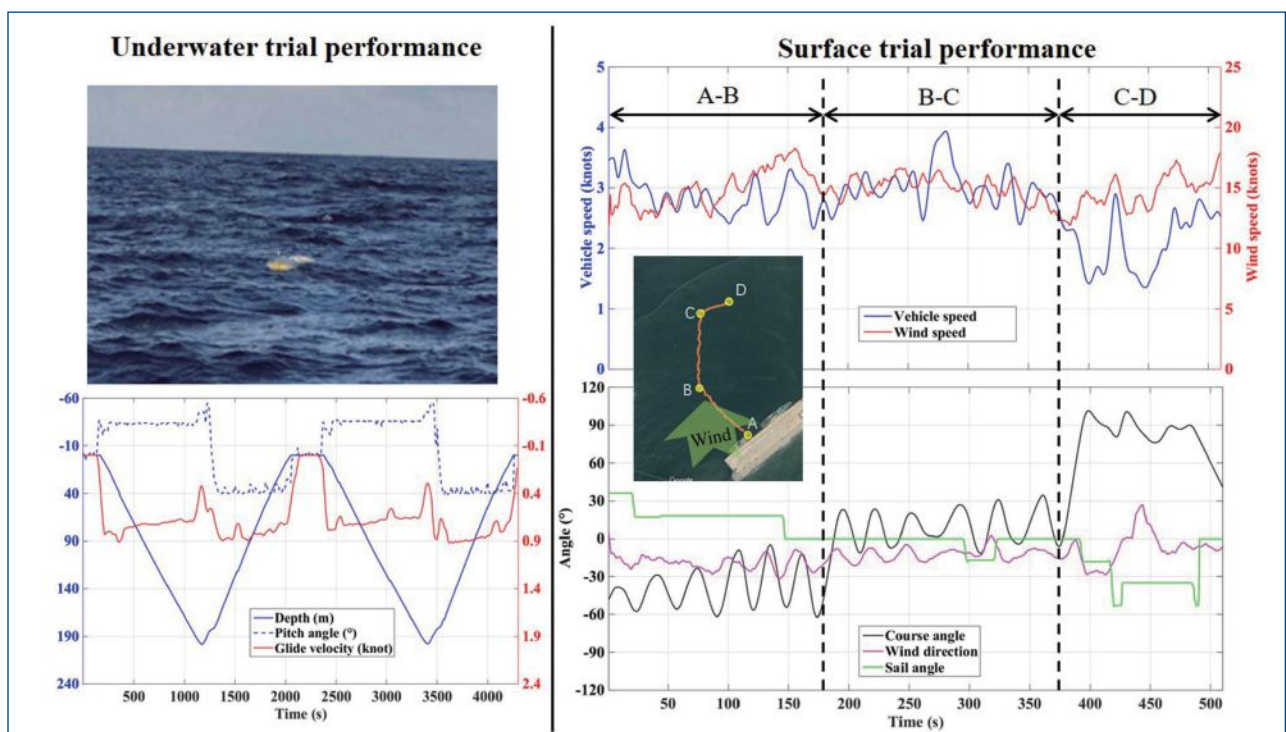
ing the front and rear tanks, the injection and drainage pumps, and water level probes, has an adjustment capacity of 46 L. The injection and drainage pumps are centrifugal, which has the advantages of large flow rate and light weight under low load condition. The average flow rate of injection and drainage is 3.4 L/min. and 2.8 L/min., respectively.

Navigation Control Unit. This unit contains a pitch control mechanism and the rudder components. The current heading and attitude information of the vehicle is measured by a compass.

The pitch control mechanism can control the motion state of the vehicle in vertical dimension, such as the glide angle. The mechanism is composed of a lead screw slider system and adjusts the motion attitude of the vehicle by moving the center of gravity. The lead screw runs along the longitudinal axis of the vehicle within 1.3 m.

The rudder components located on the stern of the hull can control the course in the horizontal dimension. The steering gear has self-locking capability to reduce the energy consumption of the system.

Communication Unit. This unit contains an Iridium satellite module and a wireless communication module with dual-mode communication function. The location of the vehicle is obtained by GPS.



The navigation performance of Petrel-Dual in underwater and surface trials.

Sea Trials

In August 2020, surface trials were carried out at the port of Qingdao National Deep-Sea Base, with a wind speed of 4 to 16 kt. When the wind speed was above 8 kt., Petrel-Dual had good maneuverability and realized route-keeping and a small turning radius of 5 m. The maximum speed of the vehicle reached 4 kt. When the wind speed was less than 7 kt., the vehicle yawed under the influence of water flow due to its insufficient power, and the turning radius became larger. In the upwind state, the vehicle made four turns to reach the target position.

In October 2020, Petrel-Dual was deployed in the South China Sea to test its underwater performance. Petrel-Dual completed several profiles, and the deepest diving depth was 202 m. The pitch angle of the vehicle was stabilized at -40° and 40° , respectively, in diving and climbing phases. The glide speed was 0.6 to 0.8 kt., and it took about 30 min. to complete a profile. Oil discharge was 2.8 L (70 percent of the total). The temperature and conductivity of the seawater were obtained by the on-board CTD sensor.

Conclusion

Petrel-Dual is a multi-modal unmanned marine vehicle that can navigate both on the surface and underwater, thus making it possible to carry out multidimensional ocean observation. It realizes low-power navigation by utilizing the wind for propulsion on the surface. Through buoyancy control, the vehicle is propelled underwater by the hydrodynamics generated from the water current on the hull and wings. The sail-keel linkage mechanism

enables the vehicle to maintain stability on the surface and underwater.

In the future, Petrel-Dual will integrate more oceanographic instruments, such as dissolved oxygen sensors, a current meter and cameras, to make it a more versatile platform capable of gathering physical and biological data. The vehicle will play an important role in the further observation of the air-sea interface and epipelagic zone.

Acknowledgments

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We would like to thank the Petrel underwater group members at Tianjin University and the engineers of the Pilot National Laboratory for Marine Science and Technology (Qingdao) who contributed to vehicle research.

References

For a list of references, contact Yanan Yang at yaohu aanjian@163.com. **ST**

Bingxi Liu received a master's degree at Ritsumeikan University in 2011 and is now a Ph.D. student in mechanical engineering at Tianjin University. He has been engaged in the design, development and operation of the Petrel series of underwater gliders.

Dr. Shuxin Wang received a Ph.D. in mechanical engineering at Tianjin University in 1994. He is a professor of mechanical engineering at Tianjin University, a Chang Jiang Scholar of China, and has more than 20 years of experience in research on underwater vehicles and intelligent robots.

Dr. Yanan Yang received a Ph.D. in mechanical engineering at Tianjin University in 2017. He is active in the development of AUVs and is a key developer of an underwater glider that utilizes energy from thermal gradients in the ocean.

Thermal Energy for Movement

Glider Buoyancy Adjustment Using Ocean Thermal Energy

By Dr. Hongwei Zhang • Jun Liu • Dr. Yanan Yang

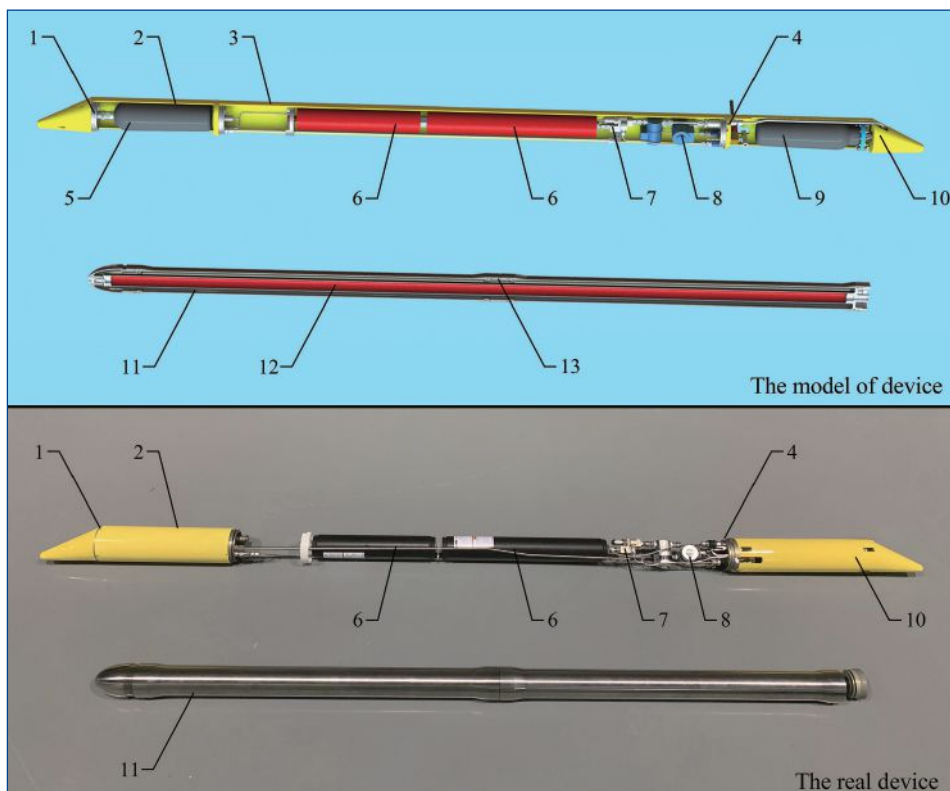
Deep-sea observation and exploration puts high demands on underwater vehicles. At present, underwater vehicles are mainly powered by batteries and fuel, which affect the carrying capacity of a vehicle and its duration capability. The utilization of ocean energy is a way to solve the problem of long-term energy supply for underwater vehicles to improve their endurance.

Ocean energy comes in various forms, such as thermal, wave, salinity gradient, wind and tidal. Here, we focus on thermal as an energy source for underwater vehicles. Ocean thermal energy comes from the temperature difference between the warmer near-surface layer and the colder depths of the ocean. This kind of energy is relatively stable, with small day-night fluctuation, and it only changes slightly with the seasons.

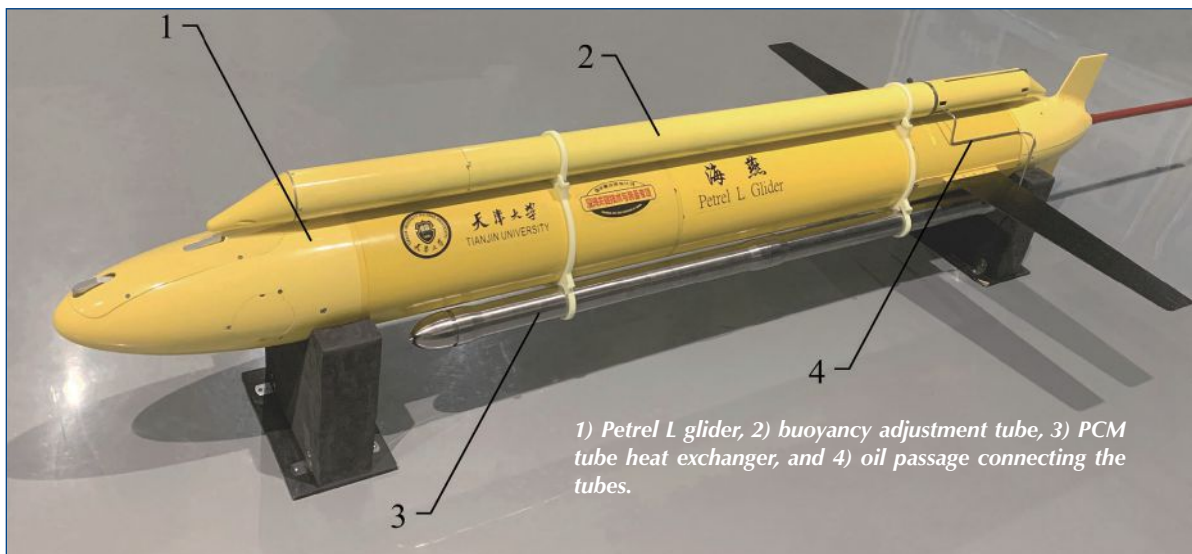
The motions of descent and ascent by underwater vehicles allows for the conversion of ocean thermal energy into power. This type

of energy is suitable to power small and medium-size underwater vehicles. When repeatedly crossing the cold and warm water layers of the ocean, underwater vehicles could convert ocean thermal energy to hydraulic energy through the periodic thermal expansion and contraction of solid-liquid phase change material (PCM) to obtain the power needed to adjust buoyancy.

Existing thermal-powered ocean technology, such as gliders and buoys, generally integrates a thermal energy drive system into the vehicle body, which increases the complexity of the system and affects the layout of subsys-



Schematics of the buoyancy adjustment device in model and actual forms: 1) head-end cover, 2) front tube, 3) middle hull, 4) tail-end cover, 5) bladder, 6) accumulator, 7) valve block, 8) solenoid valves, 9) outer oil bladder, 10) fairing, 11) pressure pipe, 12) compressible rubber hose, and 13) coupling ring.



tems. This complicates research and development with high cost and a long cycle. As an alternative, we have developed a modularized compact buoyancy adjustment device driven by ocean thermal energy.

Modular Design

The device consists of a buoyancy adjustment tube and two PCM tube heat exchangers. The pressure-resistant closed cavity of the buoyancy adjustment unit comprises a head-end cover, a front tube, a long middle hull and a tail-end cover, which protects the internal hydraulic system against the high pressure of the deep-sea environment. The head-end cover and the front tube constitute the inner cavity of the tank, where the bladder is installed. The hydraulic components, such as accumulators, valve blocks and solenoid valves, are arranged in sequence on the axis of the long middle tube. The outer oil bladder contacts with seawater and is protected by a fairing.

The buoyancy adjustment tube uses a cylindrical piston accumulator with a large length-to-diameter ratio and a simple structure, instead of a bladder accumulator or diaphragm accumulator. Two self-locking solenoid valves are used to prevent oil leakage under high pressure, and they are arranged in a cross. Oil passes through the gap between the inner wall of the long middle tube and the valves. The oil passages and cartridge valves are installed inside the tail-end cover, which functions as a valve block and pressure container. This design can greatly reduce the space occupied by the components and the diameter to achieve compactness.

The PCM tube heat exchanger has a double-layer structure. The outer layer is the pressure pipe made of TC4 titanium alloy, formed by two separate pipes connected with a coupling ring. The inner layer is a compressible rubber hose, which is arranged along the axis of the tube to physically separate the phase change material, hexadecane, from the hydraulic oil. More pressure pipes can be added to form an internal cavity of phase change material with expandable volume.

The buoyancy adjustment tube and tube heat exchangers of the modularized buoyancy adjustment de-

vice are circumferentially arranged around the body of the vehicle. As an independent function module, the device is suitable for external installation on commercial underwater glider platforms, such as the Teledyne Slocum, Bluefin Spray, and China's TJU Petrel and Seawing. Based on the distributed control framework of the platform, the device, which adopts a typical 24-VDC power supply and RS232 serial communication mode, can access the upper computer of the platform through a watertight cable. The power consumers of the device are only an oil pressure sensor and two self-locking solenoid valves, which enables low power consumption.

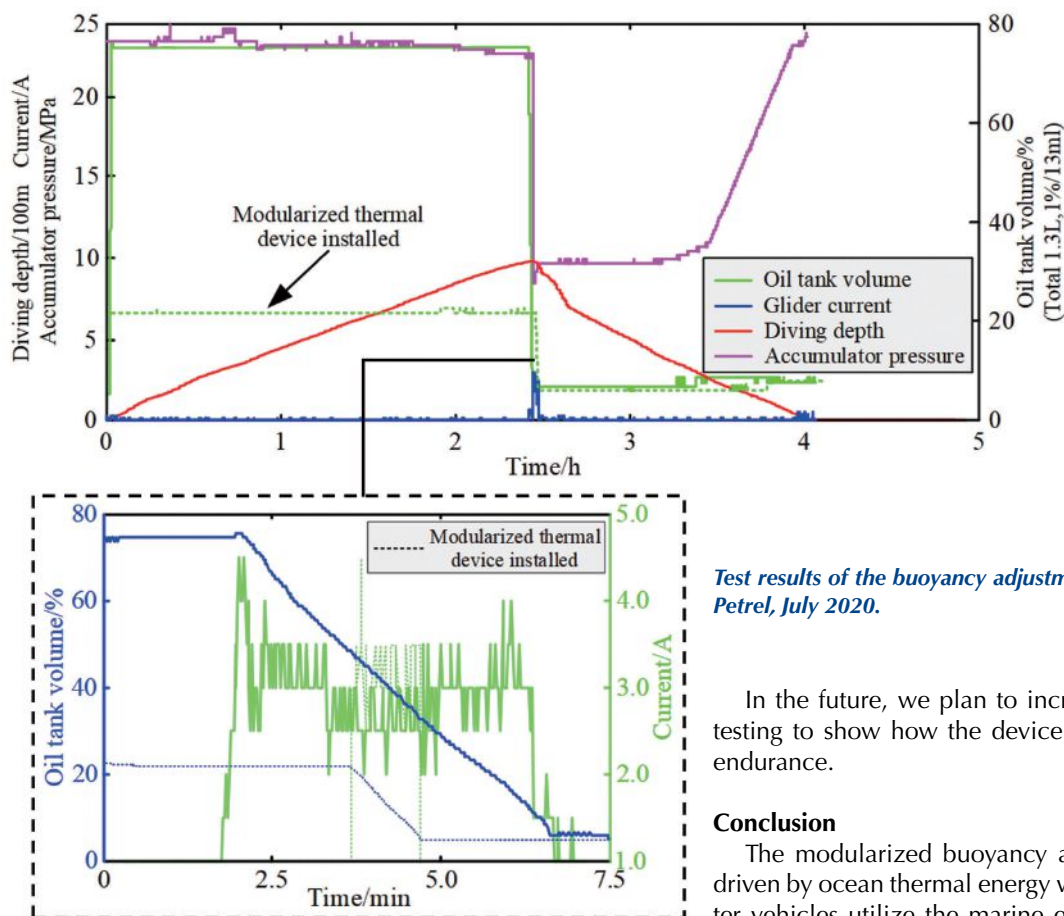
Operational Principles

During the underwater vehicle's descent and ascent, the modularized buoyancy adjustment device driven by ocean thermal energy realizes the shift of the working phase through the switch of oil passage.

At the surface stage, the oil-return solenoid valve starts to work. Under the pressure difference between the bladder (with pre-charge pressure of 0.5 bar) in tank and the atmospheric pressure, the hydraulic oil in the outer oil bladder flows into the tank through the oil-fill passage (the first oil passage). The volume of the outer oil bladder decreases gradually while the displacement of the device decreases, and buoyancy turns negative from positive, so the vehicle starts to dive.

During the diving stage, the temperature of seawater decreases with greater depth. When the temperature is lower than 18.15° C, the phase change material contained in the tube heat exchangers begins to solidify and shrink, and the hydraulic oil in the tank is drawn to the tube heat exchangers through a second oil passage until the phase change material is completely solidified.

When the vehicle dives to the target depth, the solenoid valve for oil discharge starts to work; the stored high-pressure oil flows into the outer oil bladder through a third oil passage, and the volume of the outer oil bladder gradually increases until the pressure is equal to that at the target depth. In this process, the displacement of the device increases constantly, and the vehicle gains positive buoyancy and starts to ascend.



Test results of the buoyancy adjustment device on the Petrel, July 2020.

In the future, we plan to increase the range of testing to show how the device improves vehicle endurance.

Conclusion

The modularized buoyancy adjustment device driven by ocean thermal energy will help underwater vehicles utilize the marine environment as an energy source. This will reduce marine pollution caused by chemical leakage and improve vehicle endurance and longevity. We envision an array of underwater vehicles driven by ocean thermal energy to carry out ocean research and exploration at great depths.

Acknowledgments

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We would like to thank Petrel underwater group members at Tianjin University who contributed research for this technology.

References

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Dr. Hongwei Zhang received a Ph.D. in mechanical engineering at Tianjin University in 2007. He is an associate professor of mechanical engineering at Tianjin University. He has completed several major projects on underwater gliders. His interests include technology design and manufacturing and the dynamics of underwater gliders.

Jun Liu is a master's degree candidate in mechanical engineering at Tianjin University. He works on the design, development and operation of drive devices for underwater gliders.

Dr. Yanan Yang received a Ph.D. in mechanical engineering at Tianjin University in 2017. He is active in the development of AUVs and is a key developer of an underwater glider that utilizes energy from thermal gradients in the ocean.

During the ascending stage, the seawater temperature gradually rises as the depth decreases. The phase change material melts and expands. Under the action of the expansion force, the hydraulic oil in the tube heat exchangers flows into the accumulators through the fourth oil passage. The pressure of the accumulators gradually rises until the phase change material is completely melted. At this point, the buoyancy adjustment device completes one working cycle and floats on the sea surface again, ready to enter the next working cycle.

Installation

The modularized buoyancy adjustment device has been installed on the Petrel glider and comprises three cylindrical components, which are mounted circumferentially on the hull of the glider. Both tube heat exchangers are 1.68 m long and weigh 7.4 kg, with an external diameter of 68 mm. They carry 6.34 L of phase change material in total to capture ocean thermal energy. The buoyancy adjustment tube is 2.29 m long and weighs 15.9 kg, with an external diameter of 90 mm. The accumulators in the buoyancy adjustment tube have a capacity of 0.75 L and maximum energy storage pressure of 25 MPa, which can provide reliable energy support for buoyancy adjustment.

In July 2020, a sea trial was conducted with the Petrel in the South China Sea to test the performance of the device. The trial demonstrated that the device has a working depth of 1,000 m.

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CRP Subsea Business Created

Trelleborg Offshore UK Ltd. has announced a management buy-out of the U.K., Skelmersdale-based business from the parent Trelleborg Group, with financing provided by Praetura Corporate Finance. The new owners, Alan Burgess and John Drury, expect that the buy-out will renew focus and improve performance for key customers in the oil and gas and offshore renewables sectors, delivering subsea buoyancy and bend protection solutions. In a nod to its pre-Trelleborg roots, the new business will be named CRP Subsea Ltd.

Desalination Grant for DuPont's CCRO Tech

DuPont has been awarded a three-year, \$1.3 million grant from PUB, Singapore's National Water Agency, on behalf of National Research Foundation, Singapore (NRF) to determine how closed circuit reverse osmosis technology can be applied to desalination processes to make the purification of seawater more energy efficient, flexible and reliable. Through this project, the CCRO technology will be optimized for seawater desalination systems to operate at 15 percent or lower energy than conventional reverse osmosis systems using energy recovery devices.

Testing of Methanol as Marine Fuel

Major tests of methanol as a marine fuel are scheduled at the Alfa Laval Test and Training Centre in Aalborg, Denmark. Working closely with MAN Energy Solutions and other partners, Alfa Laval will explore the possibility of running the center's four-stroke, 2-MW diesel engine on methanol without modifications or another pilot fuel. The testing is the third stage in an ongoing research project funded by the Danish Energy Technology Development and Demonstration Program.

Collaboration on USV Sales in Canada

HydroSurv Unmanned Survey (UK) Ltd. has signed a collaboration agreement with Orange Force Marine Ltd. to collaborate on the sale of USVs and provision of USV-based hydrographic and environmental surveying services in Canada.

"Our mission is to democratize ocean data, and by using our globally innovative USV technology with our cloud-based data visualization, we can put actionable intelligence into the hands of hydrographic and environmental survey commissioners," said David Hull, CEO of HydroSurv. "The Canadian market is an important market for 'robotics-as-a-service.'"

ESA to Support Blue Economy

The European Space Agency (ESA) and the World Ocean Council (WOC) have signed a memorandum of collaboration to advance support for ocean-related industry through space-based systems and data. ESA aims to establish a dialogue with the maritime sector to better understand the requirements of businesses involved

in the blue economy. The agency seeks to promote the application of existing space solutions to support the sustainable use of the ocean and is proposing mechanisms to engage maritime players in ESA activities as representatives of the sector, for example, through studies, demonstrations and tests of space applications or technologies for the maritime sector.

ClassNK's First RMSV Notation for Newbuild

ClassNK has granted its remote survey (RMSV) notation for *Century Highway Green*, an LNG-fueled PCC operated by Kawasaki Kisen Kaisha Ltd. ("K" LINE). This is the first vessel on ClassNK's registry to be marked with RMSV notation at the time of delivery.

New Company for Methanol-to-Hydrogen Tech

Ardmore Shipping Corp. has formed and invested in a new joint venture with Element 1 Corp. (E1) and Maritime Partners LLC to bring E1's methanol-to-hydrogen technology to the marine sector.

The three parties will establish an equal share partnership to form e1 Marine, a new company that will have a worldwide remit for the marketing, development, licensing and sale of E1's hydrogen generation systems for the marine industry, including shipping, refrigerated containers, offshore energy, renewable energy, passenger and leisure, and port infrastructure applications.

DNV Supports Additive Manufacturing

DNV has released a new service specification document to support stakeholders across the additive manufacturing (AM) value chain to ensure AM products, assets, and systems are safe and efficient. The specification can support the global oil and gas and other energy industries to adopt AM technology for gaining cost and efficiency benefits while maintaining safety.

Additive manufacturing, the industrial equivalent of 3D printing, is an emerging technology that uses 3D model data to fabricate parts. AM could help to avoid long, expensive production shutdowns and reduce supply chain carbon footprints. Building trust in 3D-printed parts is key to unlocking this potential.

New Kraken Contracts, Funding

Kraken Robotics Inc. has secured new contracts for subsea batteries and synthetic aperture sonar and new funding support totaling \$2.2 million. An existing U.S. defense industry customer is acquiring additional SeaPower batteries; another defense customer has awarded Kraken a contract for an AquaPix MINSAS120 sensor for integration into AUVs; and, as part of the Ocean Technology Center campus in Rostock, Germany, Kraken Power will start two projects later this year.

NOAA SBIR Grant for TCarta SDB

TCarta Marine has been awarded a Small Business Innovation Research (SBIR) Phase II grant from NOAA. The research focuses on enhancing satellite-derived bathymetry (SDB) technology for application in the coastal waters of Alaska. SDB extracts water depth measurements

from multispectral satellite imagery using advanced physics-based algorithms. Traditionally, this technology has yielded the most accurate results in clear, calm waters. TCarta has recently taken the lead in expanding SDB applications to more challenging marine environments worldwide.

OceanWise Partners with M3P

OceanWise Ltd. has partnered with Marine Pollution Prevention and Preparation SA (M3P), an independent company in Panama, Guatemala and Honduras, to offer technical environmental consulting for: shipping and ports, oil and chemical pollution, spill contingency plans, ship and port waste reception and treatment, and pollution prevention and control programs.

Key to the partnership will be the expansion of OceanWise's Port-Log data platform, which provides a quick and easy storage and publishing solution for environmental data.

ROAM Enables Remote Survey

Using its new Remote Operations Access Module (ROAM), Sonardyne surveyors based in the U.K. were able to remotely access and operate the Fusion 2 survey and construction software onboard Subsea 7 vessels in the Gulf of Mexico. By using the ROAM, potential limitations on operations posed by international travel restrictions were mitigated, and the decision to upgrade from Fusion 1 to Fusion 2 was de-risked.

ROAM is a rugged, portable communications link in a box that can operate over satellite or any other available network, such as 4G/5G and vessel Wi-Fi, providing secure access between Sonardyne engineers and any vessel needing remote expert assistance.

Thordon Bearings for Canadian Icebreaker

CCGS *Terry Fox*, one the largest icebreakers in the Canadian Coast Guard (CCG) fleet, has returned to service with new Thordon propeller shaft bearings after concluding that fitting laminate phenolic bearings would extend drydock time and costs.

The starboard shaft has been operating Thordon bearings for more than 20 icebreaking seasons.

World's Youngest, Greenest Fleet

Fleet age is the leading indicator of a greener fleet, and the Republic of the Marshall Islands (RMI) Registry comprises the world's youngest bluewater fleet, with an average age of 9.4 years, based on Clarksons Research's World Fleet Register. More than 50 percent of the gross tonnage of the RMI-flagged bluewater fleet uses green technologies.

Great Lakes Dredging Totals \$90.3 Million

Great Lakes Dredge & Dock Corp., the largest provider of dredging services in the U.S., has received dredging awards totaling \$90.3 million. The work includes the Boston Harbor Navigation Improvement Project (phase three) and rehabilitation for the Panama City Beaches Coastal Storm Risk Management Project in Florida. **ST**

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

Fish-Finding Sonar



Simrad SY50 is a compact fish-finding omni-sonar for small coastal fishing vessels. It allows users to choose any frequency between 54 and 60 kHz, adjustable in 0.5-kHz increments, for a potential operating range of up to 2,000 m (depending on acoustic conditions). Kongsberg Maritime.

High-Precision Transmissometer

LISST-Tau is compact and 2,000-m rated for underwater vehicles, profiling packages, CTDs, remotely

operated towed vehicles and other underwater systems. The LISST-Tau is available with a green or red light source and uses a 15-cm path length for high-precision measurements across a wide range of water types. Sequoia Scientific Inc.

Online Ship Supply Marketplace

Apollo is a backend solution that streamlines product ordering, payment and fulfillment into one simple, seamless action, from request to products delivered and paid. Vessel crew can select exact products for reliable, worldwide last-mile delivery with a click of a button, while suppliers gain direct access to customers. Moscord Pte. Ltd.

Next-Generation USV

XO-580 is a new aluminum design joining the fleet of XO-450s, deliv-

ering faster, deeper and longer over-the-horizon surveys. This platform offers a safe, economic and carbon-neutral solution to collecting ocean data. XOCEAN Ltd.

VeroStar GNSS Antennas



The VSP6037L-MAR supports the full GNSS spectrum, and the VSP6337L-MAR supports GPS/QZSS-L1/L2/L5, GLONASS-G1/G2/G3, Galileo-E1/E5a/E5b, BeiDou-B1/B2/B2a and NavIC-L5 signals. Both antennas support L-band correction signals. Tallysman Wireless Inc.

SonarWiz Update

SonarWiz 7.7.4 is now available with new features, including: map corrections for magnetometer; real-time display improvements for bow line; new single-beam and sub-bottom server for Teledyne Odom E20; and updates to the Grid Editor. Chesapeake Technology Inc.

3D Seismic Offshore Solution

PIKSEL is a compact marine seismic solution for acquiring seismic data for high-resolution 3D imaging of targeted offshore areas. PIKSEL draws on the low-noise performance of its Sentinel streamer's hydrophone design, as well as an optimized rigging and handling system that minimizes vibration. Sercel and Kappa Offshore Solutions.

Acquisition Software

Onboard360 with CARIS Collect delivers seamless data flow to the Ping-to-Chart workflow. When combined with the Onboard360 Process module, logged data are imported and processed automatically, allowing near-real-time and remote quality monitoring of surveys. Teledyne CARIS.

Nautical Alarm

NAS 24 comprises an operating

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panel and a control unit. Applications include: tank level alarms; bilge level alarms; boiler salinometer alarms; boiler oil level alarms; watertight doors; and fire doors. Daniamant A/S.

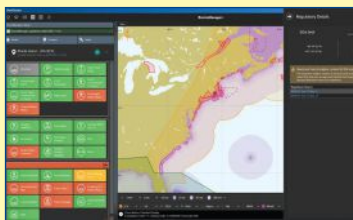
Professional Development App

The NI/IMCA DPO CPD app is for continuing professional development (CPD) of dynamic positioning operators (DPOs) who perform a safety-critical role on board offshore DP vessels and need to maintain their technical knowledge. The app features industry guidance, safety bulletins, DP exercises and training drills. Nautical Institute and the International Marine Contractors Association.

Enhanced USV

New technologies on board the Seagull USV add to its capability to operate autonomously in a busy maritime environment and to overcome communication challenges. A 360° panoramic video system with automatic target recognition and a patented automatic navigation system complement the USV's sense-and-avoid capability. Elbit Systems Ltd.

Improved Voyage Planning



OneOcean's platform has been re-modeled for more visually integrated data. Decision makers can now collaborate and see all sections of a voyage plan, allowing them to quickly understand the risks and operations. The platform unifies workflows and enables full, end-to-end passage planning, with route generation, weather evaluation, environmental compliance, safety checks, optimizations and scenario evaluation. OneOcean Group.

Protective Face Covering

Survitec Protect 360 is a hydrophilic snood-type face covering that

incorporates Polygiene ViralOff, a self-cleaning textile treatment technology proven to reduce 99% of known viruses from adhering to material surfaces. It is designed to reduce the spread of viral and bacterial infection. Survitec Group Ltd.

Maritime Internet

TracPhone V30, an ultracompact Ku-band VSAT antenna is designed to deliver data speeds as fast as 6 Mbps down/2 Mbps up for leisure and commercial boats. Measuring just 37 cm (14.5 in.) in diameter and weighing 10.6 kg (23.4 lb.), the TracPhone V30 uses a single power-data coax cable and DC power. KVH Industries Inc.

Global AIS Vessel Tracking

exactAIS Platinum Plus offers real-time AIS vessel identification and tracking data services. The additional AIS receivers will provide significantly enhanced vessel detection in ports and regions of high vessel density. Platinum Plus will track and identify more than 600,000 AIS-equipped vessels globally. exactEarth Ltd.

Imaging Payload

Swordfish, a fully integrated, geo-referenced, still and video imaging system payload for small AUVs, comes standard with a 12.3-MP camera; high-output LEDs producing 60,000 lm (strobe) or 6,000 lm dimmable (continuous); onboard CPU; and a 512-GB solid-state data drive. Arctic Rays LLC.

Coax Connectivity

The BIRNS 1V series features a compact coax contact that offers 75Ω impedance in the same footprint of a 50Ω contact. It is ideal for HD/SD video with signal frequencies to 3 GHz. The 1B series, developed for the U.S. military, comprises new ultralow-loss RF pressure-rated connectors for use to SHF band Ku (18 GHz). BIRNS Inc.

Hull Optimization Program

The HullKeeper program features hull monitoring, fouling risk alerts, inspections and advisory services. Jotun. **ST**



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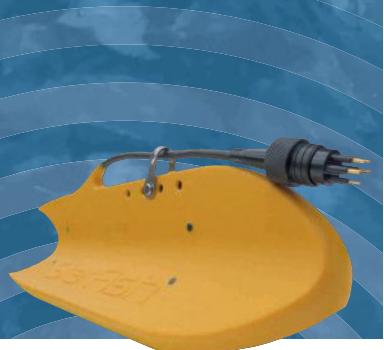
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Support for Land and Water Conservation Fund

The U.S. Interior Department has taken steps to strengthen the Land and Water Conservation Fund (LWCF) by rescinding Trump administration policies that significantly undermined the landmark conservation program. Secretarial Order 3396 revokes an order signed on November 9, 2020 (Secretarial Order 3388) that unilaterally imposed new restrictions to inhibit the availability of LWCF funding for federal land and water acquisitions.

In addition to rescinding the November 2020 Bernhardt policy, Secretarial Order 3396 instructs the National Park Service to revise the Land and Water Conservation Fund Assistance Manual to remove the restrictive policies implemented in the previous order, and to reinstate pre-existing implementation of the LWCF state assistance program and Outdoor Recreation Legacy Partnership (ORLP) program. The ORLP program is the only LWCF competitive grant program dedicated to addressing the recreational gap in underserved urban areas.

Since its inception in 1965, the LWCF has funded \$4 billion worth of projects in every county in the country. Last year, Congress permanently funded the LWCF at \$900 million per year with wide bipartisan support.

At no cost to taxpayers, the LWCF supports increased public access to and protection for federal public lands and waters—including national parks, forests, wildlife refuges and recreation areas—and provides matching grants to state and tribal governments for the acquisition and development of public parks and other outdoor recreation sites.

Reducing Risk of Fishing Gear Entangling Whales, Sea Turtles

The National Marine Sanctuary Foundation, California Ocean Protection Council, and California Department of Fish and Wildlife are collaborating to test fishing gear innovations in the California Dungeness crab fishery with local fishermen in real-world simulations in order to reduce the risk of entangling protected whales and sea turtles in the future.

Whales can become entangled in buoy lines used by fishermen to connect crab traps on the seafloor with surface buoys. The project will test new gear innovations designed to reduce or eliminate the time a buoy line is in the water column or the breaking strength of buoy lines. The testing program will evaluate acoustic and timed-release pop-up systems and a weak-sleeved rope design.

The foundation seeks to recruit up to 15 active California commercial Dungeness crab fishermen during the fishing season who can provide expertise and feedback on the usability and reliability of the gear types under real-world fishing conditions.

Flood Acts Introduced in House Committee

U.S. House Environment Subcommittee Chairwoman Mikie Sherrill (D-N.J.) introduced two bipartisan bills that address flood research, data collection and com-

munications: the Flood Level Observation, Operations, and Decision Support (FLOODS) Act and the Providing Research and Estimates of Changes in Precipitation (PRECIP) Act.

The FLOODS Act directs the National Weather Service to better predict, forecast and communicate about flooding events, which will help communities better respond to floods. The PRECIP Act provides critical updates to extreme precipitation data, which will improve understanding of how changing precipitation patterns affect flood risk.

Schultz Delivers Coast Guard Address

The Commandant of the U.S. Coast Guard has delivered his third state of the Coast Guard address at Coast Guard Sector San Diego. Adm. Karl Schultz outlined his vision for the service to protect the homeland, enhance economic prosperity and advance America's national security interests. He discussed a variety of ongoing and emerging fleet recapitalization programs, providing updates on the Polar Security and Offshore Patrol Cutter acquisitions; efforts to replace the aging fleet of inland buoy and construction tenders with Waterways Commerce Cutters; and initial steps to transition to an all MH-60 Jayhawk helicopter fleet.

Schultz further highlighted the Coast Guard's operations in the nation's system of ports and waterways, or the Marine Transportation System (MTS). The MTS is a key economic engine for the nation, fueling 26 percent of U.S. gross domestic product (GDP), which equates to \$5.4 trillion of annual economic activity.

US House Science Committee Leaders Introduce NSF for the Future Act

U.S. House Science Committee Chairwoman Eddie Bernice Johnson (D-Tex.) and Ranking Member Frank Lucas (R-Okla.) along with Subcommittee on Research and Technology Chairwoman Haley Stevens (D-Mich.) and Ranking Member Michael Waltz (R-Fla.) introduced the National Science Foundation (NSF) for the Future Act. This legislation increases the funding for more excellent research; advances research and development to address persistent challenges in STEM education across all education levels; addresses challenges for data access and accountability, as well as security threats that undermine the integrity of federally funded research; and creates a new Directorate for Science and Engineering Solutions that will enable the foundation to take big risks and experiment with new approaches to accelerating the translation of science and technology into solutions to society's major challenges.

US Congress to Consider Plastic Pollution Act

The Break Free From Plastic Pollution Act has been reintroduced in Congress. If passed and signed into law, the act will ban certain nonrecyclable single-use plastic products. It will also shift the responsibility for waste management and recycling to the manufacturers of packaging, containers and food-service products by requiring these producers to design and finance the programs. **ST**

Industrial Cooperation for European Patrol Corvette Program

NAVIRIS, the 50/50 joint venture company between Fincantieri and Naval Group for development of cooperation programs, and NAVANTIA have signed a memorandum of understanding to increase industrial cooperation for the European Patrol Corvette (EPC) program, the most important naval initiative within the Permanent Structured Cooperation (PESCO) project.

The EPC will be a smart, innovative, affordable, sustainable, interoperable and flexible vessel to meet missions in the mid-21st century. EPC will be a surface combatant to carry out diversified missions, primarily aimed at enhancing maritime situational awareness, surface superiority and power projection, particularly in the context of governmental peace time actions, such as those aimed at counteracting piracy and smuggling, as well as those actions dedicated to humanitarian assistance, migration control and ensuring freedom of navigation.

GRSE, GE to Collaborate on Propulsion

Garden Reach Shipbuilders & Engineers Ltd. (GRSE), a shipbuilding company in India, has signed a memorandum of understanding with GE Power Conversion to design electric and hybrid propulsion systems for future commercial and naval shipbuilding projects.

"With the growing demand for alternative propulsion systems, which not only improve overall efficiency but also reduce greenhouse gas emissions, there is a pressing need to find effective implementable solutions quickly," Chairman and Managing Director of GRSE RAdm. V.K. Saxena said. "Electric and hybrid propulsion is a fast-growing and promising solution to this problem. These technologies have significant naval applications due to the growing power demand of future warships."

Radar to Support Mine Countermeasures

Belgium Naval & Robotics has selected Terma as the supplier of 12 units of the SCANTER 6000 radar for the Belgian and Royal Netherlands Navies mine countermeasures replacement program. This new asset will give superior capabilities to the ships in terms of the detection and tracking of targets.

This radar will support mine hunters as they secure total situational awareness. The radar is able to detect and track small targets in all weather conditions. The first radar will be delivered in 2022.

NRL Uses LiDAR to Measure Bubbles To Improve Ocean Modeling, Acoustic Simulation

U.S. Naval Research Laboratory (NRL) researchers from the Ocean and Atmospheric Science and Technology Directorate along with the Scientific Development Squadron (VXS) 1's UV-18 Twin Otter has conducted airborne research in Homer, Alaska. The team's objective was to measure bubbles using LiDAR, a laser system for measuring ocean properties.

Improved understanding of bubble fields has many applications, including radiance, surface properties and characterization of the ocean's surface.

Quantifying the oceanic whitecaps and subsurface bubbles is important to the Navy's oceanographic models to characterize the long-term evolution of the ocean environment because bubbles are the primary way the atmosphere and oceans exchange heat, momentum and gas.

NRL's lidar system consists of a self-contained unit installed in a weatherproof enclosure, designed to be mounted on the Twin Otter's research compartment with the laser pointed down into the water.

South Africa Inshore Patrol Vessel Launch

Damen Shipyards Cape Town has launched the first of three Multimission Inshore Patrol Vessels (MMIPVs) procured by ARMSCOR for the South African Navy. The vessels will enhance the country's capability to respond effectively, rapidly and cost-effectively to threats such as illegal trafficking and fishing.

The MMIPVs are built according to the patented Damen Axe Bow design, which ensures low resistance, high sustained speed in waves and superior sea-keeping characteristics in the toughest conditions. As vertical accelerations are reduced significantly and bow slamming almost eliminated, vessel and crew safety increase, reducing operational risks. The multimission deck supports diving, search and rescue, and anti-piracy operations. **ST**

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Composite Jumper for Deep-Sea Mining

A composite jumper designed and manufactured by Strohm (formerly known as Airborne Oil & Gas) will be featured in deep-sea mining technology being developed by offshore contractor Allseas to recover polymetallic nodules from the seabed at depths of 4,000 to 6,500 m.

Key metals such as cobalt and nickel required for renewable energy technologies and electric vehicle batteries are in increasingly high demand as the world gets behind the energy transition. Allseas is developing a deep-sea collection system to source nodule-rich minerals from the seafloor with minimum environmental impact.

This is the first time Strohm's thermoplastic composite pipe (TCP) solution will be used in a deep-sea mining application. Strohm will provide Allseas with a spoolable

TCP jumper to connect the seabed vehicle to the vertical transport system. TCP is 80 percent lighter in weight compared to its metallic equivalents, reducing the need for buoyancy. Its strong composite wall provides good collapse resistance while maintaining flexibility.

ENGIE, Equinor to Develop Low-Carbon Hydrogen

ENGIE and Equinor have signed a memorandum of understanding to investigate the development of low-carbon hydrogen value chains in Belgium, the Netherlands and France. In the coming months, ENGIE and Equinor will start discussions with potential customers to assess the project, as well as with stakeholders and relevant authorities. ENGIE and Equinor will investigate the production and market potential for hydrogen from natural gas, with the CO₂ to be captured

and stored permanently offshore. ENGIE and Equinor believe that it is essential to develop low-carbon and renewable hydrogen projects at scale in order to make it possible for industrial customers to significantly reduce CO₂ emissions before 2030. This development of low-carbon and renewable hydrogen will accelerate the construction of new hydrogen infrastructure and the repurposing of current natural gas infrastructure, thus paving the way for net zero in 2050.

3D at Depth New Division

3D at Depth Inc. has launched its offshore Geophysical Survey Services division to provide optimized surveys to support nearshore, inshore and offshore deepwater development activities for offshore wind farms, pipeline routes, environmental site surveys, offshore hydrocarbon projects, and civil engineering surveys.

3D at Depth first commercialized subsea LiDAR technology for the offshore industry in 2014.



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ABB Advisory Software For Offshore Wind Vessel

United Wind Logistics' module deck carrier *VestVind* will rely on ABB Ability Marine Advisory System – OCTOPUS to support real-time decision making as it transports large wind farm components such as turbines, foundations and blades to offshore installation sites.

By minimizing unwanted vessel motions and accelerations, ABB Ability Marine Advisory System – OCTOPUS software will help protect high-value payloads in transit while boosting vessel efficiency by optimizing the route based on vessel motions resulting from weather and wave conditions. This will allow the module deck carrier to increase its operational window.

UTEC to Survey for Coral-Sul FLNG off Mozambique

UTEC has been awarded survey work by TechnipFMC plc to support the development of the Coral-Sul FLNG (floating liquefied natural gas) project, the world's first in ultradeepwater. The Coral-Sul FLNG, which is approximately 50 km from the Mozambique coast, will operate in 2,000 m of water in Coral field, which is in the southern part of Area 4 in the Rovuma basin. Eni is the operator of the Coral South Project on behalf of the Area 4 Partners.

The work includes pre-lay surveys; long baseline array installation and calibration; survey and positioning support; support for the installation of manifold foundation piles, manifolds, tether piles, flexible lines, umbilicals, wellhead jumpers and flying leads; pre-commissioning operations surveys; and riser hook-up and as-built surveys.

Ultrasonic NASA Tech For Offshore Assets

ABSG Consulting Inc. (ABS Consulting) has signed an exclusive global licensing agreement to offer an innovative ultrasonic nondestructive testing (NDT) solution that supports expanded use of composite materials on offshore assets to extend service life. Developed to test the heat shield on the Orion space capsule, this is the first prov-

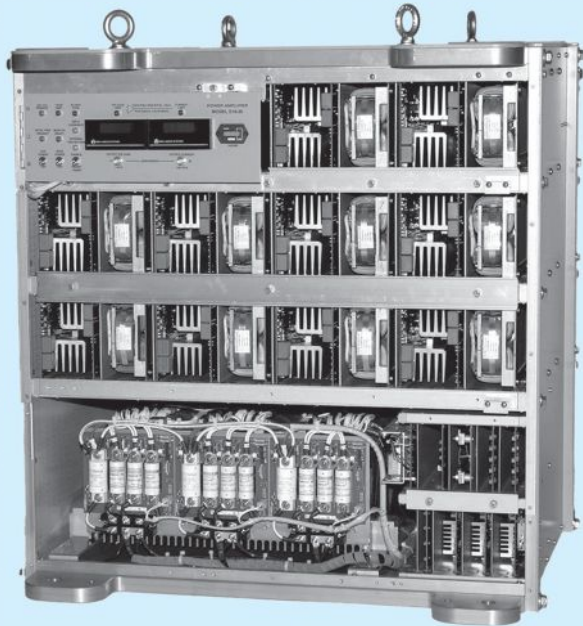
en nondestructive evaluation (NDE) technology that can successfully scan layered composite material for defects, offering unprecedented visibility into the integrity of these materials. Through the licensing agreement, ABS Consulting is working with global leaders in composite repair and offshore clients to further develop the technology for new and expanded applications in the offshore industry.

EBS by TDI-Brooks off Angola

TDI-Brooks International Inc. has completed environmental baseline studies (EBS) for Cabinda Gulf Oil Co. Ltd. (CAGBOC) for the Republic of Angola and ExxonMobil. TDI-Brooks safely and efficiently deployed the RV *Proteus* to blocks 0 and 14 for CAGBOC and Block 15 for ExxonMobil offshore Angola to complete these programs, with laboratory analysis. **ST**

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Award to Develop AUV Asymmetric Propulsion

ARMADA Marine Robotics has won a Marine Technology Initiative Award from the Consortium for Marine Robotics at Woods Hole Oceanographic Institution. This award includes membership in the Consortium's D'Works and will enable ARMADA to rapidly develop prototypes of its asymmetric propulsion for autonomous underwater vehicles.

This novel technology provides both propulsion and low-speed maneuvering using a single electric motor. This eliminates the need for fins and additional motors, thereby reducing weight, drag, complexity and cost. This is a major advancement in the ability of a single unmanned underwater vehicle to conduct both rapid large area surveys and low-speed inspections at close range with a high degree of maneuverability not available in existing platforms.

New Member of Ship Data Sharing Platform Consortium

Korea-based maritime solution provider marineworks has joined IoS Open Platform (IoS-OP), the ship IoT (Internet of Things) data sharing platform promoted by Ship Data Center Co. Ltd. (ShipDC). As the first Korean company to join the initiative, marineworks will be involved in the transmission and utilization of ship operation data in IoS-OP and help raise awareness of the platform. With marineworks, the IoS-OP Consortium has reached 61 member organizations.

IoS-OP is a universal platform that enables sharing of ship operation data among shipbuilders, manufacturers and service providers without compromising the profits of data providers. The platform comprises a data center for collecting and providing data, and the IoS-OP terms of use guide data distribution.

Guidelines for ROVs, AUVs

ClassNK has released "Guidelines for ROV/AUV," which sum-

marize the performance and safety requirements for innovative technologies and third-party certification. Up until now, ROVs and AUVs have been mainly used for oceanographic surveys and offshore oil and gas field development, but in recent years, their utilization as a means for maintaining offshore wind power generation facilities and pipelines has been steadily increasing. Although the utilization of ROVs and AUVs is increasing worldwide, no international standardization of such technologies has yet been implemented.

The guidelines are available to download free of charge at www.classnk.com for those who have registered for the ClassNK "My Page" service.

Geotechnical Survey Autonomous Subsea Vehicle

Marine-i has agreed to support marine engineering specialist Feritech Global in its plan to create the world's first autonomous subsea vehicle specially designed for geotechnical survey work. Such a design would result in safer, more efficient and cost-effective seabed survey operations.

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

Marine-i and Feritech are collaborating on a structured development program to define the industry standards that the new vehicle must meet, specify the tool requirements, and create a design solution. This will result in the construction of a pre-commercialization prototype for sea trials.

Successful Trials for IoT

Danish ship technology specialist Danelec Marine and TeamViewer, a global provider of secure remote connectivity solutions, have completed trials of an innovative, low-cost and simple-to-deploy sys-

tem for ship data transfer and remote access. As an alternative to virtual private networks (VPN) for IoT connectivity, the Danelec and TeamViewer solution promises to lower costs and boost access flexibility while relieving the technical workload on IT teams and enabling more uptime for digital vessel and fleet management applications.

Danelec and TeamViewer have developed a customized version of the TeamViewer IoT agent that perfectly embeds into the operating system of Danelec's Vessel Remote Server (VRS) and launches on demand. The system enables a secure ship-shore connection to be established quickly and easily, with a user-friendly interface providing remote access management centrally for a whole fleet. This reduces the IT department burden of enabling remote access while providing a foundation for secure and easy-to-manage access for employees and third parties.

Kongsberg USVs, AUVs for Norway Marine Research

Kongsberg Maritime will supply Norway's Institute of Marine Research (IMR) with two Kongsberg Maritime Sounder USVs and two KONGSBERG AUVs, which will form the practical basis of IMR's long-term strategy to monitor and manage marine environments and resources. The AUVs are scheduled for delivery this year, with the USVs following in 2022.

The four autonomous vessels will be equipped with KONGSBERG's Blue Insight, a cloud-based ecosystem designed to facilitate remote instrument operation, data visualization and smart management of oceanographic and meteorological data.

Infrastructure for automated classification of fish through machine learning is a key feature of the delivery, consolidating the long-running partnership between KONGSBERG and IMR toward the goal of implementing seagoing drones for ecosystem management.

IMR aims to promote sustainable practices at sea, and digitalization is a cornerstone of this policy. **ST**

environmental monitoring

Studying Nitrous Oxide's Role in Climate

Deep in the ocean off Vancouver Island's west coast, a gas associated with climate warming is making its way to the surface. Nitrous oxide (N_2O) is a product of plankton decomposition, pulled to the surface in areas where deep-sea waters migrate upward in what's known as coastal upwelling. University of Victoria (UVic) Ph.D. student Brett Jameson is trying to find out where this gas is coming from, in collaboration with Ocean Networks Canada, a UVic initiative, and the Canadian Healthy Oceans Network.

The world's oceans both consume and produce gases that affect climate warming. A quarter of the N_2O released into the atmosphere comes from the ocean. By pulling up water rich in N_2O from the deep, upwelling can transfer deep-ocean N_2O to the atmosphere.

Jameson's research looks at the production of N_2O by microbes in marine sediments and at the factors that determine whether the gas ends up released to the atmosphere or consumed along the way.

Nitrous oxide isn't as prominent as carbon dioxide in the public discussion around climate warming, but it has more than 300 times the potency of CO_2 as a greenhouse gas.

Jameson conducted research in the waters off Bermuda and Vancouver Island and found that the Atlantic mangrove sediments seem to act as a "sink," absorbing N_2O from the atmosphere, while Pacific deep-sea sediments off Vancouver Island release nitrous oxide to the water, and then to the atmosphere.

This research will need to be followed up in other parts of the world to learn how other ocean environments are managing N_2O .

Determining Erosion Due to Waves and Rainfall

Coastal cliffs are vulnerable to erosion, and multiple serious collapses have occurred in California in recent years. A team of research-

ers studying coastal cliff erosion have succeeded in quantifying and separating erosional effects caused by ocean waves from erosion due to rainfall, *Eos* reported. The team conducted more than 150 LiDAR surveys in Del Mar, California, over a three-year period.

Studies on causes of erosion are typically at seasonal time scales. In southern California, where both rainfall and increased wave action occur in the winter, higher frequency surveys that capture individual rainfall and large wave events are needed to separate and quantify how these processes drive cliff erosion. For their new study, published in *Geomorphology*, the research team mapped a 2.5-km stretch of cliffs and adjacent beaches an average of once per week for three years. The researchers gathered the bulk of data using a truck-mounted LiDAR, which they drove slowly along the beach in multiple passes, aiming it at different angles to precisely capture all the variations of the cliff face and the beach elevation. They supplemented their LiDAR data with wave pressure sensors they buried along the beach, as well as rainfall data provided by their local weather station and data from the nearby La Jolla tide gauge.

Data analyses concluded that erosion of the lower part of the cliff was more strongly correlated with wave impacts and that rainfall was more closely correlated with erosion of the upper cliff.

This research could be influential for cliff modeling at longer time scales, such as projections of how quickly and how far coastal cliffs will retreat.

Six-Month Summers Predicted

Without efforts to mitigate climate change, summers spanning nearly six months may become the new normal by 2100 in the Northern Hemisphere, according to a new study in *Geophysical Research Letters*. The change would likely have far-reaching impacts on agriculture, human health and the environment.

In the 1950s, in the Northern Hemisphere, the four seasons arrived in a predictable and fairly even pattern. But climate change is now driving dramatic and irregular changes to the length and start dates of the seasons, which may become more extreme in the future under a business-as-usual climate scenario.

Researchers used historical daily climate data from 1952 to 2011 to measure changes in the four seasons' length and onset in the Northern Hemisphere. They defined the start of summer as the onset of temperatures in the hottest 25 percent during that time period, while winter began with temperatures in the coldest 25 percent. Next, the team used established climate change models to predict how seasons will shift in the future.

The new study found that, on average, summer grew from 78 to 95 days between 1952 to 2011, while winter shrank from 76 to 73 days. Spring and autumn also contracted from 124 to 115 days, and 87 to 82 days, respectively. Accordingly, spring and summer began earlier, while autumn and winter started later. The Mediterranean region and the Tibetan Plateau experienced the greatest changes to their seasonal cycles. If these trends continue without mitigation of climate change, the researchers predict that by 2100, winter will last less than two months, and spring and autumn seasons will shrink further as well.

Waves Affect Arctic Sea Ice

In the Arctic, the end-of-summer sea ice extent in 2020 was the second-lowest in the last 42 years. Sea ice influences global climate, regional commercial shipping and naval operations, and coastal erosion. Waves can erode the ice edge and break up ice. To monitor offshore Arctic waves, Nortek Signature500 ADCPs have been mounted on fixed moorings and paired with drifters with Signature1000 ADCPs to get a complete picture of changing wave conditions. Signature1000s have also been attached to moorings to assess waves in shallower waters. This equipment will enable a long time series of data. **ST**

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contracts

Underwater Contracting (UCO), Aberdeen, Scotland, will collaborate to reduce costs of underwater inspection and survey. One of UCO's observation and inspection ROVs will be permanently installed aboard the MV *Viking* so the spread can be mobilized at short notice for rapid transit up to 60 mi. from shore. Gulfstream.

Shanghai Electric Guoxuan New Energy Technology Co. Ltd., Shanghai, China, has signed a memorandum of understanding on the strategic manufacturing of battery energy storage systems, with the aim to explore and deliver new energy storage system projects. Pacific Green Technologies Inc.

Alphatron Marine, Rotterdam, Netherlands, has secured an order for three FarSounder Argos 500 forward-looking sonar systems for yachting customers. Various.

Innovex One, Singapore, has signed a multi-year contract to digitize a sea transportation operator's fleet operations using Innovex One's marineM solution to streamline ordering, vessel and job planning, real-time updating, and billing operations. R W Marine Services.

Indian Register of Shipping, Mumbai, India, will provide classification services for a fleet of fast patrol boats and landing craft assault (LCAs) currently under construction. Indian Army.

CRP Subsea, Skelmersdale, U.K., will supply its unique low-drag VIV-suppressing helically grooved drill riser buoyancy, designed for riser drag reduction and VIV suppression for drilling operations in high-current environments. Maersk Drilling.

NIBC Bank, the Hague, Netherlands, has entered a multi-year partnership to enable financial or operational lease solutions for customers of Damen Shipyards Group. Damen

Ship Lease and Damen Financial Services.

ASL Environmental Sciences Inc., Victoria, Canada, has secured a product distribution and service partnership with a Canadian representative predominantly operating in eastern Canada. DASCO Equipment Inc.

Greensea Systems, Richmond, Vermont, has partnered to develop a simulation environment for OPEN-SEA and OPENSEA-enabled control systems, with the objective to further develop virtual training standards. GRi Simulations. **ST**

meetings

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

JUNE

June 8—Sea Scotland, Virtual. www.seascotland.scot.

June 8-10—Capitol Hill Ocean Week, Virtual. <https://marine-sanctuary.org/capitol-hill-ocean-week-2021>.

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

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

AUGUST

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

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

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

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

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

August 31-September 2—Subsea Tieback, Galveston, Texas. www.subseatiebackforum.com.

SEPTEMBER

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

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

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

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

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

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

OCTOBER

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

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

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

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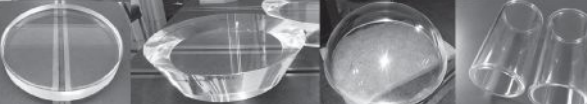
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How to Evolve C3 for Unmanned Systems—Keith Wichowski

Keith Wichowski is the head of the Digital Engineering Strategy, Platforms and Payload Integration Department at the Naval Undersea Warfare Center (NUWC) Division Newport. NUWC Newport provides research, development, test and evaluation, engineering, and fleet support for submarines, autonomous underwater systems, undersea weapons systems, and countermeasures associated with undersea warfare.



NUWC Newport provides research, development, test and evaluation, engineering, and fleet support for submarines, autonomous underwater systems, undersea weapons systems, and countermeasures associated with undersea warfare.

Understanding the struggles and challenges of watchfloor operators is essential for building the future U.S. fleet, and digital transformation will help.

Since the early days of developing UUV command, control and communications (C3) software, my favorite part of the job has always been talking with the sailors and getting their feedback. The engineers on my team stood watches with them in the Unmanned Operations Center to get the sailors' perspective of tools in development. It was a unique opportunity that I draw upon whenever I work with next-generation efforts in the research and development community. When I worked on the Theater Anti-Submarine Warfare Offset Strategy to integrate and deploy a large-scale unmanned sensing system comprised of UUVs, USVs and other systems in theater, I knew that the sailors would be responsible to stand watch for all of these systems scattered across the sea.

The human-machine interface and operator workload have always been among my main concerns for complex systems. From designing software, choosing hardware and implementing cybersecurity controls, to striving to incorporate subject matter expertise into the tools we build, operator feedback is the critical piece. In the end, there is always a human making the decision

to push the button based on the information provided.

To alleviate problems faced by watchfloor operators, the U.S. Navy's digital transformation strategy for unmanned systems currently includes four approaches: DevSecOps, a secure operational development environment on which to build software factories; a locus for all data providing an integrated data environment and digital infrastructure, such as Project Overmatch; the Rapid Autonomy Integration Lab (RAIL); and continuous operator feedback.

The goal of DevSecOps is to quickly deliver cybersafe code. DevSecOps bakes cybersecurity practices into every step of the software development process, as software engineers establish a "security as code" culture and collaborate on a common goal with cybersecurity teams. Stovepiped tasking is replaced with continuous interteam communication, and security requirements are instilled during continuous software development and delivery.

DevSecOps software engineers leverage Platform One, the Air Force-established repository for sharing tools and training that was developed for the Department of Defense (DoD) as a conveyor belt of software to build mission applications. Platform One was initiated to help set up "software factories" and was designated as the DoD's DevSecOps Enterprise Services Team. This approach results in software that is a collection of small reusable services, "micro-services," that work together to form applications. Platform One is compliant with the DoD Enterprise DevSecOps Initiative and has DoD-wide reciprocity. It is part of a cultural shift in software development that, according to the Platform One website, provides teams with "collaboration tools, cybersecurity tools, source code repositories, artifact

repositories, development tools, DevSecOps as a service, chats, etc."

For some applications, the Navy's Project Overmatch provides end-to-end solution, tools and cloud resources—infrastructure as a service—that serves as the Navy's version of Platform One. RAIL, the Navy's pilot program for autonomy development, provides the digital engineering infrastructure, tools and processes to rapidly develop, test, certify and deploy new autonomous capabilities. RAIL will help scientists and engineers test and integrate new advances in autonomy software with existing unmanned vessels. This program lowers development costs as it speeds the integration of new systems into the fleet. Project Overmatch provides the conveyor belt, and RAIL is the software factory that integrates apps and micro-services that travel down the conveyor belt and are verified and validated in each stage of the pipeline.

Operator feedback is part of the continuous development process. Developers using DevSecOps, Platform One or Project Overmatch and RAIL are testing and getting real-time usability feedback from operators without disrupting their operation. When paired with a strong simulation environment seamlessly integrated with the live/virtual/constructive environment, the operator can run the equivalent of "gun drills" for unmanned systems.

The Navy needs the right infrastructure, intelligent agents, human-machine teaming, and C3 architecture to direct the coming fleets of autonomous systems, regardless of mode of transportation. All of these elements and common data ontologies are necessary for it to work. Change is happening now, and the community must collaborate to evolve quickly. Knowing what works from a design sense and what is possible from a technical perspective is the key. **ST**

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