ON&T

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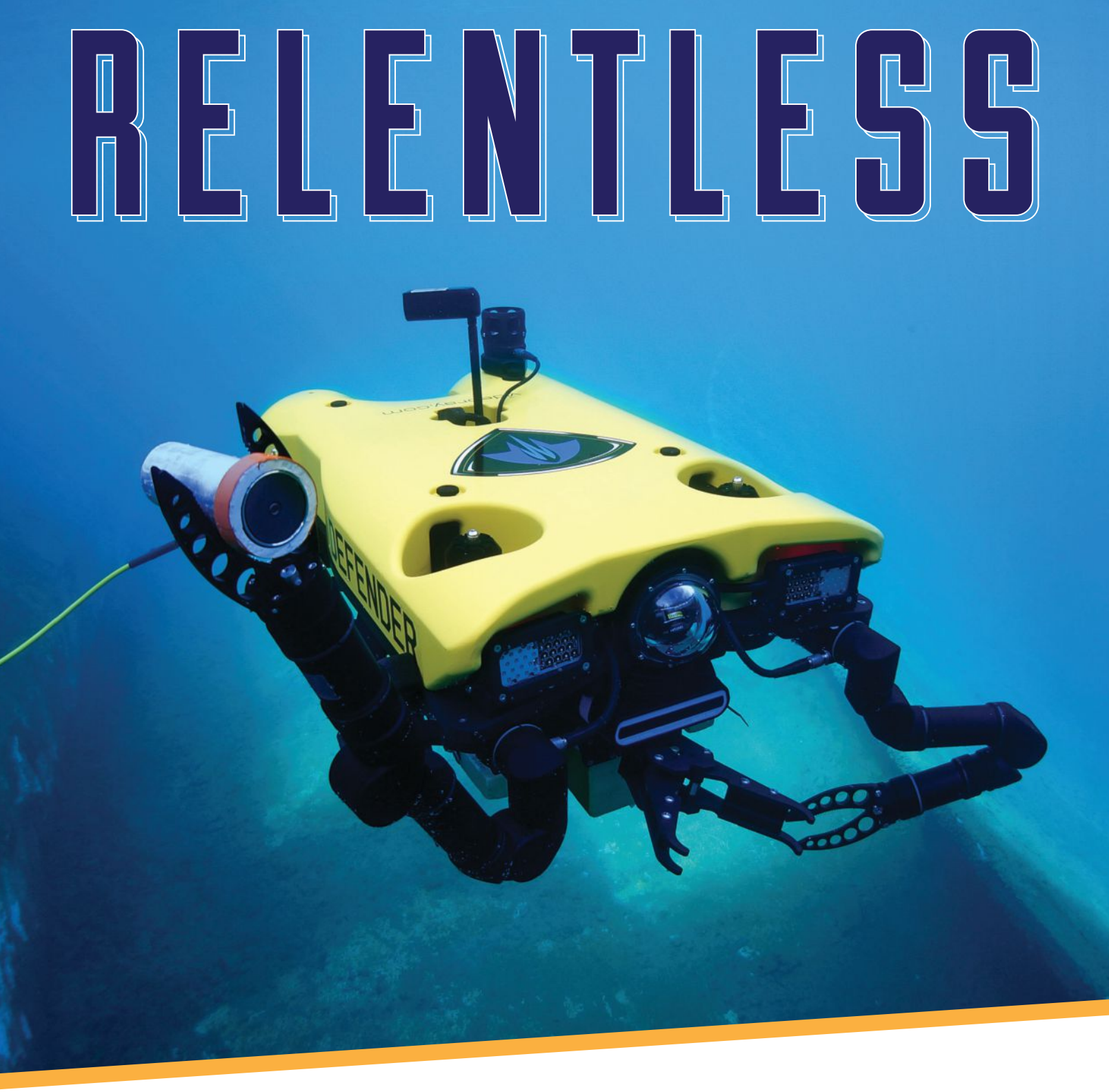
SEPTEMBER 2023

REMOTE MARINE OPERATIONS

RELENTLESS



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VROV
Virtual Remotely Operated Vehicle

iDEA
Digital Twin

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Thousands of water and sediment samples from near-shore and offshore were collected and tested for major dispersant constituents, such as butoxyethanol, dipropylene glycol N-Butyl ether, propylene glycol, and dioctyl sodium sulfosuccinate (DOSS). Few water and sediment samples showed detectable levels. None of the water samples showing detectible levels exceeded EPA's aquatic life benchmarks.

The EPA conducted toxicity tests on eight dispersants listed on the NCP (National Contingency Plan) product schedule. Results indicate that none of the dispersants tested displayed biologically significant endocrine-disrupting activity; dispersants alone were less toxic than dispersant-oil mixtures. Corexit 9500A was generally similar to toxicities of other available dispersants.
After seeing images of oil and gas flowing, many people had difficulty believing that oil was disappearing rapidly from open waters, fish could metabolize PAHs (Polycyclic Aromatic Hydrocarbons), and the seafood testing was reliable.

The lack of DOSS (dioctyl sodium sulfosuccinate) in tested seafood (fishes and crustaceans) seems to support our expectation that either dispersant degraded rapidly, or it was metabolized quickly by exposed animals."

NOIA
America's Offshore Energy Industry

USA ENERGY WORKERS

The Gulf of Mexico (GOM) has a long history of feeding and fueling America through energy and fisheries production.

Let's keep it going!

Help maintain the GOM as a superior province delivering America's Energy and Seafood Security by improving regulations to assure offshore deepwater responses are efficient, effective, and aligned with Americas National Response Priorities (§40CFR300.317);

1. Safety of human life
2. Securing the source
3. Use all necessary containment and removal tactics.

This can be accomplished by reducing bureaucratic challenges and allowing the Federal On Scene Coordinator (FOSC) to grant TEMPORARY APPROVAL for subsea dispersant injection for up to 5 days. This will allow the capping stack to be installed and the well to be shut-in, thus securing the source without delay!

National Oceanic and Atmospheric Administration - NOAA - Department of Commerce

"Dispersants work by breaking up oil slicks into lots of small droplets, similar to how dish detergent breaks up the greasy mess on a lasagna pan. These tiny droplets have a high surface area-to-volume ratio, making them easier for oil-eating microbes to break them down (through the process of biodegradation). Their small size also makes the oil droplets less buoyant, allowing them to scatter throughout the water column more easily."

Florida Department of Environmental Protection

"Chemical dispersants remove the oil from the surface of the water and into the water column. Once in the water column, the oil is diluted to less harmful levels, and eventually is used as a food by bacteria. Birds, marine mammals, turtles, and Florida's sensitive coast are protected when oil is removed from the water surface. Chemical dispersants do not cause the oil to sink but remain in suspension in the water column."

The chemical dispersants used today are generally not as toxic as the oil itself and, with adequate dilution, will not harm aquatic life. As an added precaution, chemical dispersants are not applied to shallow nearshore waters, mangrove areas, marshes, or waters over coral reefs and seagrass beds.

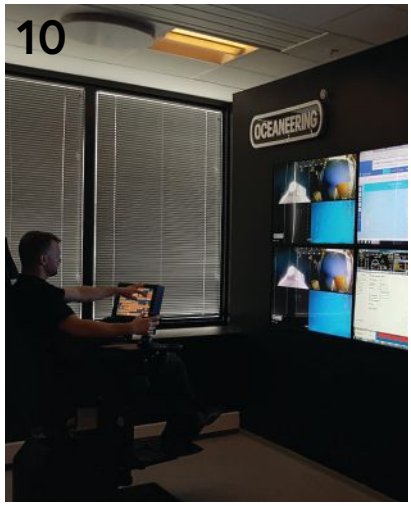
Effects of Crude Oil/Dispersant Mixture and Dispersant Components on PPARγ Activity in Vitro and in Vivo: Identification of Dioctyl Sodium Sulfosuccinate (DOSS; CAS #577-11-7) as a Probable Obesogen

"We investigated the obesogenic potential of COREXIT 9500–dispersed MC252 crude oil and identified the major COREXIT component, dioctyl sodium sulfosuccinate (DOSS), as a likely obesogen. In addition to it being a major component of the dispersant COREXIT, **DOSS is widely used in pharmaceuticals and personal care products** [U.S. Department of Health and Human Services (DHHS) 2014; Environmental Working Group (EWG) 2015a]."

Proceedings from the National Academy of Sciences - PNAS Science in support of the Deepwater Horizon response - December 3, 2012 | 109 (50) 20212-20221

"Arguments in favor of subsea application of dispersants included:

i. direct injection would maximize the exposure of oil to dispersant before it significantly weathered and emulsified with water,
ii. compared with surface applications to slicks, significantly less dispersant would be required to achieve the same goal and
iii. potential exposure of spill response workers to both airborne dispersants from surface application and volatile organic compounds associated with spill could be minimized.



FEATURES & SPOTLIGHTS

DEPARTMENTS

IN EVERY ISSUE

ON THE COVER:
Oceaneering's resident-capable Freedom™ AUV conducts rapid subsea autonomous pipeline inspections at low altitudes, providing detailed external pipeline views, all in a single pass. (Image credit: Oceaneering)

[WITH THANKS - Ed.]

Conceptually speaking, for most at-sea tasks the associated benefits of tried-and-tested remote marine operations—diminishing costs, carbon emissions, and HSSE risks—are well-documented.

However, as with any paradigm shift of this nature, the true rate of trial, adoption, and integration of new ways of working lags, naturally so, behind an emerging cast of enabling technologies and support infrastructure services.

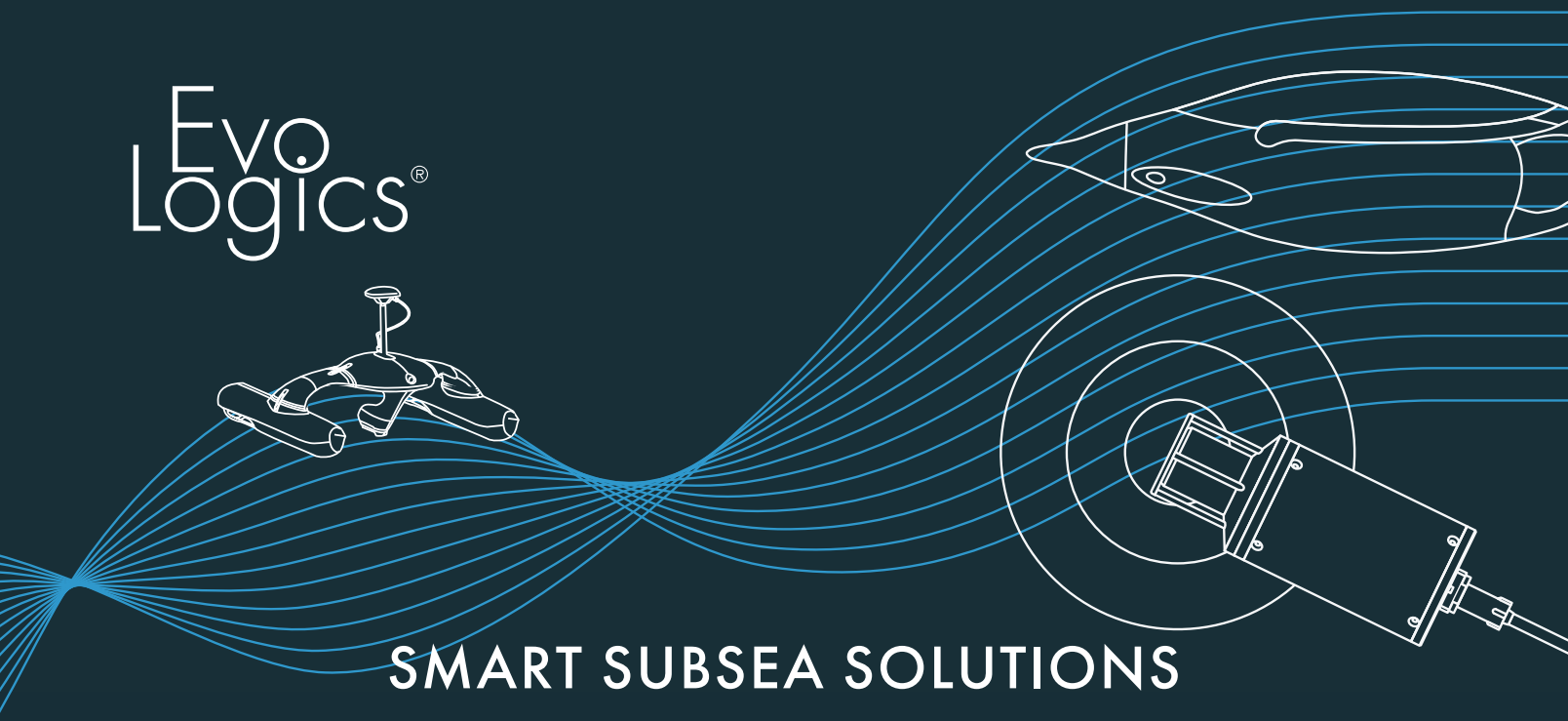
However, today, as exemplified by the leading protagonists of September's ON&T, the stage is set. If there was ever any doubt about the ocean industries' capacity to successfully orchestrate game-changing remote marine operations, read on. Our thanks this month go to Oceaneering, EvoLogics, Sonardyne, GRi Simulations, Cathx Ocean, and Unique Group.

Happy reading!

editor@oceannews.com

Ed Keenan

EvoLogics®



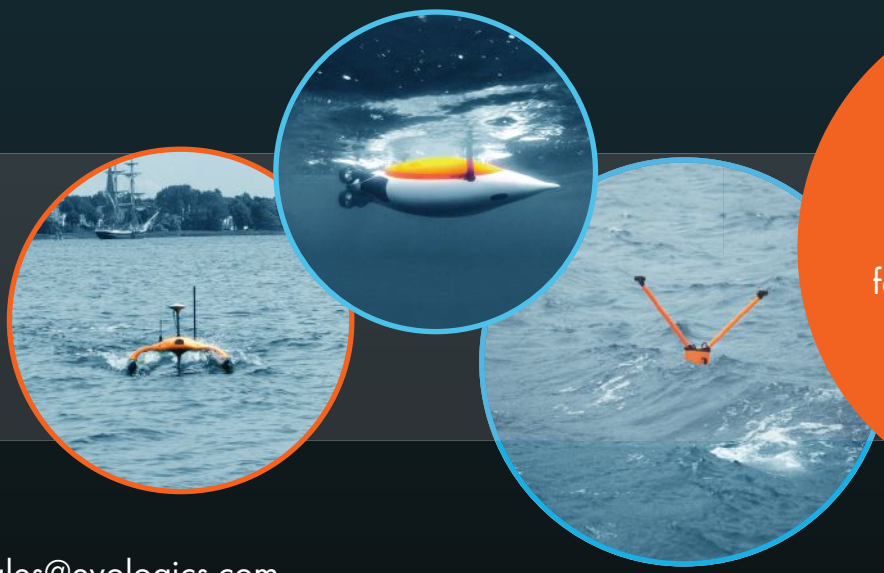
SMART SUBSEA SOLUTIONS

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

Accurate USBL and LBL positioning of underwater assets

Modem emulator and other cost-saving developer tools

Autonomous surface vehicle for bathymetry, monitoring, search & rescue, and AUV support



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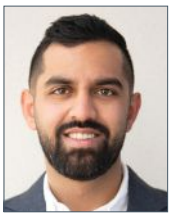
THE FUTURE OF REMOTE OPERATIONS HINGES ON TODAY'S USV TECHNOLOGY



By Sahil Gandhi
CEO
Unique Group

In the world of subsea engineering, innovation is the cornerstone of progress. It fuels our pursuit of safer, more efficient, and sustainable solutions for marine operations in the renewable energy and offshore sectors. In recent years, the successful introduction and integration of uncrewed surface vessels (USVs) to standard marine survey operations highlights the capacity for investments in technological development to push the boundaries of what's possible in challenging environments.

This has been Unique Group's core focus in recent years and has resulted in an exclusive portfolio of commercial USVs, ranging from compact (person portable) to medium and larger models fit for longer endurance missions. Our goal has always been to offer customers choice and, therefore, the flexibility to scale the use of uncrewed systems to a particular project task. In support of this, we also recently launched a state-of-the-art generative AI (artificial intelligence) chat solution, Aquila Subsea, which provides instant and accurate responses to technical queries from survey engineers and technicians.

NEW ERA OF MARINE SURVEY

In terms of versatility and capability, USV technology is a game changer. USVs can carry out a wide range of tasks, from bathymetric survey to geophysical mapping to pipeline inspections and environmental monitoring—all without putting human lives at risk. The days when exploration of the seafloor required costly manned missions are soon to be surpassed. Now, a range of task-adapted USVs that venture offshore, all armed with cutting-edge sensors and technology, deliver high-quality data, providing insights into the marine and subsea environment.

The incorporation of these uncrewed assets has been nothing short of extraordinary. It's not just about the data these vessels collect; it's about how they undertake the acquisition. Their ability to operate 24/7 significantly reduces the time and cost involved in undertaking marine surveys. This efficiency has established a faster turnaround of results, assisting clients to make informed decisions with greater confidence. Moreover, the use of USVs enables operators to meet increasingly tighter carbon emission constraints and heightened industry standards when compared to traditional manned survey vessels.

REAL-WORLD APPLICATIONS

Consider the carbon-conscious rig debris survey marketplace. Unique Group recently completed such a survey project in the Port of Cromarty Firth, Scotland, using our Uni-Pact USV in less than 90 minutes. This USV was equipped with a sensor (Ping DSP side-scan sonar), which provided both 2D and 3D side-scan images coupled to bathymetry data. The remote-control interface (4G) enabled real-time data acquisition to be analyzed and interpreted by the surveyor working remotely from Copenhagen, Denmark. In other words, the USV was quickly and easily deployed, delivered high-quality data, and was able to serve multiple stakeholders in different locations. This is remote operations in practice.

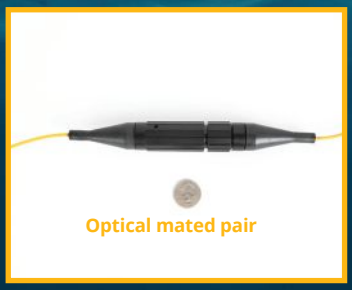
Whilst we celebrate the development of USVs in subsea data acquisition, it's essential to acknowledge that this transformation is not without its challenges. USV technology is still evolving, and we must continue to refine and adapt our approach to maximize its potential. However, the lack of industry legislation, coupled with no global regulatory framework, impedes the introduction of this innovation, which in turn would allow the industry to undertake more responsible and safer operations.

The ongoing shift towards increasingly remote marine operations among ocean professionals is somewhat contingent on enhancing USV technology to optimize efficient, sustainable, and safe ways of working at sea. As industry continues to explore the depths of our oceans, it requires us to do so with a commitment to continuous innovation and social responsibility, ensuring these subsea endeavors benefit both humanity and the environment we all cherish.

Finally.

Compact Wet Mate connector technology has arrived.

Optical wet mate



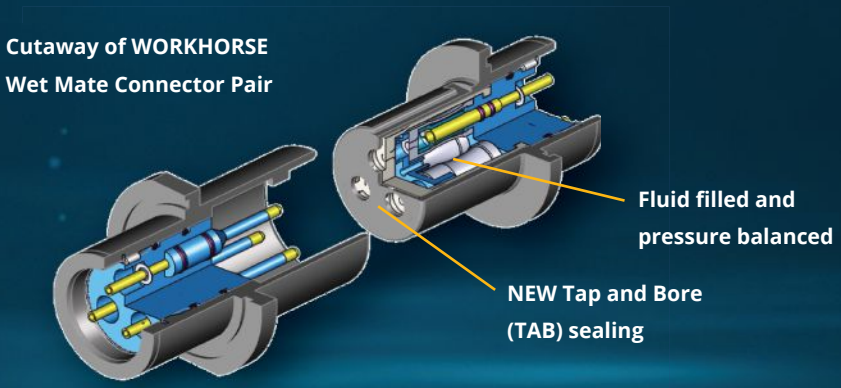
Optical mated pair

4-way electrical wet mate

Ready to disrupt an industry that's been virtually unchanged for the past 30 years?

Miniature, lightweight wet-mateable connectivity is now a reality, thanks to a breakthrough sealing technology. Developed by the inventor of the first fluid-filled wet mate connector, complex spring-and-stopper mechanisms are replaced with a simple, one-piece seal for the highest reliability in a compact package.

Be the first to acquire the technology and launch a new class of compact electrical, fiber optic and hybrid (electrical / optical) wet mate connectors.



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TAKE 5

THE ON&T INTERVIEW

Welcome to Take 5, ON&T's new monthly interview feature. Our first guest is none other than Oceaneering's President and CEO Rod Larson, who shares his thoughts on the world of remote offshore operations and the opportunities that automated subsea technologies present to companies at the forefront of the so-called energy transition.

with Rod Larson
President & CEO

OCEANEERING®

1 ON&T: What does the energy transition mean to Oceaneering?

RL: The energy transition presents an opportunity to incorporate the latest technologies to make energy cleaner and safer, while also ensuring that the world's energy security needs are met as renewables gain traction and infrastructure is built.

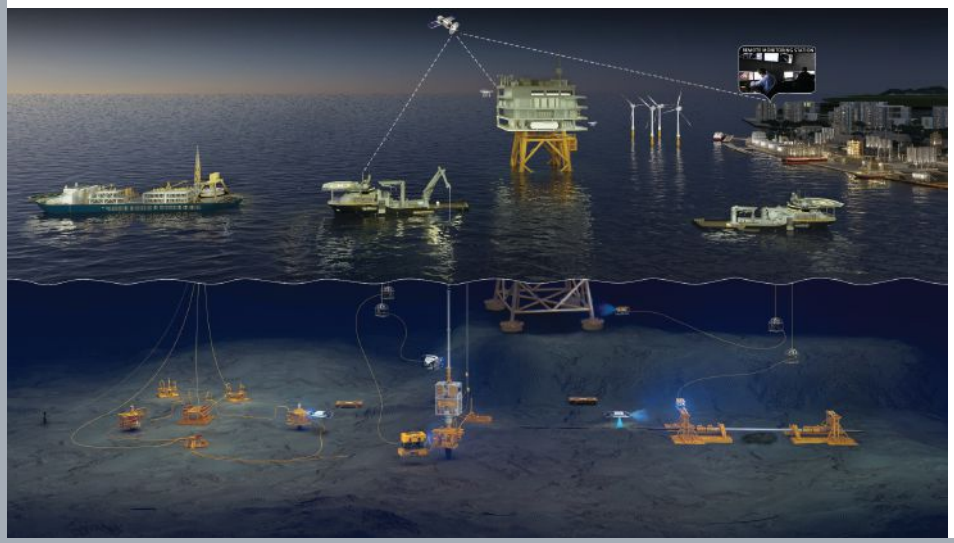
Oceaneering is committed to helping the energy industry deliver the safest, cleanest barrels. New technology development has allowed service companies to deliver reduced emissions in offshore operations with decreased risk to human workers.

2 ON&T: What role do you see Oceaneering playing?

RL: As an offshore services provider, we have done a lot of work throughout the last three years to support our customers' energy transition goals and carbon reduction targets, including making significant investments in our Offshore Remote Operations Centers (OROCs), the first of which was opened in 2015 in Stavanger, Norway, to serve as a base for remote operations. Now, project personnel (pilots, specialists, and client representatives) can monitor operations from an office environment and share expertise between multiple projects and clients.

The various remotely operated vehicles (ROVs) and autonomous robots that we have been developing over the last decade are also instrumental to curbing emissions. Vehicles like our battery-powered Liberty™ E-ROV and Freedom™ autonomous underwater vehicle (AUV) can be deployed by a vessel of opportunity and recovered when practical after work scopes are completed, thereby reducing the total number of vessel days.

We are also working on several technologies to specifically make a positive impact on the offshore wind and renewables markets. In 2019, we launched our Isurus™ ROV, engineered for offshore renewables projects, greatly improving efficiency in areas that experience harsh weather and current conditions, such as the UK and Asia.



» *OROCs allow project personnel to monitor operations from an office environment and share expertise across multiple projects. (Image credit: Oceaneering)*

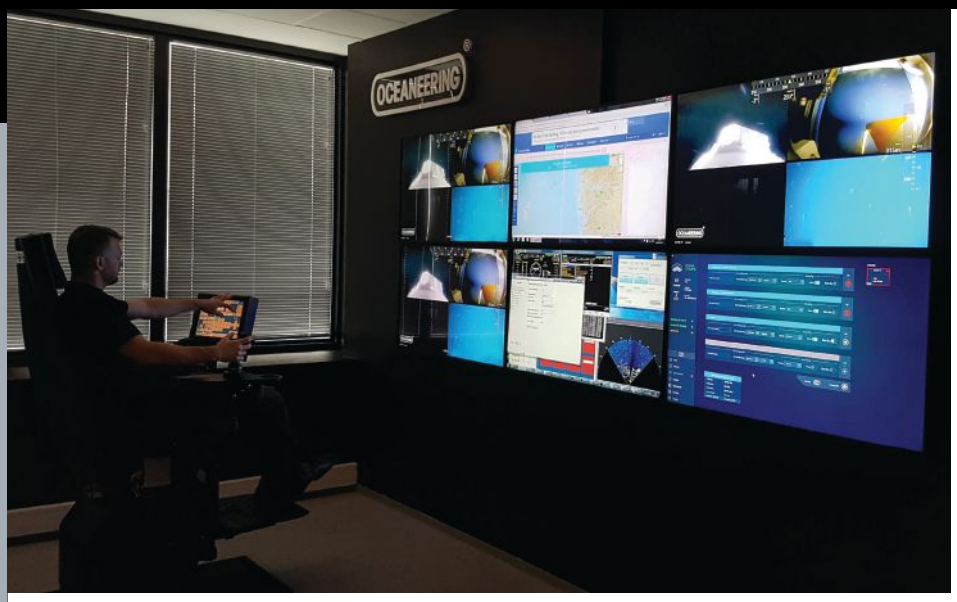
Additionally, we are conducting field trials for our Ocean Perception™ marine mammal mitigation software platform. Ocean Perception ensures renewables developers comply with regulatory requirements by providing real-time, around-the-clock local and remote monitoring of protected marine wildlife. Traditionally, wildlife is observed by a team of protective species observers (PSOs) working on a separate vessel. By utilizing sensor and camera data, you can take traditional observers off the vessel, reducing the need for a dedicated vessel, and lessen carbon emissions. With Ocean Perception, we can also extend operational windows. Traditional operations with PSOs end at night fall, but with Ocean Perception's infrared cameras, species observation can continue through the night.

3 ON&T: Tell us about some of the work being managed out of Oceaneering's OROCs...

RL: To date, we have established three main OROCs; one in Stavanger, Norway; Morgan City, Louisiana, and a third in Aberdeen, Scotland. These OROCs offer redundancy and support for any operation conducted around the world.

We use these facilities to operate our fleet of Work Class ROVs and our resident-capable vehicles, such as Liberty and Freedom, to complete a variety of remote tasks from commissioning, rig moves, underwater inspection in lieu of dry-docking (UWILD) operations, and inspections.

We have worked with major operators around the world to prove remote piloting



» *An operator's view from inside Oceaneering's Norway OROC. (Image credit: Oceaneering)*

of ROVs from shore, including a cross-border campaign with BP in late 2021 where our ROV was tasked with observing drilling operations in West of Shetland. In October 2022, we worked with Shell to prove our remote inspection capabilities while using LTE communications coverage in the Gulf of Mexico.

Our Liberty E-ROV has performed a wide range of tasks in the North Sea for Equinor from remote subsea production system commissioning activities to remote subsea pipeline isolation.

4 ON&T: How is Oceaneering's oil and gas expertise supporting the US renewables sector?

RL: So much of the expertise in the offshore oil and gas industry translates well to offshore floating and fixed wind projects, such as construction, installation, and inspection of structures.

For decades, Oceaneering has owned, operated, and chartered one of the largest fleets of US-flagged, Jones Act-compliant, dynamically positioned multi-service vessels (MSVs). This fleet is outfitted with state-of-the-art tooling, rigging, and crews that deliver the experience necessary for safe and efficient operations.

Later this year, we will also introduce a new uncrewed service vessel (USV) service to support remote AUV tracking and geophysical data collection. This will support our core deepwater geophysical and asset inspection offerings and help us to grow in the offshore renewables market with a dedicated platform for nearshore surveys. The USV will work in conjunction with our existing assets such as the Freedom vehicle and other Hugin AUV units.

Our Grayloc® Clamp Connectors also play a critical role in carbon capture, utilization, and storage (CCUS), hydrogen, and nuclear projects. The clamp's design and signature metal-to-metal sealing technology makes it suitable for applications from small scale testing to full scale power generation and in nuclear reactors, heat transfer, and cooling systems. Additionally, we have supplied thousands of Clamp Connectors for hydrogen projects around the world to provide critical high temperature performance, ensuring leak-free operations.

We look forward to continuing to help the offshore renewables and offshore energy industries solve critical challenges and deliver high performance products and services that meet the energy needs of the future.

5 ON&T: What is Oceaneering's long-term vision for the integration of automated operations?

RL: Robotics and automation will be at the forefront of Oceaneering's long-term strategy. We are continually looking at ways to enhance the capabilities and efficiency of our subsea robotics technologies to enable them to perform tasks with increased precision and accuracy.

One such area we are investigating is the development of 360-degree views for ROV pilots to create better situational awareness. We are working with artificial intelligence and machine learning to make our vehicles more intelligent and capable of making decisions while carrying out missions.

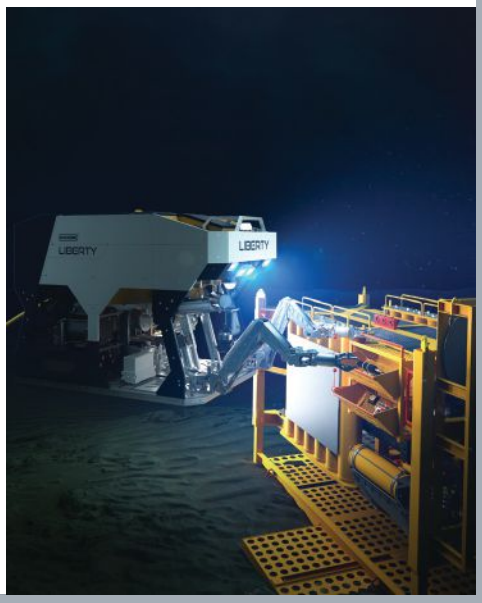
Another product in the works is a Virtual Command Center to provide a centralized and real-time digital twin for all assets related to remote operations.

Outside of the energy sector, we are expanding our engineering expertise to other industries that require robotics and automation, such as manufacturing, healthcare, entertainment, and aerospace.

In 2022, we relaunched Oceaneering Mobile Robotics, which offers both automated guided vehicles and autonomous mobile robots to service hospitals, pharmaceuticals, automotive manufacturers, and other clients. We offer a variety of vehicles from autonomous forklifts to underride robots that can work alongside workers and in areas where space is limited.

For more information, visit: *www.oceaneering.com*.

» *Resident-capable assets like the Liberty™ E-ROV can be deployed and recovered as part of a remote operations campaign. (Image credit: Oceaneering)*



RESEARCH EXPEDITION EXPLORES GULF STREAM IMPACT ON CARBON CYCLE

Scientists from the National Oceanography Centre (NOC) recently joined a 5-day research expedition to study the role of the Gulf Stream in a critical component of the global carbon cycle.

The Gulf Stream is thought to play an integral role in the oceanic carbon cycle, delivering high-nutrient, low-anthropogenic (human derived) carbon waters to the North Atlantic subpolar gyre where they sustain biological carbon drawdown and enable the uptake of large quantities of CO2 from the atmosphere.

However, many unknowns remain regarding how these deep waters reach the surface, and their effect on carbon uptake. C-Streams is studying the physical and biogeochemical processes of the Gulf Stream, and how these processes might change into the future as a response to climate change.

» *Deployment of a glider during the expedition. (Image credit: NOC)*

The 5-day expedition saw scientists travel onboard the R/V *Walton Smith* to the Florida Straits offshore of Miami to study the role of the Gulf Stream in the downstream air-sea CO2 fluxes, and the transport of old, nutrient-rich waters northwards.

To collect key ocean data, the team deployed three different types of autonomous observing platforms in the Straits of Florida: gliders, biogeochemical Argo profiling floats and tall, deep-water moorings. This challenging environment hosts some of the strongest currents on Earth (>2.5 m/s) making it logistically and physically difficult to both deploy observing technologies and keep them in position.

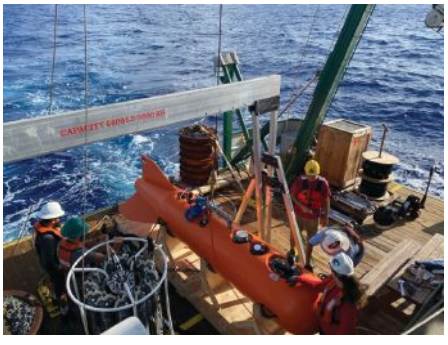
The gliders were equipped with sensors that can measure the strength of the turbulent mixing at the millimeter scale. The aim of this mission is to measure the mixing vertically and horizontally to analyze its contribution to nutrients being added to or removed from the shallow layer of the Gulf Stream.

Two Biogeochemical-Argo profiling floats were also released from the R/V *Walton Smith*. Their repeat profiling to the ocean bottom, as they are swept northwards by the ocean currents, will document in detail the downstream evolution of the Gulf Stream's physical (temperature and salinity) and biogeochemical properties (oxygen, pH, nitrate, chlorophyll) as far as the subpolar North Atlantic. Finally, three tall moorings were deployed across the western half of the Florida Straits. These will sample continuously the deep transport of biogeochemical properties at the start of the Gulf Stream, giving novel information on how these waters vary over multiple timescales, and enabling links to be made to surface activity downstream.

The C-Streams project is a four-year UK-US collaboration that is supported by the Natural Environment Research Council (NERC) and the US National Science Foundation (NSF). Researchers from the National Oceanography Centre, the University of Southampton, the University of Liverpool, the Scottish Association of Marine Science, the British Antarctic Survey and the University of Miami are involved in this project.

» *MicroRiders mounted on top of the gliders. (Image credit: NOC)*

» *A 'Stablemoor' buoy on the deck. (Image credit: NOC)*



» *Deployment of a BGC Argo float. (Image credit: NOC)*

PAST CLIMATE WARMING DRIVEN BY HYDROTHERMAL VENTS

» *Drill ship JOIDES Resolution off the Norwegian coast. (Image credit: Peter Betlem/IODP)*

An international drilling expedition off the Norwegian coast led by Christian Berndt, Professor of Marine Geophysics at GEOMAR Helmholtz Centre for Ocean Research in Kiel, and Sverre Planke, Professor of Marine Geophysics at the University of Oslo, has confirmed the theory that methane emissions from hydrothermal vents were responsible for global warming about 55 million years ago. The study, published in the journal *Nature Geoscience*, shows that the vents were active in very shallow water depth or even above sea level, which would have allowed much larger amounts of methane to enter the atmosphere.

Further studies of the Karoo large igneous province in South Africa revealed an abundance of hydrothermal vents associated with magmatic intrusions into the sedimentary basin. This observation among others led to the hypothesis that large amounts of the greenhouse gases carbon dioxide and methane could have entered the atmosphere through hydrothermal venting.

Around 30 scientists from 12 nations took part in the IODP (now the International Ocean Discovery Program) research cruise to the Vøring Plateau off the Norwegian coast on board the scientific drill ship *JOIDES Resolution*. Five of the 20 boreholes were drilled directly into one of the thousands of hydrothermal vents. The cores obtained can be read by scientists like a diary of the Earth's history.

As far as today's climate warming is concerned, there are some interesting conclusions to be drawn from the cores. On the one hand, they do not confirm that the global warming at that time was caused by the dissolution of gas hydrates—a danger that has been much discussed in recent years.

On the other hand, they show that it took many millennia for the climate to cool down again. So, Earth's system was able to regulate itself, but not on time scales relevant to today's climate concerns.

DEVELOPING SUBSEA TOOLS TO MONITOR THE UTILITY OF OCEAN-BASED CLIMATE SOLUTIONS

» *Chemical sensors developed by MBARI engineers have been critical to understanding a changing ocean. (Image credit: Lori Eanes, Monterey Bay Aquarium)*

There is growing interest in harnessing the ocean's natural ability to store carbon, including engineered climate interventions like marine carbon dioxide removal (mCDR). To this end, in a partnership with Woods Hole Oceanographic Institution (WHOI) and MRV Systems, LLC, next-generation chemical sensors developed by MBARI engineers will be integrated with a fleet of autonomous robotic gliders to offer a more nimble and cost-effective option for mCDR.

New federal funding from NOAA will allow MBARI and collaborators from WHOI and MRV Systems to join an upcoming field test of mCDR and deploy a fleet of robotic gliders equipped with MBARI's chemical sensors to evaluate how scientists and industry can best leverage autonomous technology to monitor future carbon removal efforts.

In 2025, WHOI researchers will conduct the first large-scale field trial of ocean alkalinization, a type of mCDR that uses alkaline materials, like minerals, to jumpstart the ocean's natural absorption of carbon dioxide. The WHOI team will monitor this field trial in the Gulf of Maine from research vessels using computer modeling to determine how much carbon dioxide is removed during the experiment and observing the associated ecological response.

MBARI scientists and engineers have developed sensors that can precisely measure ocean pH, or the acidity of seawater. pH is closely tied to carbon dioxide chemistry in the ocean, so these sensors can provide important information about biogeochemical processes. This technology is already in use aboard robotic floats like MBARI's Coastal Profiling Float and a fleet of biogeochemical (BGC) Argo floats deployed by the Global Ocean Biogeochemistry Array (GO-BGC) and Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) project.

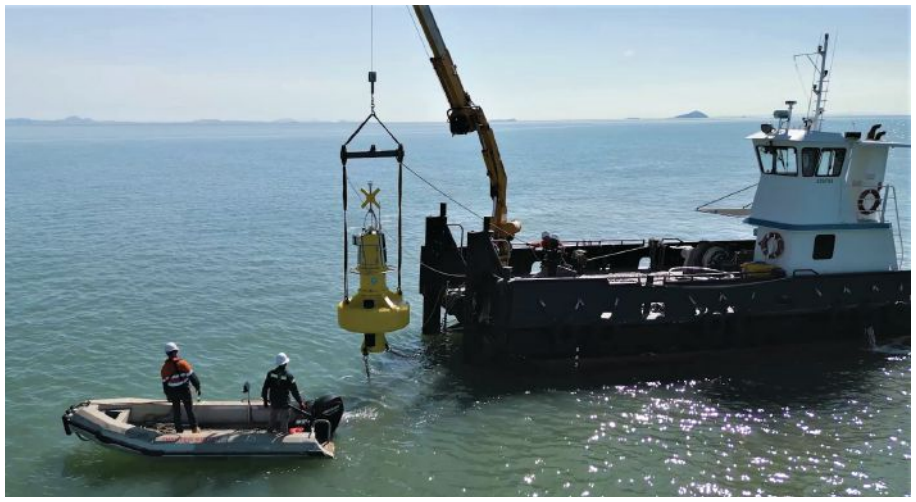
Now, the MBARI teams have created a smaller, more power-efficient pH sensor that can be used in a variety of ocean-going platforms, not just floats. The project will outfit a fleet of five Spray2 gliders—a second-generation glider developed by the Scripps Institution of Oceanography Instrument Development Group and commercialized by MRV Systems—with these new pH sensors to observe upcoming mCDR interventions and independently assess carbon removal and ecosystem response.

Before alkalinization gets underway, WHOI and MRV Systems will use the Spray2 gliders to characterize the conditions of the test site. The gliders will establish a biogeochemical baseline for the natural ebb and flow of carbon there. Once alkalinization gets underway, the gliders will track how much additional carbon is stored in the ocean, in conjunction with WHOI's ship-based monitoring.

This glider-based field program will lay the foundation for future experiments, and ultimately industry, to build upon as they look for ways to restore the climate and ocean health. The team hopes to gain insight into the ways autonomous technology can grow mCDR monitoring efforts and bring us toward a future where cost-effective monitoring, reporting, and verification can be achieved entirely by autonomous robots.

» *The Spray glider is an autonomous robot that moves through the water by changing its buoyancy. (Image credit: Joseph Warren, MBARI)*

CSIRO DEPLOYS WORLD-FIRST SENSORS IN SOUTHERN GREAT BARRIER REEF



» *HydraSpectra water sensor being installed on Darumbal Sea Country in Keppel Bay, where CSIRO are monitoring for sediment and dissolved carbon plumes. (Image credit: CSIRO)*

Australia's national science agency, CSIRO, has installed specialized sensors on Darumbal Sea Country in the Southern Great Barrier Reef to help monitor and forecast sediment run-off, which impacts the UNESCO World Heritage site's marine ecosystem.

The reef is one of seven test sites for CSIRO's AquaWatch Australia Mission, which is creating a world-first 'weather service' for water quality using a combination of specialized sensors and satellite data.

Dr. Alex Held, CSIRO's AquaWatch Mission Lead, said the project has the potential to support planning decisions in protecting areas of the reef, which brings in $5.2 billion annually and generates more than 64,000 full-time jobs.

"We are testing our systems for monitoring the flow of sediment and dissolved organic carbon—an indicator of the carbon exchange between land and ocean—from the Fitzroy River out into Keppel Bay towards the southern region of the reef," Dr. Held said. "Too much sediment can be a problem for coastal areas surrounding the river outlet because it blocks sunlight from reaching the seafloor, restricting the growth of marine plant life like seagrass.

"This then impacts the food availability for biodiversity in the area, including the reef's colorful array of marine wildlife. Dissolved organic carbon blocks light that phytoplankton in the ocean need for photosynthesis, a process that removes carbon dioxide from the atmosphere much like plants do. We will also be able to identify higher levels of chlorophyll in the water, which can be indicative of a potential harmful algal bloom. Harmful algal blooms can be devastating for marine ecosystems when they produce toxins that can cause health problems and even kill fish."

» *Satellite image from Sentinel Hub showing sediment flow from the Fitzroy River out to Keppel Bay and the Southern Great Barrier Reef. (Image credit: European Union, contains modified Copernicus Sentinel data 2023, processed with EO Browser)*

Dr. Nagur Cherukuru, a senior CSIRO researcher, said modelling and artificial intelligence (AI) would be applied to the combined sensor and satellite data set to predict the sediment flows—ultimately identifying certain areas of the river where interventions can be made.

» *HydraSpectra water sensor being used for the water-based sensor network as part of AquaWatch. (Image credit: CSIRO)*

"The modeling and AI will integrate not only the AquaWatch sensor data, but other factors like ocean currents, wind speed, wind direction and tidal conditions to improve the accuracy of forecasts from AquaWatch," Dr. Cherukuru said. "Much like having a weather report for guidance, the information can be used by water managers to inform marine and land planning decisions both during normal environmental patterns and in flood situations, when large volumes of sediment can be washed out to sea."

While this test data will only be available to research partners and Traditional Custodians initially, the long-term goal for AquaWatch is to provide national water quality monitoring and forecasts to all Australians via an app or integration into current weather reporting.

USV OBJECT RECOGNITION TECHNOLOGY PROVES IDEAL PARTNER FOR DIVE TEAM

By Maria Pleskach
Technical Writer

Integrated systems that offer a synergy of technologies are gaining traction for optimizing underwater operations. In August 2023, EvoLogics successfully combined their object recognition in side-scan sonar imaging of the Kreidesee lakebed with acoustic communication and tracking for divers, who received a waypoint for investigating what the Sonobot had discovered.

THE KREIDESEE IN HEMMOOR

The Kreidesee (German for "chalk lake") in Hemmoor, Germany, is a former chalk mining quarry that has been transformed into a unique recreational diving site. The lake is 60 meters deep and is known for good visibility, as the water is poor in nutrients and therefore free from algae.

Freshwater filled the mine after mining activities ceased in the 1970s. The encircling factory buildings were dismantled, with some being submerged in the lake's waters to fortify the edges. During the 2000s, the lake became a popular diving spot and today the crystal-clear waters attract divers from around the world keen to explore the preexisting geological features—now under water—as well as some other purposely placed wrecks, such as cars, trucks, boats, and even a single-engine plane.

Unsurprisingly, the site is a great location for testing and demonstrating hi-tech underwater equipment, and in August 2023 EvoLogics conducted a complex object recognition and diver coordination mission with a Sonobot 5 uncrewed surface vehicle (USV) and the company's new acoustic tracking technology for divers.

USV GUIDES DIVERS

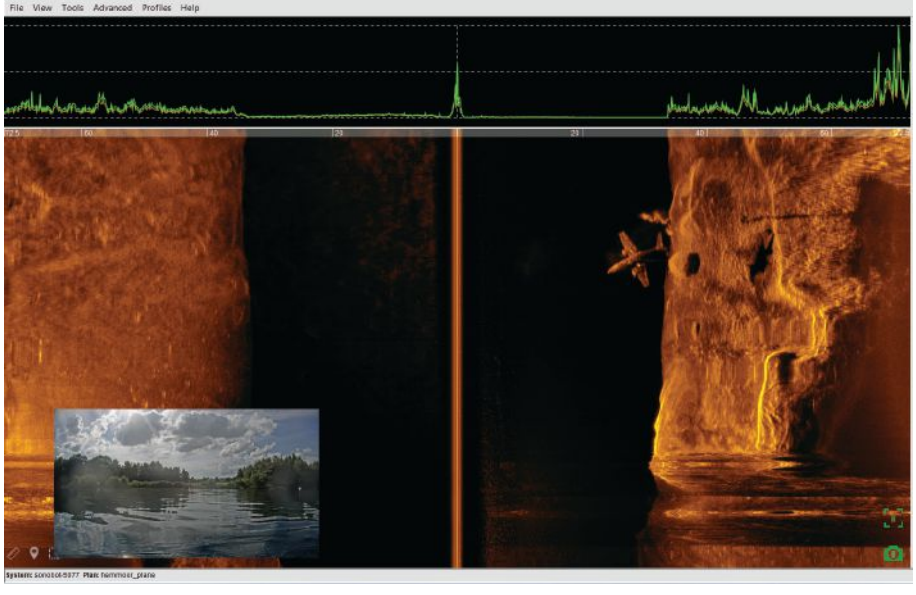
EvoLogics' compact Sonobot 5 USV is available with several hardware options that cater to various missions, with a configuration that packages side-scan sonar imaging with object recognition software available on the market since 2020. This set-up is ideal for running riverbed and seafloor side-scan sonar campaigns that trigger the automatic detection of objects. The AI-based system is an extra module that runs directly onboard the Sonobot and analyzes raw side-scan sonar output. Objects of interest are detected and visually flagged in the onshore operator's control command in real time during the mission.

» *S2C T 18/34 underwater acoustic modem in molded diver tracker configuration. (Image credit: EvoLogics)*

In Hemmoor, EvoLogics deployed the Sonobot 5 to detect an underwater object located on the lake floor, having previously trained the AI system for this object class. After "discovery" in the side-scan sonar feed, the object's location was automatically transmitted to SiNAPS, the EvoLogics positioning software tracking a team of divers, as a point of interest to investigate further.

DIVER TRACKING SYSTEM

EvoLogics is in the final testing phases of an acoustic diver tracking system that simplifies complex underwater tasks involving multiple team members, like search and rescue, salvage, recovery, or cleanup ops. This system enables better coordination through two-way communication among divers, between divers, and with the sur-



» *Side-scan sonar image of the sunken airplane in the Kreidesee Lake. (Image credit: EvoLogics)*

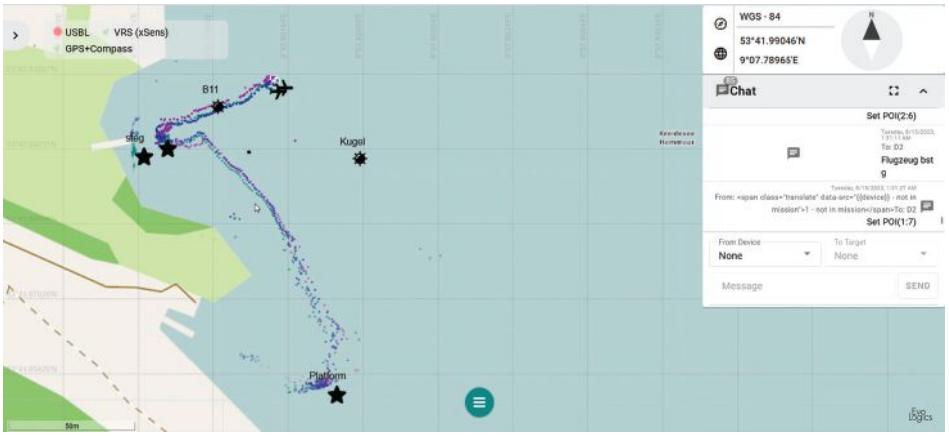
face dive supervision team. This improves task management and information sharing, making diver operations more effective.

EvoLogics uses the compact battery-powered 18/34 T-series "tiny" acoustic modems as the diver trackers, with the acoustic transducer positioned on the diver's back for unobstructed signal transmissions. The lightweight system easily connects to scuba gear with minimal adjustments, and EvoLogics is currently testing out several molded unibody designs tailored for various diving equipment to ensure broad compatibility and simple installation.

The surface acoustic node for the operation is the USBL buoy, EvoLogics' mono-unit with a USBL antenna, integrated PC running SiNAPS positioning software, dual-antenna GNSS receiver, and WiFi access point. It is designed for mobile scenarios with a speedy setup and fully supports diver tracking with bidirectional message exchange.

The diver console is a compact wrist tablet that connects to the modem tracker by cable. It provides the diver with access to the SiNAPS user interface—hence visualizing the map of the current operations area, the positions of all divers, the proximity of the support vessel—and the text chat tool.

The USBL buoy uses acoustic signals to calculate diver positions and display them in the support team's SiNAPS. This allows the surface team to oversee divers, monitor their positions, communicate messages, and adjust mission waypoints. With bidirectional acoustic links, all mission divers gain access to tracker positions.



» *SiNAPS positioning software during the mission shows the three divers that traveled to the B11 object discovered by the Sonobot, then to the plane submerged in the lake. (Image credit: EvoLogics)*

Just like texting on a smartphone, SiNAPS allows the divers to exchange short messages with each other and the surface, while also tracking each other's positions in real time. Map waypoints can be added before or even during the mission to coordinate operations, and mark discovered objects or infrastructure for further investigation.

> "THIS SYSTEM ENABLES BETTER COORDINATION THROUGH TWO-WAY COMMUNICATION AMONG DIVERS, BETWEEN DIVERS, AND WITH THE SURFACE DIVE SUPERVISION TEAM."

Setting up SiNAPS waypoints during a diver mission was extensively tested in Hemoor, with points of interest added by the surface team, by the divers underwater, and automatically imported from the Sonobot control software after object discovery.

OBJECT RECOGNITION

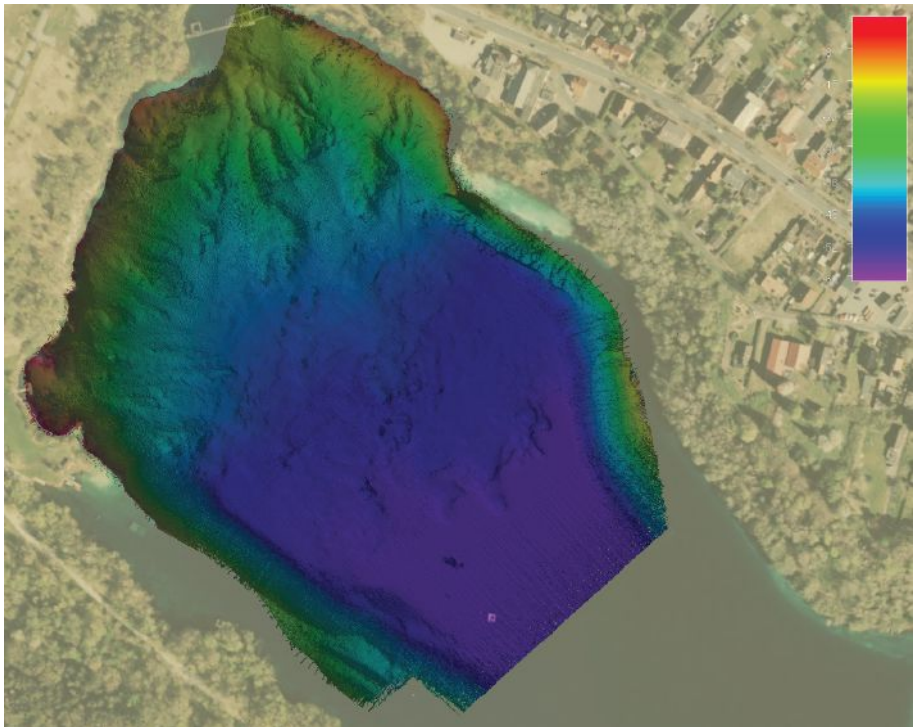
As luck would have it, the underwater test object for the joint Sonobot-diver mission was placed near an exciting Kreidesee diver attraction—the sunk Piper Aerostar 601 airplane showed up in side-scan sonar imagery during a test run with the Sonobot's side-scan sonar.

For the coordinated Sonobot-diver operation, the vehicle was launched on an automated side-scan sonar survey of the area. The test object was successfully recognized and highlighted in the Sonobot control software, while its georeferenced coordinates were exported to SiNAPS as a point of interest. Using acoustic signals, the USBL Buoy transmitted this waypoint to diver consoles to direct the team toward the object.

In SiNAPS onshore, the observed three divers moved towards the object and confirmed its location over the text chat. The divers also ventured to the plane's location and added it as a SiNAPS point of interest.

The Kreidesee trials demonstrated a deep integration of EvoLogics technologies, proving how a USV can effectively support a diver team on a complex search task. Such missions can significantly benefit from efficient information exchange and advanced automation, the main vectors of ongoing development work at EvoLogics. And the team is packing for the field once again—this time the Sonobot-aided diver coordination system is set for a Fall trip to Portugal for a fresh mission.

For more information, visit: *www.evologics.de*.



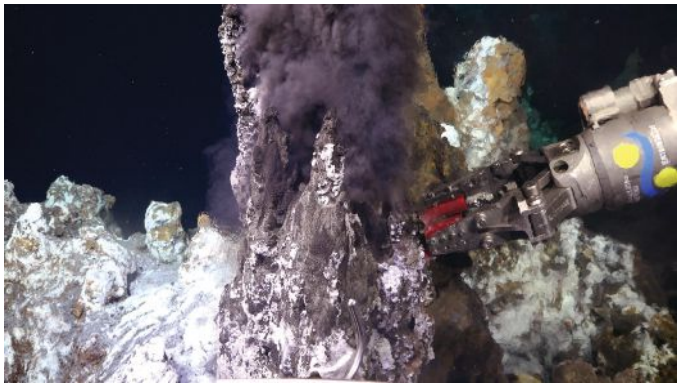
» *Bathymetry of the area taken with the new EvoLogics Multibeam. (Image credit: EvoLogics)*

SCIENTISTS DISCOVER NEW ECOSYSTEM UNDERNEATH HYDROTHERMAL VENTS

A new ecosystem has been discovered in volcanic cavities beneath hydrothermal vents at a well-studied undersea volcano on the East Pacific Rise off Central America. The landmark 30-day expedition aboard Schmidt Ocean Institute's research vessel *Falkor (too)* was led by Dr. Monika Bright, University of Vienna, along with an international science team from the United States, Germany, the Netherlands, France, Costa Rica, and Slovenia.

Using an underwater robot, the science team overturned chunks of volcanic crust, discovering cave systems teeming with worms, snails, and chemosynthetic bacteria living in 75 degrees Fahrenheit (25 degrees Celsius) water. The discovery adds a new dimension to hydrothermal vents, showing that their habitats exist both above and below the seafloor. Scientists have spent the past 46 years studying hydrothermal vents and microbial life in the subsurface but have never looked for animals under these volcanic hot springs.

Additionally, they found evidence of vent animals, like tubeworms, traveling underneath the seafloor through vent fluid to colonize new habitats. Tubeworms are one of the foundational hydrothermal vent animals but very few of their young have been found in the water above hydrothermal vents, leading Dr. Bright's team to suspect they travel beneath the earth's surface to create new hydrothermal communities.



» *ROV SuBastian takes a geologic sample from a hydrothermal black smoker near Tica Vent on the East Pacific Rise 2,500 meters deep. (Image credit: Schmidt Ocean Institute)*

» *The Control Room of Falkor (too). (Image credit: Schmidt Ocean Institute)*

Hydrothermal vents act like underwater hot springs that flow through cracks in the earth's crust as a result of tectonic activity. When a new hydrothermal vent appears, the ecosystem rapidly follows as animals colonize an area within a few years. How animal larvae find new vent fields is unknown by scientists. Dr. Bright's team is the first to examine and confirm that tubeworm larvae can settle and even live underneath the seafloor.

To determine if animals travel through vent fluids, the science team used Schmidt Ocean Institute's underwater robot, ROV *SuBastian*, to conduct experiments by gluing mesh boxes over cracks in the earth's crust. When the boxes were removed after several days along with the crust they discovered animals living below the surface in hydrothermal cavities. Scientists will study results from their experiments in the months to come.

AST TO REVOLUTIONIZE MARITIME ASSET MANAGEMENT WITH IRAMS

Applied Satellite Technology (AST) recently announced the launch of its latest ground-breaking software solution, the Integrated Remote Asset Management System (IRAMS), which promises to transform the way maritime organizations monitor and manage their remote assets.

IRAMS brings together live asset performance data, predictive maintenance scheduling and environmental impact reporting onto one single platform.

Over time, many more features/modules will also be available within IRAMS which will be led by our customer feedback, with crew welfare, tracking and route optimization already being scoped for future iteration.

This innovative software system provides access to vital information and data in real time, whether a vessel is in dock or an asset out at sea anywhere in the world, at any time of day.

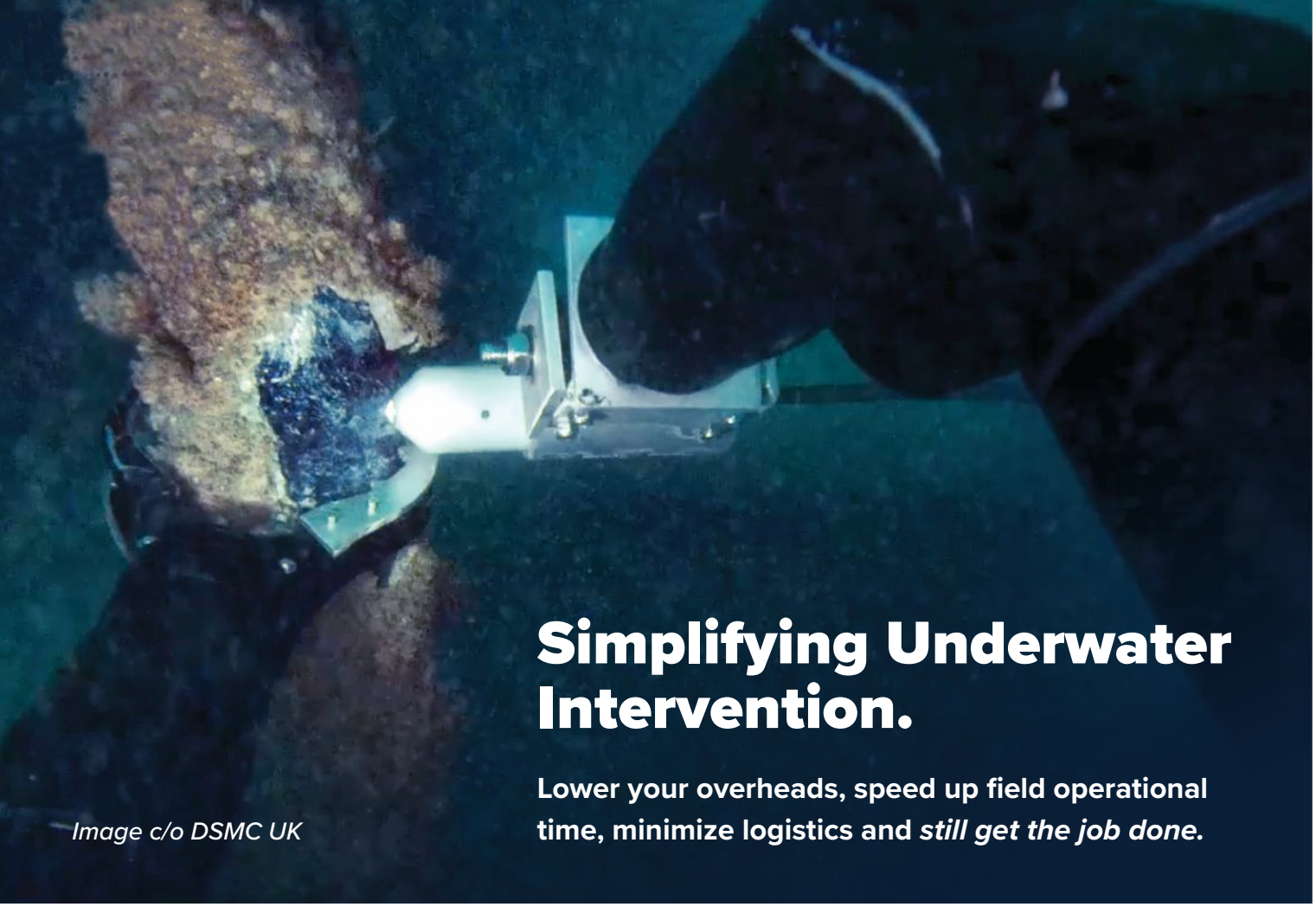


Image c/o DSMC UK

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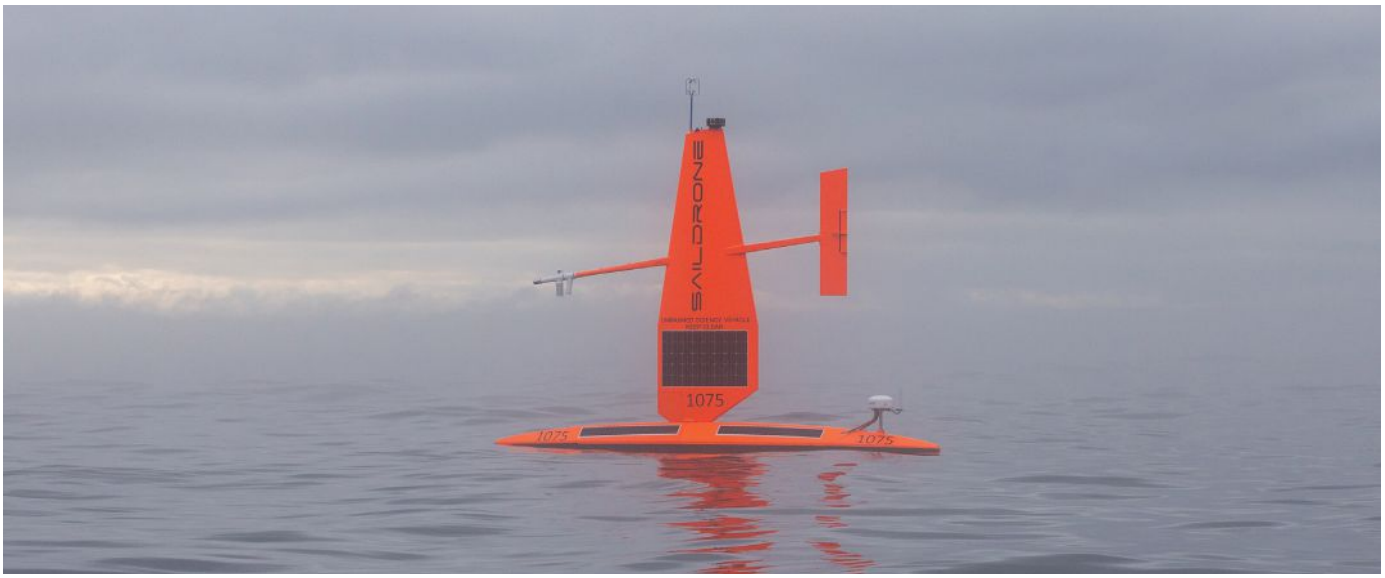
NEW ACOUSTIC TECH PROTECTS MARINE MAMMALS WHILE ENABLING RENEWABLE OFFSHORE ENERGY



» *Two Saildrone USVs were deployed off the coast of Massachusetts to listen for North Atlantic right whales. (Image credit: Saildrone)*

Saildrone, the world leader in uncrewed surface vehicles and autonomous ocean data collection, together with RPS, a leading provider of protected species monitoring and mitigation compliance services, has announced the completion of the first phase of a project to create a monitoring network to detect, classify, and localize marine mammals.

As the demand for clean energy continues to grow, offshore wind farms are becoming increasingly common. However, the construction and operation of these farms can impact marine ecosystems. Many large whale species are highly dependent on acoustics to conduct important life functions and, therefore, sensitive to underwater noise.

Traditional visual and acoustic methods for monitoring marine mammals require trained biologists to be deployed offshore on crewed vessels. Whale vocalizations are often very low frequency, making them difficult to detect and easily masked by man-made sounds.

Two Saildrone USVs equipped with proprietary underwater acoustic systems were deployed off the coast of Massachusetts to listen for North Atlantic right whales and other marine mammals for a two-week period, during which numerous marine mammal vocalizations were recorded.

Now, RPS's acoustic scientists are identifying the types of calls using RPS's machine learning tool, Neptune, a predictive algorithm for accurate, reliable detection of marine mammal vocalizations.

"The global development of offshore wind is key to moving away from traditional, non-renewable power generation, especially fossil fuels. But development must not negatively impact the marine mammals that share the habitat. Saildrone and RPS are working together to provide a unique, flexible, and adaptable solution to marine mammal monitoring of large areas over significant time periods, using smart tools to reduce personnel in the field but without decreasing the monitoring and mitigation provided to protect our marine animal neighbors," said Stephanie Milne, RPS Team Leader, US Offshore Renewables.

"This milestone achievement represents a significant step forward in our ability to study and protect whales and other marine mammals," said Saildrone CTO Brian Hernacki. "Saildrone's passive acoustic technology allows us to gather vital information in a non-invasive and cost-effective manner, and combined with the mobility and endurance of our uncrewed platforms, provides unprecedented monitoring capability, facilitating research, conservation, and commercial enterprise."

The project is supported by a significant award from the National Offshore Wind Research and Development Consortium (NOWRDC) to facilitate offshore wind's coexistence with wildlife and other ocean users and support other industry initiatives.

"NOWRDC is excited to award projects that directly respond to challenges in the offshore wind industry," said Lyndie Hice-Dunton, Executive Director of NOWRDC.

"As we approach the deployment of commercial-scale offshore wind in the US, these projects have the potential to provide real solutions to near-term industry challenges—ranging from stakeholder coordination to transmission resiliency. By harnessing the power of technology and innovation, we can strike a balance between sustainable economic development and the preservation of our fragile ecosystems."

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CARBON REMOVAL COMPANY COMPLETES WORLD'S FIRST SEAWEED BAILING AND SINKING TEST

» *Deployment from RV Polarstern. (Image credit: Seafields)*

Seafields, a carbon removal company based in the UK, has shared details of the world's first seaweed biomass sinking trials for carbon removal to test the impact on the surrounding environment.

This trial is Seafields' first step towards an environmental impact study and will assess four different types of biomass—unprocessed Sargassum, Ulva (green algae), kelp and terrestrial biomass. Sinking to the bottom of the sea floor, it's anticipated that the bales of seaweed will be able to lock away carbon for millennia, helping to reduce atmospheric greenhouse gas concentrations in the future, whilst limiting the impact on the ocean floor to a minimum.

Joining forces with Running Tide and the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), the team deposited the bales in June during an expedition to AWI's LTER (Long-Term Ecological Research) Observatory HAUSGARTEN on the RV *Polarstern* at a depth of 3,483 meters. The joint operation was made possible through the collaboration with Frank Wenzhöfer and the AWI's Deep-Sea Ecology and Technology team.

To study the processes on the seafloor around the four biomass packages, Seafields will collaborate with the AWI and Running Tide to deploy a remotely operated vehicle (ROV) at the deposition site from *Polarstern* during next year's expedition to the long-term observatory in the Fram Strait.

With over two decades (since 1999) of studying this specific location in the Fram Strait, it provided the perfect location for Seafields to conduct the test. The team will return to the site next year to survey the area on and around the bales and take sub-samples to study them in the laboratory. The samples will be analyzed using various methods to investigate the carbon content and integrity of the biomass bales.

CELLULA ROBOTICS INITIATES SEA TRIALS FOR SOLUS-XR SYSTEM

Cellula Robotics recently reached a monumental moment in a project that commenced in early 2023, showcasing the company's dedication to advancing Extra Large Unmanned Underwater Vehicles (XLUUVs). The Solus-XR XLUUV has officially embarked on its highly anticipated sea trials, signifying a crucial stride in the company's development of its long-range hydrogen fuel cell powered autonomous underwater systems.

Building upon the foundation of Cellula's preceding innovation, Solus-LR, the remarkable Solus-XR XLUUV has been meticulously crafted to attain unparalleled operational ranges, reaching an impressive 5,000 kilometers. Through its port-to-port mission capability, Solus-XR removes the necessity for auxiliary support vessels, thus facilitating access to challenging and remote locations frequently encountered in Arctic sub-ice missions. Beyond the elimination of environmentally taxing high-emission support vessels, the cutting-edge hydrogen fuel cell technology developed by Cellula empowers the system to engage in sustainable operations, ensuring minimal ecological footprint.

The initial sea trials are designed to evaluate surface performance and autonomy, offering a valuable opportunity to assess the vehicle's capabilities in the dynamic context of real-world maritime conditions.

Looking ahead, Cellula Robotics Ltd has planned demonstration missions for 2024, a pivotal step in showcasing the full spectrum of the Solus-XR XLUUV's capabilities in real-world scenarios. These missions will underscore the vehicle's potential to redefine underwater security and operations, solidifying its place as a game-changing technology.

Further bolstering its achievements, the Solus-XR XLUUV proudly claims the title of the largest UUV ever developed in Canada. This accomplishment underscores the nation's capacity to drive innovation and lead in the development of cutting-edge underwater technology.

» *The Solus-XR XLUUV. (Image credit: Cellula Robotics)*

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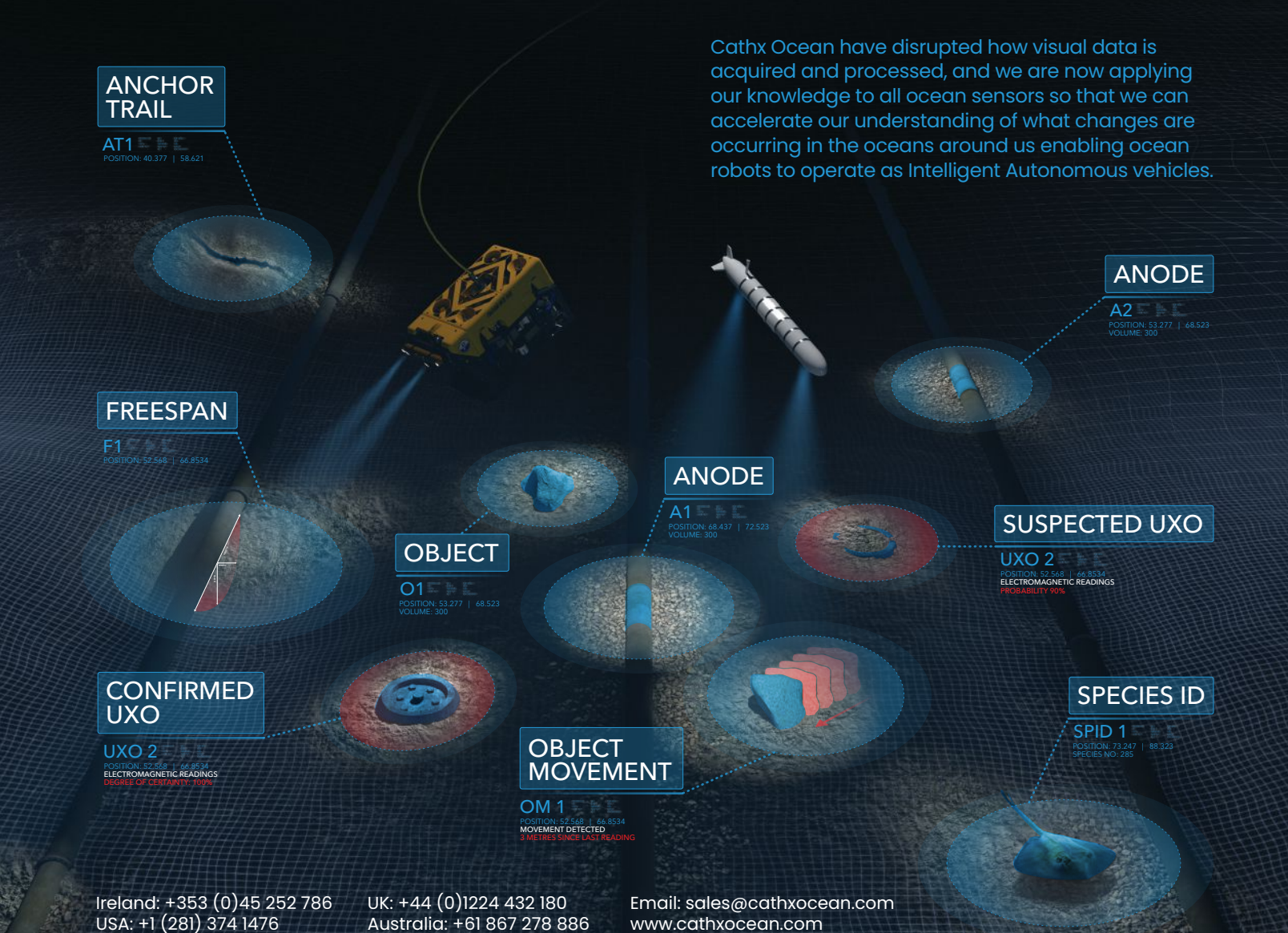

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OSCILLA POWER PREPARES FOR LAUNCH OF TRITON-C WAVE ENERGY CONVERTER

» *Triton-C Wave Energy Converter. (Image credit: Oscilla Power)*

In preparation for launching its Triton-C wave energy converter (WEC), Oscilla Power has completed two key preliminary steps: relocating the Triton-C and performing setup and staging activities at the launch site at the Wave Energy Test Site (WETS) in Hawaii. These steps are necessary precursors to a full, commercial-scale demonstration once work on the WETS site is completed by the US Navy.

During the 12-hour effort, the Triton-C was towed from Honolulu Harbor to the grid connection point at the WETS site in Kaneohe Bay where the Triton-C will eventually be tethered for a commercial-scale demonstration. At this location the team was able to rehearse and work through some of the activities needed for the ultimate deployment. Activities included testing the ability to manually activate various systems under some of the significant motions experienced by the system. As a result, the team is now making any necessary adjustments in advance of full power performance tests in the coming weeks.

Oscilla Power's Triton™ WEC will make ocean wave energy a cost-effective resource that can complement solar and wind in many locations worldwide including the US West Coast. The innovative design of the Triton overcomes the main limitations that have prevented ocean wave energy from being adopted previously by offering increased levels of energy capture, conversion efficiency, and survivability in the harsh ocean environment.

"It was an incredibly rewarding experience to get the Triton-C out to its final deployment location and see just how it operates, if only for a few hours," said Tim Mundon, Chief Technology Officer of Oscilla Power. "We now know what to expect from both setup and operations as we plan for the next phase of the launch—a more expansive testing of the energy capture and power generation components of the Triton. I am proud of the entire team and our partners who have gotten us to this critical juncture."

Perhaps most important is that the WEC is now staged only two miles away from the WETS launch site, allowing Oscilla Power to opportunistically take advantage of suitable weather and wave conditions for both further testing and the ultimate installation. The WETS site is a pre-permitted location and includes all required infrastructure, such as the subsea grid connection and moorings.

GLOBAL MARITIME AWARDED MWS SERVICES FOR INNOVATIVE OFFSHORE GAS FIELD PROJECT

Global Maritime announces the award of Marine Warranty Surveyor (MWS) Services for the ground-breaking ONE-Dyas N05-A Gas Field project in the North Sea.

The project will include the installation of the N05-A six-legged platform, export gas pipeline, and subsea power cable. Global Maritime's MWS services will encompass comprehensive third-party document review and onsite surveillance throughout the mobilization, transport, and installation phases of the offshore infrastructure.

The N05-A project blends the production of gas with offshore wind, with the nearby Riffgat offshore wind farm providing electricity to power the platform. This innovative approach to platform electrification means ONE-Dyas are bringing the N05-A platform emissions close to zero and championing the energy transition, a movement that requires cooperation between all stakeholders.

For this project, ONE-Dyas is exploring opportunities for nature-inclusive construction, identifying further system integration between wind and gas and opportunities that can contribute to research and nature development in the area. The project sets a new benchmark for sustainable energy projects and exemplifies the commitment to energy transition and a CO2-neutral energy supply.

Matthew Taylor, Global Maritime UK MWS Lead, said: "This is an exciting project for Global Maritime to be involved in, not only does it build our relationship with ONE-Dyas, but showcases our expertise in both gas and renewable energy projects."

With extensive expertise and global reach, Global Maritime continues to provide competent and critical support to clients across the maritime sector.

» *Visualization of the N05-A platform and the connection to the Riffgat wind park 2. (Image credit: ONE-Dyas)*

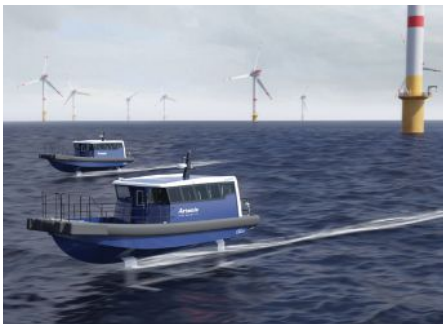
ARTEMIS TECHNOLOGIES UNVEILS ENHANCED 100% ELECTRIC CREW TRANSFER VESSEL

Artemis Technologies has announced the latest version of the Artemis EF-12 crew transfer vessel (CTV), featuring a revitalized design that raises the bar for crew comfort and operational excellence during offshore missions.

The Artemis EF-12 CTV has been designed to offer seamless transportation for personnel between port or vessel and offshore installations.

Key enhancements of the Artemis EF-12 CTV include the option of an additional propulsion system on the rudder, providing twice the power during bollard push maneuvers, as well as improved slow speed control when approaching the turbine. With a capacity of up to 12 passengers, the vessel incorporates advanced safety measures, including improved impact resistance, and state-of-the-art fire suppression technology.

The EF-12 CTV offers enhanced communication capabilities, facilitating real-time data exchange between crew members and onshore operations. The state-of-the-art telematics system enables boat owners and operators to efficiently manage their fleet in real-time, minimizing operational downtime.



» *The latest version of the Artemis EF-12 CTV. (Image credit: Artemis Technologies)*

"The introduction of the revitalized Artemis EF-12 CTV marks a significant step forward in our ongoing drive to provide the most advanced maritime solutions," said David Tyler, Co-Founder at Artemis Technologies. "The enhanced cabin design, coupled with our unwavering commitment to maritime innovation and safety, sets a new benchmark for crew transfer vessels, ultimately enhancing the efficiency and effectiveness of offshore operations."

Artemis Technologies has partnered with leading renewable energy company Ørsted, offshore access specialist Tidal Transit, and maritime leader Lloyd's Register, to deploy the first EF-12 CTV at Ørsted's Barrow wind farm on the UK's west coast next year. The project was awarded £2.4 million as part of the Clean Maritime Demonstration Competition Round 3 (CMDC3), funded by the UK's Department for Transport and delivered in partnership with Innovate UK.

EQUINOR APPOINTS DEEPOCEAN AT TROLL B IN THE NORTH SEA

» *Offshore operations at Troll B are planned for 2024. (Image credit: Øyvind Hagen/Equinor)*

Ocean services provider DeepOcean has been awarded a contract by Equinor to support the Troll B – Increased Gas Export project, located in the northern part of the North Sea.

The Troll B – Increased Gas Export project involves a replacement of the current 15" gas export riser with a new 13" gas export riser at the Troll B platform.

DeepOcean's contract scope includes engineering, transportation and installation of the gas export riser, subsea tie-ins and pre-commissioning support.

DeepOcean has successfully performed similar riser replacement operations, including complex marine operations, at several Equinor-operated fields including Njord, Kristin, Troll C and Åsgard. In addition, DeepOcean recently completed a similar riser replacement job at the Snorre field.

Project management and engineering for the Troll B riser replacement will commence immediately at DeepOcean's office in Stavanger with further support from the company's Haugesund office in Norway.

Offshore operations are planned to take place in 2024 utilizing the *Edda Freya* installation vessel, which is on charter to DeepOcean.

Troll B is a floating processing and accommodation platform with a concrete substructure, located in the northern part of the North Sea.

DeepOcean applies its specialist subsea engineering and project management competence to ocean-based industries such as offshore renewables, oil and gas, subsea minerals and recycling of subsea infrastructure.

Across these industries, the group delivers marine services such as seabed surveys, engineering, project management, installation, inspection, maintenance & repair (IMR) services.

ENERPAC TP LEVELING AND FIXATION SYSTEM FOR CALVADOS OFFSHORE WIND FARM

Enerpac has been awarded a contract by Saipem to supply the Hydraulic Leveling and Fixation System for the installation of 64 transition pieces (TP) at Calvados offshore wind farm in France.

The Enerpac system allows accurate levelling and fixation of the transition pieces on the monopile foundation, enabling maximum turbine power generation.

Grouted connections are widely used in offshore wind turbine construction to transfer multiple loads from the transition piece fitted on top of the monopile foundation. The transition piece is first lowered onto the monopile and levelled. It is then grouted into position to fix the TP to the monopile.

» *Enerpac leveling system. (Image credit: Enerpac)*

For the Calvados offshore wind farm, each transition piece will be 24 meters high and weighs approximately 500 tons. Each TP will require six fixation cylinders and six levelling cylinders to ensure accurate leveling and fixation on their monopile foundations. In total, Enerpac is supplying 768 custom-built cylinders to Bladt Industries A/S production facilities in Aalborg, Denmark, who are responsible for the fabrication and assembly, before load-out, of all the transition pieces.

Located more than 10 kilometers off the French coast in water depths ranging from 22 to 31 meters, the Calvados offshore wind farm will comprise 64 Siemens Gamesa wind turbines with a total capacity of 450 MW.

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DEFINING THE FUTURE OF INTELLIGENT ADCP TECHNOLOGY

By Michelle Barnett
Business Development Manager – Ocean Science
Sonardyne

Acoustic Doppler current profilers (ADCPs) are nothing new. The technology has been in use for around 50 years, profiling currents and providing fairly standard data.

All of that has just changed…

Launched in April 2023, Sonardyne's Origin 600 and 65 represent the future of intelligent ADCP technology. Our first truly dedicated ADCPs, Origin 600 and 65 feature several innovations making them the most advanced ADCPs on the market.

These include an integrated modem for communications and positioning, new Edge processing capability and an ecosystem for writing your own apps. Alongside industry standard PD0, our new and exclusive A-gram and B-gram proprietary data formats offer up to ten times greater spatial resolution producing astonishing data sets.

- Origin 600 has a five-beam configuration including a central vertical beam. With a maximum sampling frequency of 4Hz on all beams, it's suitable for wave and turbulence applications as well as mean currents. Combining field proven transducers with an integrated modem, internal rechargeable battery and Edge processing, Origin 600 re-writes ADCP capability for acquiring mid-range current profiles.

- Origin 65 boasts a unique acoustic design increasing robustness and reducing cost, while maintaining outstanding current profiling performance. The integrated modem allows for remote actions, whilst its Pressure Inverted Echo Sounder (PIES) functionality delivers high-precision time-of-flight and average in-situ sound velocity data.

PAST PROBLEMS, SOLVED

Seabed ADCPs have always been bugged by a critical problem—once deployed, you must wait until retrieval to assess the data.

Anecdotal evidence suggests many missions end up being costly, time-consuming mistakes when—on retrieval—it's discovered that the ADCP wasn't deployed level, data gathering has failed, or even that the equipment hasn't been switched on.

> "THE LAUNCH OF THE ORIGIN 600 MARKS A HUGE STEP FORWARD IN ADCP TECHNOLOGY, PROVIDING THE USER WITH EXPANDED ADCP CAPABILITY, WHILST PRESENTING A NUMBER OF OPERATIONAL POSSIBILITIES AND ADVANTAGES, INCLUDING IN-FIELD FLEXIBILITY AND DATA ASSURANCE."

Many of the 'cross your fingers and hope' elements of ADCP operations are eliminated by Origin. The acoustic modem provides the ability to check operating status, test data quality, change schedules mid-mission—all whilst Origin is on the seabed and without the cost and risk associated with interfacing an external modem or running a cabled ADCP operation.

Compatibility with Ranger 2 transceivers provides easy communication and data retrieval during deployment. In any operation, external sensors can be connected via an RS232 cable and their data integrated into Origin's via the Edge processing apps.

» *Origin 600 from Sonardyne, available with additional internal battery capacity (right). (Image credit: Sonardyne)*

This allows users to get the most out of any single deployment, saving time and money. To further minimize cost, cut carbon emissions and personnel risk, data can be harvested via a USV rather than a crewed vessel.

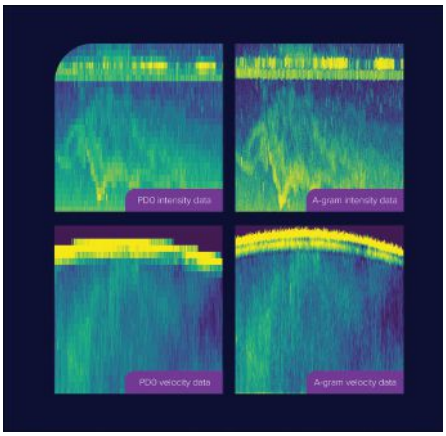
ONE SIZE FITS ALL

The new ADCPs are simple to operate with best-in-class data results and integrated communications and positioning, making them ideal for a wide range of applications, including marine research, offshore renewable energy, and defense.

For Ocean Science

Origin 600 delivers improved spatial resolution and high-fidelity data formats across a wide range of marine applications.

- For biological oceanography: it can help you track fish schools, monitor zooplankton migration, and study currents, waves, turbulence, and sediments.



» *A comparison of standard PD0 and A-gram data. (Image credit: Sonardyne)*

- For academic research: its high-fidelity data formats give you deeper insights into ocean processes, and the built-in modem allows you to harvest data and update missions in-situ.
- For environmental monitoring and management: it provides exclusive A-gram and B-gram data which can be used to parameterize currents, turbulence, and waves, helping you understand your coastal oceanography and develop more effective management strategies.
- For fisheries and aquaculture: it gives the high quality, consistent, and reliable data you need to monitor and manage fish stocks and aquaculture sites, leaving you free to focus on your farming.

"Origin represents a significant advance in ocean current profiling technology. It will provide our customers with the highest quality data, specifically tailored to their needs, in the most challenging of environments," says Geraint West, Head of Science, Sonardyne.

For ORE

Origin 600 has applications for every stage of offshore renewable energy (ORE) operations.

At consenting stage, its integrated modem gives optimal data assurance for metocean surveys. Currents, waves, and turbulence can all be assessed via the Edge processor and the data transmitted to your control room.

At installation and operational stages, the integrated acoustic modem and Edge data processing excel again. Customizable apps and fast, reliable data export give near real-time monitoring of any ORE site, enabling teams to make time-critical decisions for maintenance, improving safety in crew transfer and underwater operations.

Connect a sensor via the third-party integration port to determine what sediment is in the water column and where it's going. This is invaluable for monitoring scour which can threaten the stability and integrity of an ORE installation.

» *An Origin 600 being deployed offshore Plymouth. (Image credit: Sonardyne)*

» *An Origin 65 being deployed offshore Oban. (Image credit: Sonardyne)*

RECOVER. RECHARGE. REDEPLOY.

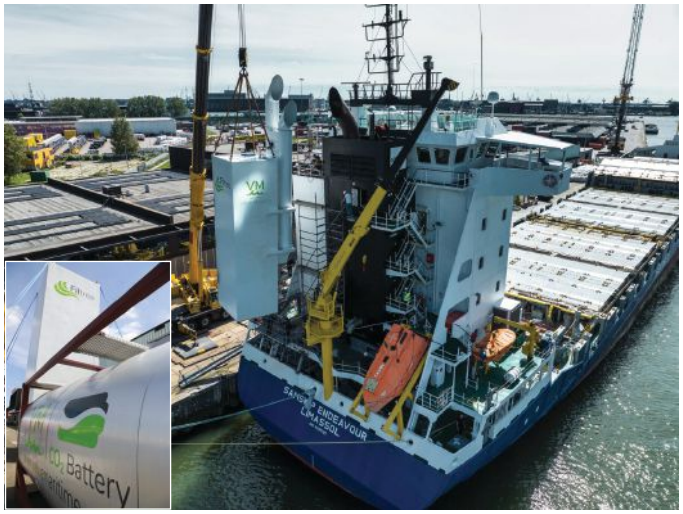
Origin 600 is compatible with standard mounting infrastructure. Straightforward back-deck deployment is coupled with the assurance you can locate, communicate with, and update the ADCP throughout its mission via the acoustic modem.

At the end of the campaign, users simply recover Origin 600 from the seabed, retrieve the data, recharge the internal battery (no tricky back-deck battery changes!), and it's ready to redeploy.

Origin 65 has all the features of the 600 plus PIES functionality and an integrated mechanical release, making it ideal for water column density mapping. As with the Origin 600, Edge data processing within the 65 maximizes the performance of the acoustic modem by only transferring critical data to the surface. To reduce the cost, carbon intensity, and safety risk, data harvest can be performed via a USV rather than a crewed vessel. Combined with up to 6 years' battery life, Origin 65 provides the perfect solution for long-term environmental monitoring operations where access to data during deployment is required.

So, what are you waiting for? Give your ADCP operations the Edge with Origin. For more information, visit: *www.sonardyne.com*.

VALUE GROUP WELCOMES SHELL VENTURES TO ACCELERATE MARINE DECARBONIZATION



» *The Filtree System cleans sulphur, ultra-fine particulate matter, and CO2 from ships' exhaust emissions. (Image credit: Value Maritime)*

Sustainability pioneer, Value Group (Value Maritime and Value Carbon) recently announced that Shell Ventures has joined Value Group's investor base to accelerate and expand Value Group's carbon capture utilization and storage strategy.

Value Maritime is the pioneering developer and installer of one of the first commercially viable hybrid CO2 capture and exhaust gas cleaning systems (Filtree), which shipowners and operators can lease to help them lower their emissions.

Shell Ventures, the corporate venture capital arm of Shell, supports companies in their early, scale and growth phases, providing investments that stimulate the development of new technologies and disruptive business models to lower emissions and accelerate the energy transition.

Since 2017, Value Maritime has supported multiple shipowners and operators in reducing their emissions with its Filtree System. This unique system cleans sulphur, ultra-fine particulate matter, and CO2 from ships' exhaust emissions as well as oil residue and particulate matter from the vessels' washing water. As a result, the Filtree System supports both the lowering of CO2 emissions and a reduction of acidification of seawater.

The Filtree System also features an integrated carbon capture feature that allows ships to store the CO2 they collect onboard in dedicated fixed tanks or non-fixed battery containers. These onboard storage facilities are filled with CO2, which can then be sustainably offloaded in port for re-use or storage elsewhere.

WINTERSHALL DEA AWARDED CCS LICENSE FOR THE UK'S CAMELOT FIELDS

Wintershall Dea is intensifying its carbon capture and storage (CCS) activities in the Southern North Sea. The company has been awarded a new license by the North Sea Transition Authority (NSTA) to store CO2 under the seabed. The Camelot license's annual storage potential is up to 6 million tonnes and provides a significant and valuable contribution to the CO2 abatement potential in the UK.

With ambitions to become a leading gas and carbon management company, Wintershall Dea views the award as an important steppingstone to access the UK's CCS industry, and to develop Northwest Europe as a key region for carbon management technologies in the company's portfolio.

"Wintershall Dea is among the leading CCS players in the North Sea with a total of four licenses in three North Sea countries. With the Camelot project, we are once again reaffirming our intention to develop CO2 storage sites in the North Sea to deliver solutions to tackle climate change and decarbonize industries," said Hugo Dijkgraaf, Wintershall Dea's Chief Technology Officer, and member of the Executive Board. "We are pleased to be maturing this project and thus adding another essential puzzle piece to a European CO2 infrastructure, utilizing our expertise from our CCS projects in Norway and Denmark."

The license is for the Camelot area, which is a combination of depleted gas fields and an overlying saline aquifer. Wintershall Dea will hold a 50 percent interest together with Synergia Energy, who will be project operator in the appraisal phase.

The work program will be developed and managed by Wintershall Dea Carbon Management Solutions UK. The entity was established in August 2022 to assess and implement carbon management projects in the UK sector of the North Sea.

» *Wintershall Dea plans to make Northwest Europe a key region for its carbon management technologies. (Image credit: Thor Oliversen/ Wintershall Dea)*

ENERGY CYCLE TURNING UP HEADING INTO FALL

By G. Allen Brooks
Expert Offshore Energy Analyst & ON&T Contributor

CRUDE OIL

Energy strategists have been talking about oil being in a "super cycle" for a while. They point to the history of oil prices showing consistent multi-year cycles with oil prices either rising and remaining elevated or slumping and staying low.

The bullish case is based on global demand continuing to grow, while the industry's fidelity to capital discipline, coupled with the recent period of low oil prices that discouraged exploration for new reserves, keeps supply limited and oil prices elevated. They believe it will be years before supply swamps demand. On the other side, the bears believe we are at peak oil demand as the world slips into a slower growth phase with potential recessions further eroding consumption. Importantly, they are convinced the world will rapidly transition away from hydrocarbon use making oil and gas assets stranded and worthless.

Since the pandemic started in early 2020, oil prices have been on a roller coaster. When economic lockdowns began, oil demand collapsed sending oil prices briefly below zero as the industry struggled to shut down its global supply chain. With COVID-19 coming under control, economic activity recovered, along with oil consumption. Oil prices followed economic activity. In late 2021, economic growth accelerated, and oil consumption surged along with oil prices.

Climbing oil prices were supercharged in early 2022 when Russia invaded Ukraine creating an energy shock the world had not experienced since the 1970s. Oil prices soared to $120 a barrel, but soon retreated, finishing 2022 in the high $70s as the worst supply fears failed to materialize. Not surprisingly, energy was the best-performing investment sector in 2022.

The super cycle debate in early 2023 was framed by the energy transition and recession fears against evidence industry investment was lagging as returning capital to investors took precedence, demand grew faster than expectations, and supply was under control. Healthier world economies need more energy. However, the economic growth surge expected from a reopened China failed to materialize as anticipated. The stumbling economic data fueled uncertainty about oil demand, thus oil price volatility increased. After crashing into the mid-$60s this summer, OPEC+ leaders Saudi Arabia and Russia organized production cuts to better control supply and tighten oil markets. Economic growth outlooks are strengthening with recession fears dissipating along with global oil inventories. Refined product demand strengthened, elevating their prices which helped pull up crude oil prices.

Oil prices were positive in July, and surprisingly soared in the final days of August, producing a second consecutive positive month. Oil prices closed in August knocking on the door of a technical price resistance level, only to jump over it on the first day of September. OPEC+ supply discipline remains strong, supporting further oil market tightening.

Having breached the price resistance level, oil prices may climb to the next resistance level in the mid-$90s. Everything is not clear, but industry trends and discipline amongst all the players suggest this fall will be a fun time for energy companies and investors.

NATURAL GAS

Our focus on the natural gas market is all about heat and liquified natural gas exports. The latest weekly report (ending August 25) shows 3,115 billion cubic feet of gas in storage, 484 Bcf above the same point last year and 249 Bcf above the 5-year average. As the accompanying storage chart shows, 2023's storage volume, which tracked close to the 5-year average maximum volume has fallen close to the middle of the range. The slippage reflects the impact of increased heat on air conditioning demand and the increased

electricity needed. The media has stories of grid operators imploring residents to conserve their electricity usage. For some utilities, it means instructing people not only to raise their thermostats by 2-3 degrees and not cook but also to not charge electric vehicles until night when electricity demand eases.

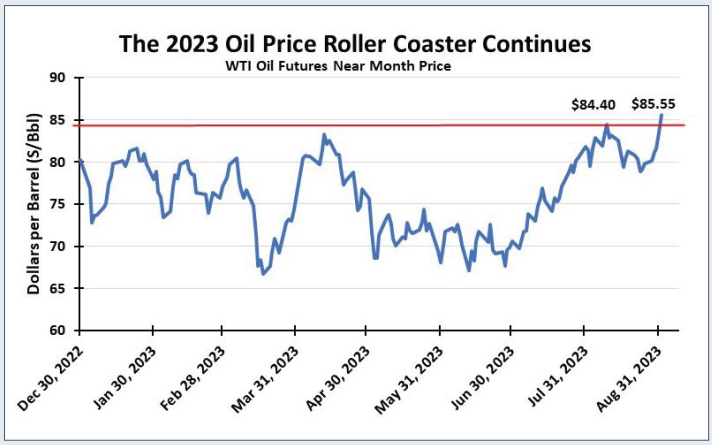
Although the weekly gas storage increases were low throughout August, the nation is not at risk of having inadequate supplies when winter arrives. Additionally, natural gas production continues growing adding to supply. What will be important for storage heading to the start of winter is that gas prices are high enough to entice producers to inject supplies rather than sell them for current consumption or export.

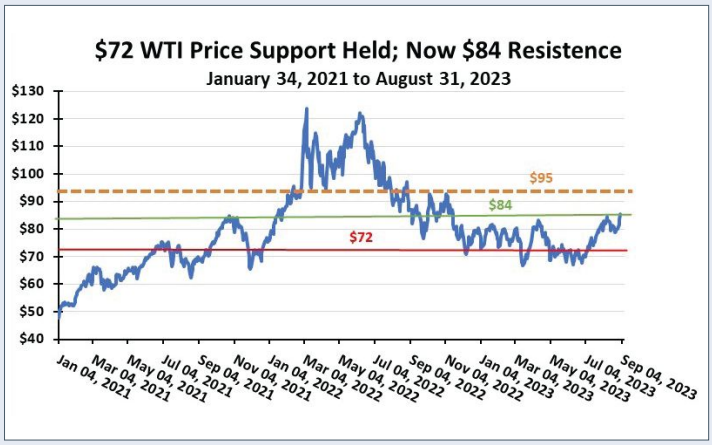
Looking at our natural gas pricing chart, weekly prices peaked ($2.80 per thousand cubic feet) in mid-August before settling back ($2.55) at the end of the month. As the chart shows, the peak price was bumping up against the resistance level that existed for 2015–2020. The interim pandemic period was marked by the Russia/Ukraine war that created a European gas crisis that was alleviated by US LNG exports but at substantially higher prices. Once the European gas crisis was averted, prices retreated as growing US supplies overwhelmed demand helped by the unseasonably warm 2022–2023 winter.

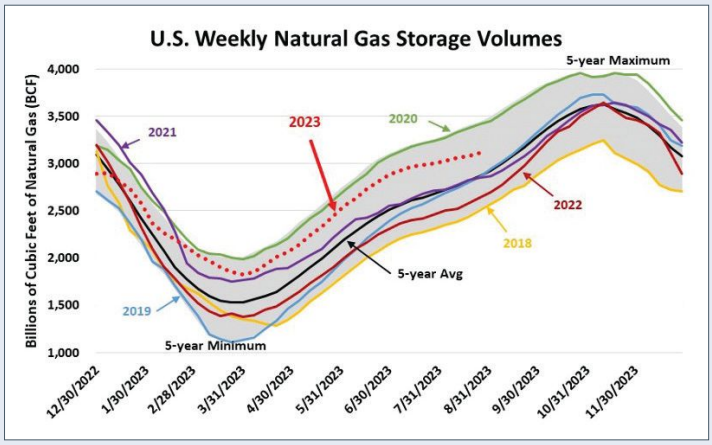
What's the outlook for the gas market? The Farmer's Almanac winter weather forecast is titled "The BRRR is Back!" Its accompanying chart shows Cold in five of the nation's seven regions. The other two regions—Southwest and Southeast—were labeled with Wintery Temps and Chilled. If their forecast comes to pass, gas demand will be greater than last year, which will boost prices to attract storage volumes during the winter and begin refilling the caverns in 2024.

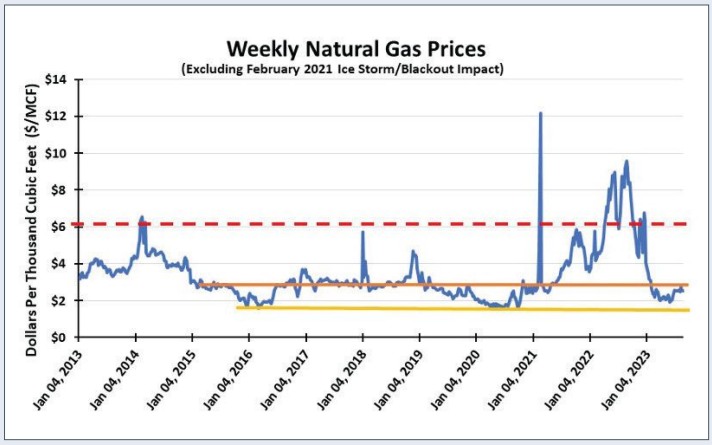
We have written about LNG export terminal expansions and additions. The US is on the road to becoming the globe's largest natural gas supplier which will support demand and gas prices. Furthermore, we are building new natural gas generating capacity to meet increasing electricity demand and to back up intermittent renewable power. Natural gas plants are also replacing coal plants to reduce our carbon emissions.

Natural gas markets will remain dependent on the weather not just in the US but also around the world as we become the largest LNG exporter. Gas prices have probably seen their lows for a while.









TEST PROGRAM SUCCESS FOR COLLABORATIVE RENEWABLE SUBSEA POWER PROJECT

A collaborative renewable subsea power project has successfully completed its initial four-month test program in the UK North Sea, proving that a subsea battery storage system can reliably power subsea equipment through being recharged by a wave energy device.

Deployed in the waters five kilometers off the East coast of Orkney, Scotland in February 2023, the Blue X wave energy converter—built by Edinburgh company Mocean Energy—was connected with a Halo underwater battery developed by Aberdeen intelligent energy management specialists Verlume in a 'first-of-its-kind' project.

» *Blue X wave energy converter. (Image credit: Verlume/Mocean Energy/Colin Keldie)*

The four-month RSP test program was devised to prove the concept of using renewables to power subsea equipment, employing intelligent subsea battery storage to manage the inherent intermittency and deliver a continuous power output through the batteries.

A key objective of the project was to demonstrate that the system could provide power to subsea electronics modules, provided by Baker Hughes, simulating the control and communications needed for subsea well heads using 100% renewable energy.

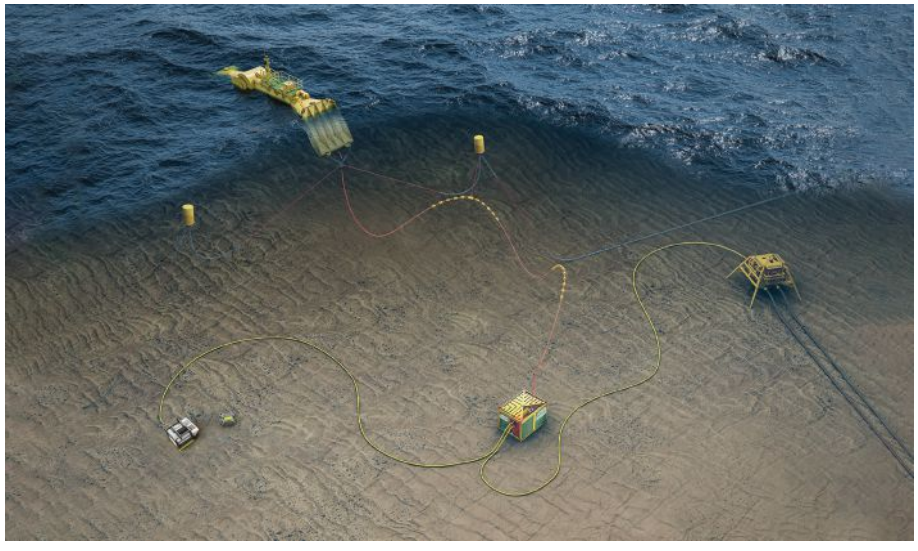
In addition, tests were conducted using a resident autonomous underwater vehicle (AUV) provided by Transmark Subsea. This included having a docking station integrated onto the Halo system to create a charging point and a communications link to the surface via the Halo through the Blue X. The AUV was charged 50 times to show effective clean power delivery to underwater vehicles.

Following the success of these tests, showing an integrated alternative to subsea umbilical cables, the test program has been extended. The technologies will remain in the water and will conduct additional testing deliverables until spring 2024, allowing for further industry-leading project data to be captured around maintainability, survivability, and reliability.

Alongside the two project lead companies, Mocean Energy and Verlume, industry players include Baker Hughes, Serica Energy, Harbour Energy, Transmark Subsea, and the Net Zero Technology Centre (NZTC). The most recent addition is Thai State energy major PTTEP, demonstrating the international interest in this decarbonization project.

The Orkney deployment is the third phase of the Renewables for Subsea Power project. In 2021, the consortium invested £1.6 million into phase two of the program—which saw the successful integration of the core technologies in an onshore test environment at Verlume's operations facility in Aberdeen.

In 2021, Mocean Energy's Blue X prototype underwent a program of rigorous at-sea testing at the European Marine Energy Center's Scapa Flow test site in Orkney where they generated first power and gathered significant data on machine performance and operation.



» *Tests were conducted using a resident autonomous underwater vehicle (AUV) and included having a docking station integrated onto the Halo system to create a charging point and a communications link to the surface. (Image credit: Verlume/Mocean Energy)*

FUGRO AWARDED TWO GEOTECHNICAL INVESTIGATION CONTRACTS IN THE NETHERLANDS

Fugro has been awarded two geotechnical investigation contracts for the development of the Dutch Nederwiek wind farm sites II & III (noord). The contracts, awarded by the Netherlands Enterprise Agency (RVO), are part of the Dutch Government's Offshore Wind Energy Roadmap 2030/31, which aims to accelerate the development of offshore wind in the Netherlands. Once completed, the wind farms will deliver a total installed capacity of approximately 4 GW.

The contracts cover a total area of 600 km² and involve the collection of comprehensive seabed and subsurface geodata using state-of-the-art techniques and innovations. The data will be used by wind farm developers as input for preliminary engineering design studies and future tenders, and will also be available for power cable design, archaeology, and marine biology investigations.

Fieldwork is scheduled to start in February 2024 and will be conducted using Fugro's specialized fleet of advanced geotechnical vessels for seabed testing and downhole drilling. These vessels will be equipped with Fugro's SEACALF® Mk V Deepdrive system for seabed cone penetration testing and WISON® Mk V Ecodrive for downhole sampling and cone penetration testing. In addition to this, onboard laboratory capacity will be increased to ensure faster processing of results. The subsequent extensive laboratory testing will take place in Fugro's extended laboratories in the UK and Belgium.

The data collected by Fugro will be managed through VirGeo®, Fugro's cloud-based geo-data engagement platform, and will provide near real-time deliverables to RVO and its consulting engineers. The subsequent phases of further processing, laboratory testing, data analysis, and reporting will continue into 2025.

» *Fugro Scout will be used to conduct the work. (Image credit: Fugro)*

A COLLABORATIVE MODEL FOR NET-ZERO OCEAN TECH DEVELOPMENT

By

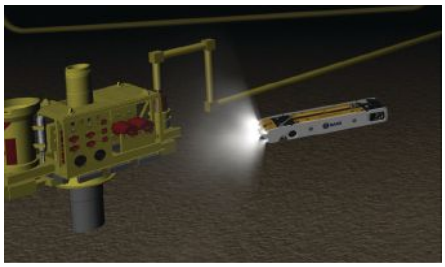
GRi SIMULATIONS

In the ever-expanding horizons of ocean technology, and in an increasingly connected world, innovative approaches to collaboration are necessary for the achievement of the most ambitious goals.

For GRi Simulations Inc., collaboration is in our blood and has always been the key to our progress. GRi doesn't build platforms, facilities, or sensors, instead GRi simulates, integrates, and visualizes the technologies of others in digital landscapes, partnering to promote safer and more efficient systems and operations. This approach is a key element of GRi's net-zero emissions objectives and to how we approach research and development.

SIMULATION & VISUALIZATION

GRi is collaborating on initiatives to develop and augment net-zero technologies through simulation and visualization. This approach creates safer, more efficient, low carbon modes of testing and verification of innovations. Many net-zero innovations involve crewless energy production utilizing seabed-resident remotely operated and autonomous vehicles in a physics and data-driven virtual sandbox. Simulation and visualization technology has a vital role to play in the conception and development of these vehicles. And, in most cases, when a system is developed, the simulator used to create and validate a technology maintains residual value as an operations planning and training tool.



» *Saab Sabertooth autonomously responding to alert signal. (Image credit: GRi Simulations)*

Aligning with the editorial focus of this issue, here we discuss two elements of GRi's net-zero collaborative initiatives: utilizing virtual subsea field architectures for innovation in subsea resident vehicles, and new modes of environmental preparedness and response.

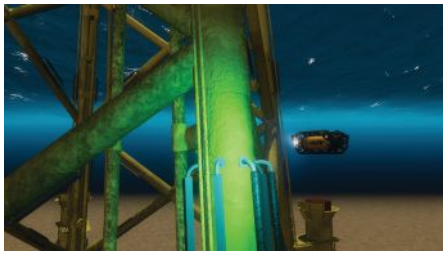
VIRTUAL ENVIRONMENTS

GRi's Interactive Design and Engineering Analysis Digital Twin (iDEA-DT) application provides generic testbeds for offshore energy, aquaculture, and harbors, as well as data rich models of real-world production facilities. Between these generic and world models are digital twins of real-world testbeds being created of The Launch, Memorial University of Newfoundland's Ocean Innovation Centre located in Holyrood Bay, and the Norwegian University of Science and Technology's (NTNU) AURLab (Applied Underwater Robotics Laboratory).

Virtual testbed environments that replicate physical marine testbed installations can provide validation of simulator fidelity to prototype systems using a low-emission, low-risk, and low-cost approach for testing marine hardware systems.

Site-representative content supports the transition from digital prototyping of subsea technologies to physical prototyping and testing in the target operating environment.

Memorial University's Marine Institute officially opened The Launch, located in Holyrood Newfoundland and Labrador, in May 2023, as a state-of-the-art marine living laboratory for training and testing of new technologies in a robust but safe marine environment. GRi is collaborating with The Launch and many of their key partners to create a virtual testbed to correspond to their real-world environment. It is the site of a diverse collaborative effort by econext called the "Community Workforce Development in Holyrood through Blue/Green Economy Project." The initiative marries an impressive real-time demonstration and deployment program of ocean and clean tech—including environmental sensing, characterization, and monitoring, remote and autonomous systems—and innovative remote digital presence tools for asset integrity assurance, such as Copsys Technologies' paint-based Intelligent Digital Skin (CIDS).



» *Transmark SubSea's ARV-i inspecting a simulated offshore wind structure. (Image credit: GRi Simulations)*

The digital twin solution GRi has developed using iDEA-DT uses an accurate 3D model of the prototype Copsys system and is able to visually indicate the location of damage detected by the CIDS smart coating. The IoT sensors are cloud-connected to the twin software and can communicate continuous real-time data outputs.

NTNU's AURLab test site has been in oper-

» *The Launch Digital Twin with Simulated SeaRobotics ASV (above) and Copsys Intelligent Digital Skin (CIDS) Corrosion Hot Spot Detection and Location Demonstration. (Image credits: GRi Simulations)*

ation since 2011 and promotes the application and use of underwater robotics in engineering and research. GRi is delivering a digital twin of the AURLab test site, and simulators for a range of existing robotic assets to support further development and testing of academic research and commercial innovations.

Both The Launch and NTNU have a formal partnership in place to advance the operations of autonomous technology. GRi's digital twins of both facilities are key foundational pieces of this important work.

SUBSEA RESIDENT VEHICLES

One of GRi's priorities is advancing the field of autonomous, hybrid, or remotely operated unmanned seabed resident vehicles to help improve system capabilities and operating limits beyond inspection to intervention, maintenance, and repair operations. GRi provides high fidelity real-time sensor and environmental data inputs suitable for use with vehicle control systems to support design and validation.

One seabed resident system featured in the development and testing is the Saab Sabertooth, a commercial vehicle that for many years has been among the leaders in subsea autonomous operations. The Sabertooth is a powerful but lightweight hybrid inspection, maintenance, and repair (IMR) platform. The vehicle has been implemented for testing and optimization in the VROV simulator for many applications over the years.

Another seabed resident technology is the ARV-i. A relatively new development by Transmark SubSea Norway and Boxfish Robotics (New Zealand), this self-contained vehicle incorporates its own dedicated docking platform also offering the flexibility of complete autonomous operation or manual control.

> "VIRTUAL TESTBED ENVIRONMENTS THAT REPLICATE PHYSICAL MARINE TESTBED INSTALLATIONS CAN PROVIDE VALIDATION OF SIMULATOR FIDELITY TO PROTOTYPE SYSTEMS USING A LOW-EMISSION, LOW-RISK, AND LOW-COST APPROACH FOR TESTING MARINE HARDWARE SYSTEMS."

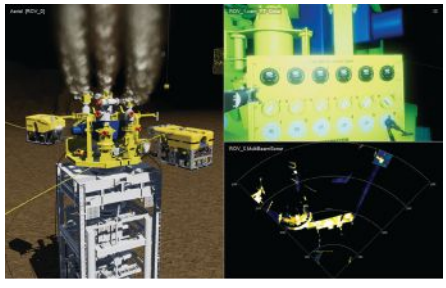
ENVIRONMENTAL RESPONSE

Another use case for advanced simulation and collaboration concerns new modes of environmental preparedness and training in spill response through the leadership of Oil Spill Response Limited (OSRL). OSRL is an industry-funded cooperative established to respond to oil spill events globally, providing preparedness, response, and complex intervention services requiring communication and interactivity among teams operating a variety of equipment.

On the heels of a successful February 2023 response/capping exercise for Occidental Petroleum and USCG, GRi is partnering with industry to broaden the depth and enhance the experience of capping exercises going forward. Starting in September 2023, GRi will enhance OSRL's exercise simulation support by updating current models and expanding simulation capabilities to accommodate new additions to the global response kits.

This enhancement aims to boost the expertise and readiness of essential incident personnel in this critical element of the offshore petroleum industry. Implemented in iDEA-DT these system simulations will be available for the testing, verifying, and training responses in digital twins of offshore assets. With respect to Source Control Preparedness training, the ROV simulator immerses attendees with realistic looking graphics and integrated operational documents into the subsea simulator world for an industry best practice sense of realism during the exercise.

For more information, visit: *www.grisim.com*.



» *Multiple ROVs working in unison during a critical BOP intervention, ensuring precision and safety. (Image credit: GRi Simulations)*

PILOT PROJECT UTILIZES USV AND AUV FOR WIND FARM SURVEY OPERATIONS

» *Autonomous Surveyor USV deployed at the Deutsche Bucht Offshore Wind Farm. (Image credit: Subsea Services Europe)*

Teams from wind farm owner Northland Power and marine technology company Subsea Europe Services have successfully concluded a pilot project to apply state-of-the-art uncrewed surface vessels (USVs) and autonomous underwater vehicles (AUVs) to marine survey and underwater inspection operations at the Deutsche Bucht Offshore Wind Farm, located in the German North Sea.

The July 2023 project was commissioned to verify performance and further develop the operational workflows of Subsea Europe Services' Autonomous Surveyor USV for multibeam surveying and *A.IKANBILIS* Hovering AUV (HAUV) for subsea inspections such as scour and marine growth surveys, when deployed from a Service Operations Vessel (SOV) mothership already resident for Operations & Maintenance (O&M) at the wind farm.

The so-called 'mothership concept' was proven successful throughout the pilot, with seamless integration of the various teams and equipment working aboard the *Albert Betz* SOV resulting in a wider weather window for marine survey and underwater inspection operations, with launch and recovery up to Sea State 3 and data acquisition according to the specified requirements.

"Supported by the great teamwork of everybody on board, the additional personnel, equipment, and workflows for managing and using the USV and AUV for marine surveying and underwater inspections blended in well with the overall operations of the SOV, demonstrating that the 'mothership concept' works in a live scenario," said Jan Schmökel, Balance of Plant Engineer, Northland Power.

"Our goal is to utilize assets that are already in place within the offshore wind farm O&M framework in order to improve the availability of marine data and significantly reduce the cost of acquiring it," added Sören Themann, CEO, Subsea Europe Services GmbH. "Both *Autonomous Surveyor* and *A.IKANBILIS* performed well, acquiring actionable data within similar time frames as conventional vehicles including crewed survey vessels and work class ROVs, both of which are more costly to manage and operate."

» *The A.IKANBILIS AUV at the Deutsche Bucht Offshore Wind Farm in July '23. (Image credit: Subsea Services Europe)*

ALLSPEEDS WEBTOOL CUTTER CHOSEN FOR SEABASS TOOL

Allspeeds, manufacturer of Webtool hydraulic cutters, has supplied a downhole cutter for James Fisher Decommissioning's SEABASS single trip subsea well abandonment tool. The smallest Webtool steel wire cutter so far at just 172 mm, it is tightly integrated within the downhole tool to cut mixed material steel wire and hydraulic lines.

The SEABASS well abandonment tool is a single trip, mechanically locking system for category 2 wells. Once lowered downhole, the SEABASS perforates single or multiple casing strings. Upper and lower perforation devices create a flow path through the casing to remove contaminants back to the surface vessel for safe disposal.

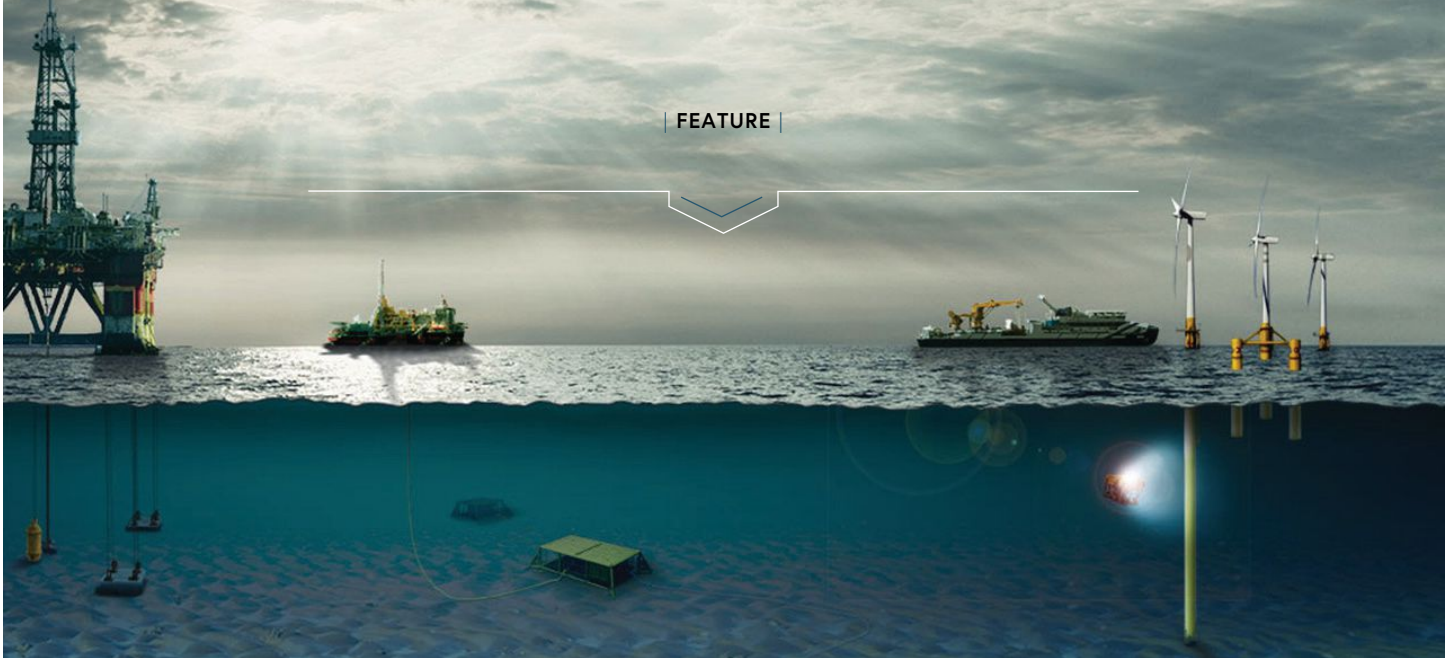
The Webtool cutter is used to cut the connection to the lower perforation device which is left in the hole. The hole is then filled and sealed with an environmental cement plug.

The Webtool cutter fits sideways within the SEABASS tool's internal bore of just 210 mm, whilst still being capable of cutting a steel wire and two hydraulic lines in a single operation. Incorporating a double acting cylinder, the 172 mm high cutter weighs less than 6.5 kg, making it the smallest subsea cutting tool ever produced by Allspeeds.

"The Webtool was an excellent solution for us, making that part of the operation both simple and reliable. It was great to work with Allspeeds on this project and their equipment helped make it a success for the maiden campaign in 2022," said Richard Henderson, Engineering Director, James Fisher Decommissioning.

"Our precision manufacturing capability has allowed us to produce this tiny cutter to the same exacting performance standards we expect from our larger cutters," added Rory McGarry, Technical Director, Allspeeds. "With over 30 years' experience in the design and manufacture of Webtool hydraulic cutters for offshore and subsea, we are still pushing the boundaries in cutter design and operation."

» *The SEABASS single trip subsea well abandonment tool being lowered. (Image credit: Allspeeds)*



» *The offshore survey landscape is on the cusp of radical change. (Image credit: Cathx Ocean)*

TECHNOLOGY SOLUTIONS FOR SCALING TRUE AUV TECH

By CATHX OCEAN

When Cathx Ocean was established in 2009, our purpose was to accelerate the development of truly autonomous and uncrewed operations, to enable scale, and facilitate a greater understanding of the impact of activity in the Ocean.

Autonomous vehicles are 'autonomous' in that they are not connected to a tether or an operator. However, their flight paths are largely predetermined. By adding sensor intelligence to autonomous underwater vehicles (AUVs), it is possible to deliver major efficiencies to offshore operations.

Today the subsea industry has progressed from in-person and onboard operations to remote operations and is progressing to uncrewed and autonomous operations faster than ever before.

RESPONDING TO CHALLENGES

Conventional inspections and remote inspections are still largely subjective, manual, labor intensive, and time consuming. Cathx Ocean's vision is to change this, step by step, by providing the building blocks and infrastructure for AUV software and sensors to transition more rapidly to true autonomy.

Since 2009, Cathx Ocean has become a global leader in visual technology solutions for underwater vehicles. Our solutions have been deployed globally to reduce both vessel and offshore personnel days while simultaneously reducing CO2 emissions by more than 50% over conventional vessel operations.

As the pioneers and inventors of Fast Digital Inspection® (FDI) and with 14 years of history and deep industry experience, our team shares unique insights into the subsea challenges. This guides our innovation; a focus to deliver reliable, quality data to thousands of surveyors and asset owners. Only through a scalable and robust solutions framework is it possible to deliver true autonomy solutions.

DELIVERING TRUE AUTONOMY

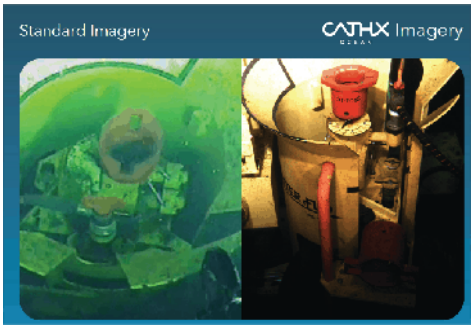
Uncovering important information as quickly as possible is central to all AUV work. Being able to report and assess anomalies or events as data is acquired (real-time information in the truest sense) fundamentally changes the economics of survey, becoming the enabler to collect much larger amounts of data and information. However while saying it is easy, doing it reliably in a challenging subsea environment is not.

» *Cathx Ocean "Right First Time" principle ensures your assets are surveyed accurately "First Time." (Image credit: Cathx Ocean)*

Cathx Ocean has already shown how to overcome the traditional visibility and speed issues during visual surveys, and this has led us to the next challenge.

To advance machine vision (MV) and machine learning (ML) based automation in the underwater environment, it is imperative to adopt a correct workflow methodology to handle the data (even if manual) at the outset.

Let us look at an example in Marine Science to illustrate this point. To reliably observe and monitor changes in coral reef health over a 10-year period, color, scale, image sharpness, lighting uniformity, and consistency all need to be standardized. This ensures variances due to contributing factors like different sensors, vehicles, operating, or environmental conditions are removed. ML algorithms cannot deliver a reliable solution until fundamental issues like these and underwater video and still imagery quality are resolved. While this



» *Protect your subsea assets with Cathx Ocean. (Image credit: Cathx Ocean)*

may appear obvious in hindsight, Cathx Ocean learned this six years ago and we are now positioned to deliver the software solutions to address these challenges.

From only this starting point, can we look at what information industry needs, as we now have the necessary building blocks.

Pipeline operators need to know about free spans or buckling; defense organizations need to scan the seabed for unidentified objects; and mineral companies want to establish both the coverage of a mineral and the megafauna and ecosystems depending on it.

All the above industries use multiple sensors, tools, and acquisition methods over much larger areas than visual data alone. Cathx Ocean is now leveraging our experience and expertise in standardizing visual workflows for Cathx sensors to all sensors.

Over the next three years, we can move the workflow to a fully autonomous one, by gradually introducing processing, automated event detection, report, and data product generation, instantaneously for a given sensor or application. This is the *CathX Factor*.

BUILDING TRUE AUTONOMY

Cathx Ocean's ability to automate feature detection via images and laser rely on our data quality and fused real-time shape information—the central building blocks for true visual autonomy. Cathx Ocean's ML techniques use 'shape' to perform this function at higher speed, more reliably and with greater precision than any other visual sensor. All the raw data needed for any further offline processing is also still captured for future use. Our technology solutions not only process and co-ordinate data from our own sensors, but can also allow processing and co-ordination of data from other vehicle sensors to identify objects with a high degree of certainty, tagging and recording these objects, their location, and providing real-time notifications.

Access to 'true real-time' critical information empowers mission planning for now and into the future. Cathx Ocean's proprietary approach to standardize data collection and processing workflows enables our customers to accurately monitor and reliably measure year-on-year variances irrespective of industry. By adopting this approach to data collection today, we can overcome the traditional industry challenges associated with manual inspection such as resourcing, vessel, and associated bandwidth issues.

> "TO ADVANCE MACHINE VISION (MV) AND MACHINE LEARNING (ML) BASED AUTOMATION IN THE UNDERWATER ENVIRONMENT, IT IS IMPERATIVE TO ADOPT A CORRECT WORKFLOW METHODOLOGY TO HANDLE THE DATA (EVEN IF MANUAL) AT THE OUTSET."

By moving this capability on to the vehicle, this sensor intelligence provides information for AUVs to navigate more accurately and reliably, a core pillar for future autonomy.

STREAMLINING DATA PRODUCTION

This month our AUV customers will have exclusive access to Cathx Pipeline inspection solution. Our experience since 2016 saw pipeline operators standardize Cathx FDI data acquisition platforms for pipeline inspection in the North Sea, Australia, the Baltic, Egypt, Azerbaijan, Gulf of Mexico, and Brazil. Over the past two years we have upgraded our Hunter and Vanguard systems to deliver real time free span and pipeline tracking capabilities to demonstrate how traditional workflows can be fundamentally changed.

These key capabilities deliver inline data pre-processing with automated event detection in milliseconds using shape information to reliably "measure" changes. Streamlined data product generation then takes these events and allows high speed color point cloud generation, achieved by combining color pixels from imagery with the shape information, to provide the input to pipeline integrity management tools within minutes and not weeks.

Our systematic approach to data acquisition, processing, automated detection to achieve real-time situational awareness accelerates our vehicle manufacturers and survey company client's path to true autonomy, creating more opportunity by making information collection and processing more affordable.

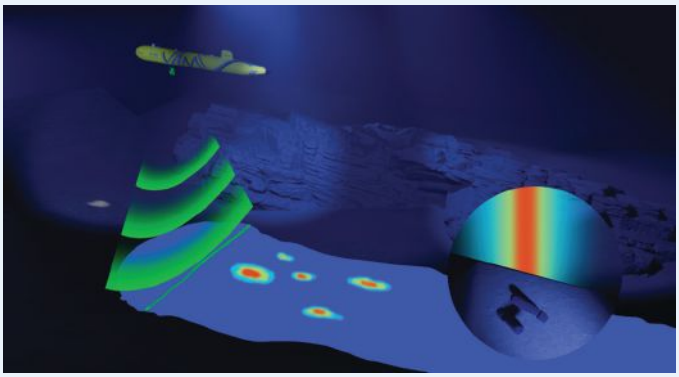
Join us on the journey to make autonomy real!

To learn more, visit *www.cathxocean.com* or contact us at *sales@cathxocean.com*.

» *Optimize your subsea surveillance and reconnaissance with Cathx Ocean technology solutions. (Image credit: Cathx Ocean)*

ELECTROMAGNETIC REMOTE-SENSING SYSTEM PATENTED BY ARGEO ROBOTICS

Argeo Robotics AS, a fully owned subsidiary of Argeo AS, has been granted a new patent from the Norwegian Industrial Patent office (Patentstyret) for a subsea electromagnetic remote-sensing system for detecting buried objects below the seafloor.



» *Scanning for explosives (UXO's) using Argeo Whisper. (Image credit: Argeo Robotics)*

This patent protects Argeo's exclusive services with the Argeo Whisper system for detecting metal objects on or buried under the seafloor. A major step change with this technology is its ability to also detect metals that are not magnetized and as such not observable using the methods commonly used by the industry today. The patent protects the use of the system on any subsea vehicle, and when the system is towed behind a surface vessel. Argeo Whisper is currently integrated on Argeo's autonomous underwater vehicle (AUV) and combined with our unique EM processing methodology.

"There is significant interest from customers in the offshore wind, oil and gas and marine minerals industry for the applications this technology can be used for and the challenges it can solve," said Argeo CEO Trond F. Crantz. "The continuously growing IP portfolio shows the success of our sensor technology development, the importance of Argeo Robotics and the value this development creates for our shareholders now and in the years to come."

"The Argeo Whisper product is a gamechanger for the subsea service market, and we are delighted to have been granted this patent," added Thorbjørn Rekdal, CTO in Argeo.

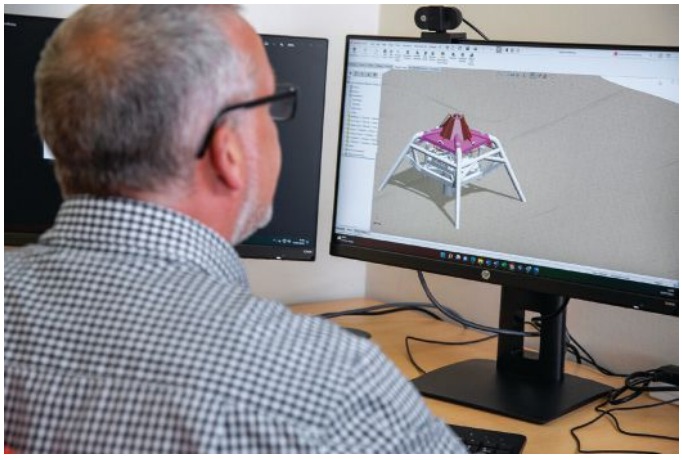
SENTINEL SUBSEA TO REVOLUTIONIZE SUBSEA MONITORING AND LEAK DETECTION

Reporting a significant increase in deployments since the beginning of the year, Aberdeen-based Sentinel Subsea (Sentinel) continues to establish itself as a trusted partner for major and independent operators worldwide. Following on from successful deployments in collaboration with Baker Hughes at the end of last year, this collaboration is celebrating further contract wins for novel passive WellSentinel™ systems globally.

Included in this latest batch of contract wins is the provision for further regulator approved WellSentinel™ Coral wellhead solutions for projects in Western Australia. The innovative system is designed to passively monitor subsea wellheads without the use of active subsea power or ongoing data communication. The simple-to-deploy monitoring systems enable operators to continuously monitor the integrity of the remote wells easily, increasing environmental safety while reducing risk and cost.

Highlighting the application of passive technology across the entire wells life cycle, Sentinel is also deploying systems for an operator as part of a drilling campaign in the North Sea. The newly drilled wells will be left for a period suspended before being fully completed. During this phase the wellheads will be fitted with a WellSentinel™ Coral system to provide continuous monitoring.

Marking continued technological advancement, further development of WellSentinel™ Clam solutions now enable operators to monitor subsea Christmas trees at any depth in addition to wellheads. As part of Sentinel's significant contract wins, a major operator will be adopting this latest innovation by deploying the WellSentinel™ Clam solution to continuously monitor the integrity of producing horizontal Christmas trees in multiple international locations.



» *Senior Design and Development Engineer, Robert Thomson, working to integrate a WellSentinel passive monitoring system with a subsea xmas tree. (Image credit: Sentinel Subsea)*

ROVOP SECURES NEW LONG-TERM CONTRACT AWARD FROM ENERGEAN

ROVOP, a leading supplier of subsea remotely operated vehicles (ROVs) to the energy industry, has secured a new five-year contract with Energean PLC, the leading independent, gas-focused E&P company in the Eastern Mediterranean.

This milestone contract is ROVOP's first dedicated field support award for an E&P company. The ROV system had been strategically placed in the region to support scopes such as this contract.

ROVOP will deploy a Work Class ROV onboard Energean's owned field support vessel, the *Energean Star*, a newly converted platform supply vessel (PSV) designed to carry out a range of support tasks for Energean.

Following a safe and successful mobilization in Cyprus, the vessel transited to the strategically important Karish gas field, located approximately 75 km offshore Israel in 1,750 m water depth.

The ROV system and offshore team will carry out a range of tasks from general ROV support to subsea survey and intervention works to support the maintenance and further development of the field.

Mark Gilmartin, ROVOP's Business Development Director, said: "We are thrilled to have been awarded this contract, highlighting our capability to support our clients no matter their location, task, or scopes. The award is a real milestone contract and reflects our strategic approach to breaking into the field support ROV market.

"It has been an outstanding start to the year for ROVOP. It is a testament to our people's expertise and professionalism, our global reach and unrivalled capability across the complete project lifecycle that we continue to go from strength to strength."

» *The Energean Star. (Image credit: Emergean)*

CHECK THE TECH

FASTER SUBSEA INSPECTION WITH 3D MODELING SENSOR

Zupt's subsea modeling system, 3D Recon, delivers accurate and detailed 3D models of subsea structures for integrity management applications. These models are geospatially correct and can offer submillimeter pixel resolution representations of subsea structures, up to depths of 4,000 meters, to aid in making decisions on structural health over time.

A WHOLE MODEL PERSPECTIVE

The 3D Recon system uses a 3D reconstruction method to build these models and offers numerous advantages over traditional video inspection. Utilizing 'Fast Digital Inspection' (FDI) techniques, this system provides comprehensive detailed models of structures in less time than a conventional GVI campaign.

Unlike traditional video inspections that rely on individual images gathered at select points throughout a survey, 3D Recon delivers a complete model of the structure, allowing for a big-picture view while also maintaining the details necessary to make decisions on the asset. Subsea engineers can then focus their attention on specific areas of interest, zooming in and navigating around the model to make distance, angular, and volumetric measurements with a known accuracy.

Notably, the data acquisition time to generate a model of an XTree can now be completed in under 20 minutes, while large manifold acquisition takes less than 40 minutes, showcasing the efficiency of 3D Recon to save operational time.

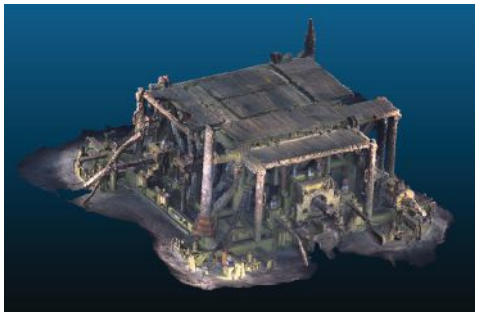
CHANGE DETECTION

By utilizing digital twin technology to compare the baseline 3D model and subsequent 3D models, we can automate change detection and effectively monitor structural alteration over time. For instance, we can revisit a structure after a certain period and accurately detect degradation such as scouring, anode depletion or corrosion by comparing the historical models. This capability provides a reliable means of tracking any changes in the subsea structures, so operators can more easily evaluate the status of their assets and therefore safely extend the life of their assets based on quantitative data.

ADDITIONAL SENSOR DATA

In addition to its core deliverables, 3D Recon users can integrate and overlay additional data, such as contactless cathodic potential measurements and methane levels, from various sensors into the models to create a comprehensive 3D spatial representation of the structure's condition. This data can be acquired through a single FDI survey. The combined dataset enriches the 3D model for a deeper analysis of factors contributing to structural integrity, making it a valuable tool for subsea intervention planning.

» *3D Recon can operate at depths to 4,000 meters and is easy integrated into ROV systems for deep-sea operations. (Image credits: Zupt)*



» *Detailed 3D spatial representations of subsea structures allow engineers to inspect particular areas of interest or concern. (Image credit: Zupt)*

ENHANCING TRADITIONAL VIDEO

High-resolution, spatially correct models enhance subsea integrity management and serve as a bridge between traditional video inspection methods. The transition is seamless with 3D Recon as it utilizes high frame rate images to construct its deliverables while achieving a 40% reduction in FDI survey time compared to traditional GVI surveys. By delivering images and video in addition to the processed 3D model, this system preserves the still image/video-based format, core to traditional GVI surveys. The integrity engineers may now use the comprehensive 3D models to make decisions based on quantitative measurements, not qualitative estimates as historically made from video.

As part of the transition towards incorporating 3D reconstruction technology into subsea inspection, Zupt acknowledges the existing landscape of inspection software such as Integrity Elements and NEXUS IC. To facilitate a smooth integration process, 3D Recon provides still images and videos compatible with incumbent inspection software for operators and engineering/inspection contractors to adapt their existing workflows gradually.

For more information, visit: *www.zupt.com*.

UNIQUE GROUP UNVEILS THE SUBSEA INDUSTRY'S FIRST GENERATIVE AI CHAT SOLUTION

Unique Group has announced the launch of a groundbreaking advancement in the subsea survey sector—Aquila Subsea. This generative artificial intelligence (AI) chat solution is set to revolutionize the industry by providing instant and accurate responses to a wide range of queries, empowering survey engineers and researchers to swiftly understand manuals, troubleshoot issues, and access critical information.

With its comprehensive repository of manuals, data sheets, and manufacturers' information, the AI platform guarantees precise and reliable solutions for queries of all complexities, providing access to a Knowledge Repository with over 10,000 Survey Equipment solutions.

Developed entirely in-house, Aquila Subsea promises to streamline operations, boost efficiency, and enhance overall productivity for survey engineers, researchers, and industry professionals.

One of the standout features of Aquila Subsea is its extensive and meticulously curated database, encompassing a wealth of technical resources. By drawing on this repository, the AI-driven platform provides precise solutions tailored to the specific queries posed by users and ensures that technical hurdles are surmounted in a matter of seconds, reducing downtime, and significantly contributing to cost savings, while elevating operational efficiency to unprecedented levels.

Unique Group is excited to announce that limited signups to access Aquila Subsea are now open. This exclusive opportunity allows industry professionals to be among the first to experience the transformative potential of this game-changing technology. Register under www.aquilasubsea.ai.

With its ability to provide swift, accurate, and insightful solutions, Aquila Subsea is poised to reshape the way survey engineers approach their work and ultimately redefine industry standards.

» *Aquila Subsea's Knowledge Repository is equipped with over 10,000 Survey Equipment solutions. (Image credit: Unique Group)*

LEIDOS SELECTED BY US NAVY TO OPERATE AND SUSTAIN MEDIUM USV FLEET

Leidos was recently awarded a new task order by Naval Sea Systems Command to manage, operate and maintain the US Navy's Overlord and medium unmanned surface vessels (USVs). The single-award task order has a one-year base period of performance and two one-year options. The task order has a maximum value of approximately $95 million if all options are exercised.

"Leidos is leading a new era of naval operations," said Gerry Fasano, President of Leidos Defense Group. "The Leidos team has unmatched experience and expertise in autonomous vessel design and operations, delivering four operational medium-sized USV platforms to the Navy so far. We look forward to helping the Navy accelerate this important work and providing new capabilities at the tip of the spear."

"This task order starts an important phase in the Navy's evolution of USVs and integrating them into distributed maritime operations," added Dave Lewis, Leidos Defense Group's SVP and Maritime Systems Operations Manager. "The power of this technology lies in its ability to operate independently and extend the horizon of crewed ships. We look forward to supporting the Navy as they continue this important journey into the future."

Leidos has delivered four operational medium-sized USVs currently in the Navy's fleet: Ranger, Mariner, Sea Hunter, and Seahawk. This contract will expand Leidos' experience managing USV operations and maintenance.

» *USV Ranger transits the Pacific Ocean to participate in Exercise Rim of the Pacific (RIMPAC) 2022. (Image credit: DVIDS)*

VIKING RECEIVES MAJOR HELLENIC COASTGUARD PATROL BOAT ORDER

VIKING Norsafe Life-saving Equipment HELLAS has secured orders from Greece's Ministry of Shipping & Island Policy to deliver 31 patrol boats and three high-speed boats to the Hellenic Coast Guard. The orders, covered in three separate contracts with the VIKING Life-saving Equipment subsidiary, are part of an EU-backed Hellenic Coast Guard procurement program which was initiated four years ago.

Two of the contracts cover 31 boats based on VIKING Norsafe's proven Munin S1200 hull form, with the design adapted to meet client requirements. All of them feature 2X inboard diesel engines to support service speeds of 35 knots and top speeds of 50 knots.

In the first, co-funded by the Operational Program for Fisheries and the Sea, VIKING will supply 10 x 11.3 m length, 12-person patrol boats. In the second, co-funded by the Internal Security Fund (ISF), VIKING will deliver 21 boats to uphold border controls; in this case, one boat is also being co-funded by the Ionian Islands Regional Operational Program.

The third contract, also co-financed by ISF, covers the supply of three high-speed 'Metis 750' RHIBS, which will be loaded onboard Hellenic Coastguard vessels to provide rapid patrol and rescue capability. These 7.5 m length, 5-person vessels will be equipped with twin outboard 200 hp engines, to achieve service speeds of 35 knots and top speeds of 45 knots.

"Given the multiple stakeholders involved and the different situations these vessels will need to handle, it is especially significant that VIKING Norsafe patrol boats are once again the preferred choice for Hellenic seaborne forces," said John Georgiadis, General Manager, VIKING Norsafe Life-saving Equipment HELLAS. "Today, as well as designing and marketing a complete portfolio of boats from 5 m in length up to 60-knot interceptors, we are building the full range, including in-house GRP manufacturing and assembly: we are in very good position to have worthwhile discussions with all types of clients."

» *VIKING Norsafe patrol boats are the preferred choice for Hellenic seaborne forces. (Image credit: VIKING Norsafe Life-saving Equipment)*

DAMEN TRITON AND UK'S ROYAL NAVY COLLABORATE TO ENHANCE MARITIME OPERATIONS

Damen Digital Solutions, the digital services division of Damen Shipyards Group, and the British Royal Navy's innovation program NavyX have announced an active collaboration. The parties are working together on the development of new solutions to enhance maritime operations based on the Damen Triton data platform.

Under the arrangement, Damen will provide NavyX with its industry-leading Triton remote monitoring system and perform associated data collection.

Damen delivered a digital twin model of the Damen Fast Crew Supplier (FCS) 4008 XV Patrick Blackett that the shipbuilder delivered to NavyX in July 2022. With this, the NavyX team will be able to explore future technologies in a safe environment, prior to onboard testing.

The partnership will aid NavyX to demonstrate the support advantage that can be gained from accurate and up-to-date engineering data compared to the predicted model which will in turn inform how engineering support is transformed across the Ministry of Defence to increase the overall effectiveness and efficiency.

"We are delighted to be working with NavyX to develop innovative solutions that will enhance operational capabilities," said Toine Cleophas, Managing Director of Damen Digital Solutions. "With our combined expertise, we will be able to work towards cutting-edge solutions tailored to the specific needs of NavyX. The NavyX team will additionally benefit from the intensive warranty and technical support from the Damen UK Service Hub."

» *Damen is set to deliver the Triton remote monitoring platform and the digital twin model of XV Patrick Blackett to NavyX. (Image credit: Damen Triton)*

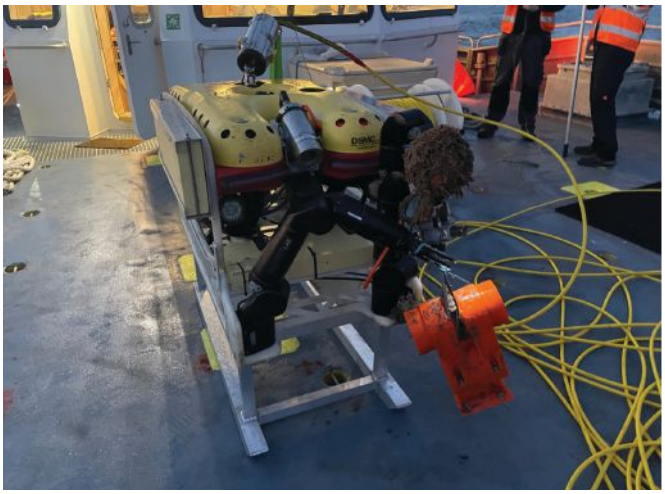
Col Tom Ryall, Head of NavyX, added: "It is exciting to be partnering with Damen Digital Solutions on this project to explore new ways of enhancing both our, and future, capabilities. By working together, we can leverage the latest technologies we can closely monitor XV Patrick Blackett's performance and maintenance conditions and inform concepts for the future Royal Navy fleet."

The collaboration started at the end of 2022.

The next stage will be Damen's delivery of the Triton remote monitoring platform and the digital twin model of XV Patrick Blackett. The two organizations are looking forward to exploring new opportunities for innovation and growth.

PART 1

REACH ROBOTICS MANIPULATORS HANDLE ROV-LED SENSOR RECOVERY



» *Offshore deployment and the recovery of the telemetry equipment using Reach Bravo manipulators. (Image credits: DSMC/Reach Robotics)*

At Diving Survey & Marine Contracting (DSMC) we carry out a range of specialist subsea services, including commercial diving, the operation of remotely operated vehicles (ROVs), and hydrographic survey campaigns.

Since 2021, we've used Reach Robotics underwater electric manipulators to execute a range of subsea inspection techniques, including Ultrasonic Wall Thickness (UT) and Cathodic Protection Potential (CP).

In early 2022, an offshore wind developer client required us to install telemetry equipment by Subsea Insight in reasonably deep waters using divers. This equipment was secured with bolts fastened to 60Nm. Later that same year, we were asked to recover this equipment. We decided that using two Reach Bravo manipulators was a safer and arguably more efficient alternative to putting divers back into the water.

The client agreed and provided a budget for workshop trials and training before deploying offshore. If successful, it would mean completing the works diver-less, with operations carried out by a small team aboard one of the client's vessels. Not only would this lead to a significant cost saving but it would spotlight a new and pioneering level of capability from an inspection-class ROV.

FITTING AN ROV FOR PURPOSE

There were several engineering challenges. First, we needed to modify the manipulator jaws to be able to grab around the large sensor housing. Second, we had to mount the hex driver to the end of a manipulator. The third hurdle was figuring out a way to increase the torque in the manipulator's constant rotating wrist to crack bolts tightened to 60Nm. Last, but not least, was the requirement to balance the ROV with additional buoyancy, to account for the extra equipment and heavy sensor, allowing it to fly and navigate in a tidal environment.

Our in-house fabricator got to work. The most prominent modification was a mount that clamped to the manipulator's forearm and held a torque multiplier. This was operated by the wrist joint of the Reach Bravo. We traded speed and gained an increase in the torque to 100Nm. The tool worked brilliantly, and so it was off to trials and in-water testing!

FROM TEST TANK TO OPS DECK

We decided to collaborate with Upper Wharfdale School, in North Yorkshire, UK, to conduct some in-water training in their swimming pool—our test tank. This allowed us to demonstrate the system to some of the students who were keen to help us with the trials and learn about the subsea robotics industry.

After a few lessons learned in the pool (positioning buoyancy is a fine art!) we ran some further checks of the system including testing the Reach Bravo's lift capacity.

We were delighted to discover that the manipulator could not only hold 10+ kg at full extent, but that it could lift much heavier weights (we used 20 kg) by limiting its range of movement.

Confident in the tooling configuration, we set a date for offshore mobilization, and our coordinates to recover the telemetry equipment.

THE OUTCOME

We successfully unbolted and recovered both sensors within one shift, significantly quicker than we had hoped.

Since then, we've continued to use the Reach Bravo to change and enhance how we operate below the water. Stay tuned for the second installment of this project in the next edition of ON&T (Oct/Nov) when we show how we removed calcite and took CP readings with the system.

For more information about Reach Robotics, visit: *www.reachrobotics.com*.

For more information about DSMC, visit: *www.dsmc.uk*.

NEXT-GENERATION DIGITAL INTERROGATOR FOR US NAVY VESSELS

BAE Systems has received a $15 million contract from the US Navy to deliver its next-generation digital interrogator for maritime vessels. The interrogator will have advanced capabilities—providing time-critical insights that reduce friendly fire incidents and support mission success in hostile environments.

» *The interrogator will provide US Navy assets with time-critical insights to reduce friendly fire incidents. (Image credit: US Navy/Petty Officer 3rd Class Samuel Osborn)*

BAE Systems' modernized AN/UPX-50(C) Digital Interrogator will provide a common modular design and open system architecture. Its design enables the rapid integration of new technology within the existing footprint through software updates instead of hardware configuration.

"The flexibility of our design provides high performance without changes to existing fleet infrastructure—getting critical system updates to the warfighter faster," said Donna Linke-Klein, Director of Tactical Systems at BAE Systems. "This investment will accommodate IFF technology growth for several decades to best equip the US Navy in the evolving battlespace."

The AN/UPX-50(C) Digital Interrogator delivers high-performance, multi-function Identification Friend or Foe (IFF) solutions for air defense, weapon systems, air traffic control, and range instrumentation.

Used for Mark XIIB IFF processing, including Mode 5 and Mode S, it provides secure and encrypted data exchange. It also includes a third receive channel for passive acquisition of Mode 5 Level 2 and Automatic Dependent Surveillance—Broadcast In, providing enhanced situational awareness for warfighters.

Work on the upgraded AN/UPX-50(C) Digital IFF Interrogator will be performed at BAE Systems' state-of-the-art facility in Greenlawn, New York.

SAAB PROPOSED UNCREWED SOLUTION TO CUT EMERGENCY RESPONSE TIMES AT SEA

A new-generation rescue craft proposed by Saab's Docksta Shipyard would use remote-operation technology to dramatically cut response times for maritime accidents.

The starting point for the development of the Loitering, Optionally Crewed, High Speed Rescue Vessel (LHSRV) was understanding the limitations of current rescue resources for remote ocean emergencies. Crewed ships can be used for such rescues, but they are expensive to maintain on station, relatively slow, and affected by heavy weather. Fixed wing aircraft have limited time on station and rescue capabilities, while helicopters have severe limits on their range, time on scene, and survivor capacity.

The proposed features of the LHSRV would allow it to overcome many of these challenges, and to work in cooperation with conventional search and rescue platforms. Measuring 20 meters, the concept vessel's hull would be based on Saab's successful Docksta 20 Interceptor craft, currently used in patrol.

Constructed from aluminum, the LHSRV would feature a self-righting design to allow it to quickly recover from capsizes and to survive rough seas. A superstructure designed to minimize ice build-up would allow for operation in cold water environments, such as the North Atlantic. Meanwhile, a substantial battery system capable of being recharged by both a generator and photovoltaic cells would enable the craft to remain on station in the remote ocean for periods of between five and 20 weeks, depending on conditions.

The range for rescue missions would be up to 300 nautical miles on top of loitering time, with the vessel able to travel 200 nautical miles or more to reach its station.

» *Loitering, Optionally Crewed, High Speed Rescue Vessel (LHSRV). (Image credit: Saab)*

The LHSRV would make use of cutting-edge autonomous and remote-operation technologies, some of which have been demonstrated by Saab's Enforcer III test craft. These would allow it to be controlled entirely remotely from a control room on land. With no crew on board, the craft could achieve speeds in high seas that no equivalent crewed vessel could manage.

Remote communications features would allow it to act as a communication hub and to interact with the crew of stricken vessels. A remotely operated man-overboard system would allow it to retrieve survivors already in the water and receive evacuees from sinking vessels. The LHSRV could then potentially convey survivors to shore or stay on the scene until other resources arrive.

SECURITY LEADERS CONVENE TO DISCUSS URGENCY IN COMPLEX THREAT LANDSCAPE

In late August, SENEDIA, the alliance for defense tech, talent, and innovation, concluded Defense Innovation Days, an important national defense convening that featured three days of policy discussion, industry networking, and planning for the future in an increasingly complex national security landscape.

Senator Jack Reed, Chairman of the Senate Armed Services Committee, participated in multiple sessions, providing critical insight and underscoring the urgency of the moment.

Urgency, innovation, and collaboration emerged as key themes at this year's ninth annual event, with speakers warning of the potential consequences if investments stall in research and development, workforce training, or military deterrence.

"Defense Innovation Days brings together the most influential voices in national security, paired with the most innovative leaders of the defense industry, and this year's event illustrated the power of that partnership," said Molly Donohue Magee, Executive Director of SENEDIA. "When we collaborate in service of our nation—guided by a desire to support our men and women in uniform—we can maintain and advance our strength at home and abroad."

Among the key takeaways are:

- China and climate change are among the greatest threats and sources of instability facing our national security landscape.
- We are in a "decade of maximum danger," which calls for a "decisive decade" of investment, training, and strategic planning in return.
- By working with and learning from private industry, as well as investing in its own internal capacity, DoD is rapidly scaling up the development and deployment of innovative and emerging technologies. Innovation must concurrently include the ability to scale to meet the demand.
- Collaboration is essential to accelerate progress, including connecting supply chain companies to DoD contracts, investing in workforce development, and enacting meaningful public policy like AUKUS.

VESTDAVIT TO SUPPLY US NAVY WITH 12 HIGH-SPECIFICATION DAVITS

Davits supplied by Vestdavit are set to play an important role in efficient launch and recovery of fast craft to support refueling operations at sea for the US naval fleet after the company was awarded a major contract for six vessels being built by General Dynamics NASSCO in the US.

The contract covers delivery of a total of 12 high-specification PLRH-5000 davits to be installed on the John Lewis-class of T-AO oilers ordered by the US Navy at the shipbuilder's San Diego shipyard, with two on each ship from T-AO 208 through T-AO 213 in the newbuild series.

The PLRH-5000 single-point davits will be used to handle the US Navy's seven-meter RHIBs (Rigid-Hull Inflatable Boats) and incorporate a range of motion compensation and safety features that allow them to function effectively also in challenging conditions with high sea states.

» *Vestdavit will deliver multiple davits for newbuild T-AO oilers under construction at General Dynamics NASSCO. (Image credit: General Dynamics NASSCO)*

These include shock absorbers for removing peak loads, constant tension for safe and efficient recovery in rough weather, and guiding arms that act as an anti-pendulation device to keep the RHIB steady.

The skid-mounted davit is delivered as a fully self-contained unit for ease of installation onboard ships, with a requirement only for welding in place, filling with hydraulic oil and connection to power supply.

As well as naval applications, the DNV-classed davit type with lifting capacity up to 15,000 kg is typically used on offshore patrol vessels, fishery protection and law enforcement vessels, and search and rescue vessels.

BISN AWARDED ISO 9001 CERTIFICATION FOR QUALITY MANAGEMENT SYSTEMS

BiSN, a leading provider of permanent downhole sealing solutions, has been awarded the ISO 9001 Certification for Quality Management Systems by the British Standards Institution (BSI). This internationally recognized standard for quality management underscores BiSN's unwavering commitment to delivering superior products and services to its valued customers while adhering to the highest standards of operational efficiency and customer satisfaction.

The ISO 9001 certification is a testament to BiSN's dedication to continual improvement and its dedication to providing cutting-edge solutions within the oil and gas landscape.

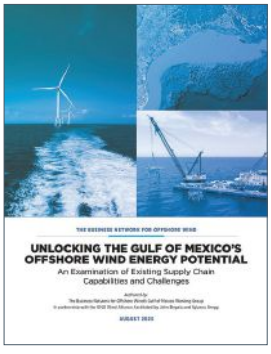
By undergoing a rigorous assessment of its internal processes and quality management systems, BiSN has demonstrated its ability to consistently meet and exceed customer expectations, while maintaining compliance with industry regulations and best practices.

Receiving the ISO 9001 certification represents a significant milestone in BiSN's journey towards excellence. It reinforces the company's core values of quality, reliability, and customer-centricity, which have been the driving force behind its success.

With this prestigious accreditation, BiSN further solidifies its position as a market leader and a trusted partner for its clients.

"The ISO certification is one more demonstration from BiSN to follow a customer-centric approach to meet operator needs," said Paul Carragher, CEO and Founder of BiSN. "Our production and quality control teams have worked tirelessly to achieve the certification and we are extremely proud of their accomplishment."

REPORT ON FUTURE FOR OFFSHORE WIND IN THE GULF OF MEXICO



The Business Network for Offshore Wind has released *Unlocking the Gulf of Mexico's Offshore Wind Energy Potential*, a report addressing the region's unique potential for offshore wind development. The report highlights how the Gulf of Mexico's history of innovation, robust offshore oil and gas experience, and strong supply chain has the potential to catapult offshore wind growth in the region.

It also addresses the key hurdles, such as how the industry will need to develop technology that can maximize power output from an environment with lower average wind speeds than the East Coast coupled with seasonal hurricane activity, which must be overcome for the region to be successful.

Unlocking the Gulf breaks down the offshore wind development process and highlights Gulf-based companies that have already been participating in the industry—despite the lack of projects in Gulf waters to this point. More than one in five offshore wind contracts identified by the Network's *Market Dashboard* have gone to companies based in the Gulf of Mexico, demonstrating the region's strong expertise.

GREENSEA SYSTEMS UNIFIES SUBSIDIARIES TO BECOME GREENSEA IQ

Greensea Systems is transforming into Greensea IQ, marking a strategic move that unites its former subsidiaries; Bayonet Ocean Vehicles and Armach Robotics, into a new business entity. This restructuring reinforces Greensea IQ as a leading force in the use of uncrewed and autonomous systems to better help improve human-kind's interactions with, and understanding of, our oceans.

Greensea IQ's innovative technologies are poised to revolutionize the maritime industries. EverClean, for instance, offers autonomous hull cleaning services that enhance ship performance, fuel efficiency, and reduce carbon emissions. With a successful commercialization phase, EverClean has proven the economic viability of its technology, and plans are in place to scale the service to a multitude of ship types in the coming years.

Additionally, Greensea IQ's advancements in the defense and environmental spheres are gaining traction. The EOD Workspace software platform offers autonomous capabilities for mine detection and classification, reducing the risk to personnel in hazardous environments. Furthermore, the company's robotics technologies are finding applications in offshore renewables, performing surveys for pre-construction work and beach landings, where traditional solutions struggle.

The restructure also prepares the company to strategically expand its operations to better serve clients across the globe with likely expansion into Europe, South America, and Southeast Asia, allowing the provision of closer service depots for robot deployments, and more effective customer support.

This reorganization not only underscores Greensea IQ's commitment to innovation but also highlights its ambition to better align business growth with environmental sustainability.

OPENSEA, Greensea IQ's hardware-agnostic open framework for the development and deployment of cutting-edge robotics technologies, can be considered the common thread that ties together all of the company's activities. It encompasses essential interfaces and utilities vital to the robotics and unmanned systems community that Greensea IQ has worked deeply within.

TOTALENERGIES SECURES INTEREST IN CO2 STORAGE LICENSE OFFSHORE NORWAY

TotalEnergies has signed an agreement with CapeOmega Carbon Storage AS, a wholly owned subsidiary of CapeOmega AS, to acquire the 40% participating interest held by CapeOmega in the CO2 storage exploration license ExL004 (the "Luna" project).

Located 120 km offshore Bergen in 200 m water depth, ExL004 covers an area of 453 km². It is adjacent to the license where the Northern Lights CO2 storage project (TotalEnergies, 33%) is under development, with a first phase due to start in 2024.

ExL004 is operated by Wintershall DEA Norge AS with a 60% participating interest. The transaction is subject to satisfaction of customary conditions, including final approvals from relevant government authorities.

"This transaction is an important milestone to grow our CO2 storage offering: subject to a successful exploration, this area could enable the storage of several hundred million tons of CO2 from hard-to-abate industries in Europe," said Arnaud Le Foll, Senior Vice-President New Business – Carbon Neutrality at TotalEnergies.

AMERICAS

OTC Brasil
Rio de Janeiro, Brazil » October 24–26
https://otcbrasil.org

TMA BlueTech Week
San Diego, CA » November 13–16
www.tmabluetech.org/bluetech-week

Floating Wind USA 2023
San Diego, CA » November 29–30
https://events.reutersevents.com/renewable-energy/floating-wind-usa

International Workboat Show
New Orleans, LA »
November 29– December 1
www.workboatshow.com

Underwater Intervention
New Orleans, LA »
November 29– December 1
www.workboatshow.com/underwater-intervention

EUROPE

Ocean Energy Europe (OEE)
The Hague, NL » October 25–26
www.oceanenergy-europe.eu/annual-event/oee2023

Offshore & Floating Wind Europe
London, UK » October 25–26
https://events.reutersevents.com/renewable-energy/offshore-floating-wind-europe

Marine Autonomy and Technology Showcase (MATS)
Southampton, UK » November 7–9
https://noc-events.co.uk/mats-2023

Offshore Energy
Amsterdam, NL » November 28–29
www.offshore-energy.biz/oeec2023

NCS Exploration Deep Sea Minerals
Bergen, Norway » December 5–7
https://events.geonova.no/event/deepseaminerals

OTHER REGIONS

Asia-Pacific Deep Sea Mining Summit
Singapore » December 11–12
www.asia.deepsea-mining-summit.com

SYMPOL 2023
Kerala, India » December 13–15
http://sympol.cusat.ac.in

AOG Energy
Perth, Australia » March 13–15, 2024
https://aogexpo.com.au/conference

MSEAS
Yokohama, Japan » June 3–7, 2024
https://meetings.pices.int/meetings/international/2024/MSEAS/Background

ICOE 2024
Melbourne, Australia »
September 18–20, 2024
www.ocean-energy-systems.org/icoe/conferences

MAST Australia
Adelaide, Australia »
November 19–20, 2024
https://mastconfex.com/australia2024

DANOS ADDS COASTAL RESTORATION TO PORTFOLIO OF SERVICES

» *Danos services extend to the production and installation of artificial reefs tailored to the local habitat. (Image credit: Danos)*

Danos has expanded its portfolio to offer coastal restoration services to customers throughout the Gulf South. In addition to providing the materials and workforce to restore or replace barriers in marine environments, the company is producing and installing artificial reefs tailored to the local habitat. Most recently, Danos partnered with the Coastal Conservation Association to develop 128 3D-printed concrete modules installed at South Marsh Island 235 south of Cypremort Point.

A major driver of Danos' investment in coastal restoration services is its partnership with Natrx, a Raleigh, NC-based technology firm developing bioengineering solutions for wetland conservation. Danos is fabricating two Natrx innovations: the patented Oysterbreak pre-cast concrete modules and the 3D-printed ExoForm™ (nicknamed "Cajun Coral") tailored concrete units. Both products represent significant improvements over existing options—such as riprap or bulkheading—saving time and money while offering greater protection and supporting the growth of landmass and marine habitats.

Danos can mass-produce and store both Oysterbreak and Cajun Coral at its Amelia, Louisiana, fabrication facility. In addition, the company will deploy a second 3D printer serving as a mobile unit to locations around the world.

"Protecting vital wetlands is a priority for our customers and communities," said Eric Danos, CEO of Danos Ventures, a Natrx investor. "By investing in this technology, we can maximize the impact of coastal restoration efforts—creating living shorelines and local jobs."

Both Oysterbreak and Cajun Coral are designed and storm-tested to deliver maximum protection of coastal areas while also growing native oyster, coral, and fish populations.

GENERAL OCEANS ACQUIRES MIND TECHNOLOGY'S KLEIN UNIT

MIND Technology, Inc. has sold its Klein Marine Systems unit for cash consideration of $11.5 million to General Oceans, Inc., a subsidiary of General Oceans AS. Pursuant to the transaction, MIND has licensed its Spectral Ai software suite to General Oceans for certain applications, particularly side-scan sonar. MIND and General Oceans have also entered into a Collaboration Agreement for the further development of Spectral Ai and potentially other software projects.

Klein has served the offshore mapping and defense industries for over 50 years and will strengthen General Oceans' already substantial capabilities in subsea sensors, serving applications from seafloor mapping to mission-specific autonomous vehicles.

Rob Capps, MIND's President and CEO, stated: "With the continued growth and opportunity we are seeing in our Seamap unit, which has seen robust customer interest in recent quarters related to our GunLink, BuoyLink and SeaLink products, we feel that it is prudent to shift our focus and capital to those operations.

"We are excited to be able to continue to work with Klein and General Oceans in the licensing and further development of our Spectral Ai software suite. Through our Collaboration Agreement, we plan to continue the development of Spectral Ai for side scan sonar operations, and we expect this to deliver us growing and recurring royalty income.

"In addition to traditional energy-related opportunities, we are seeing new alternative energy applications for our Seamap technologies, including offshore windfarms and other green energy projects. We also see growing opportunities to provide seismic streamer repair services, not only for our SeaLink streamers, but also for products manufactured by others."

OCEANEERING ACQUIRES EXAIL USV FOR REMOTE SURVEY SCOPES

Oceaneering International recently announced that its Subsea Robotics group is introducing a new uncrewed surface vessel (USV) service to support remote survey work scopes.

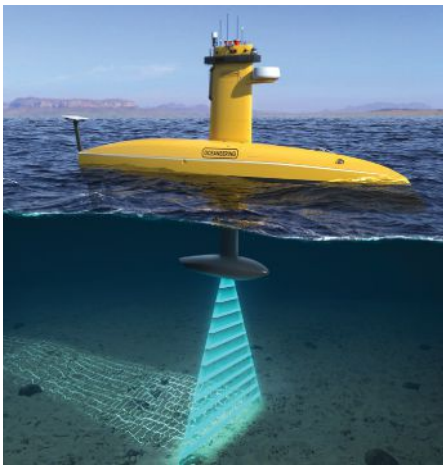
Exail and Oceaneering reached an agreement where Oceaneering will purchase its first DriX USV to support deepwater geophysical and asset inspection operations, including autonomous underwater vehicle (AUV) positioning, and offshore and nearshore surveys. The use of the DriX USV on offshore survey and inspection work scopes will enable Oceaneering to improve operational efficiencies, reduce overall vessel time on site, and significantly reduce carbon emissions.

Oceaneering's USV service offering will utilize dual independent positioning correction services from Oceaneering's C-NAV® group for uninterrupted operations, thereby improving reliability. Oceaneering's service will be the only USV equipped with true, dual redundancy for guaranteed continuity of service.

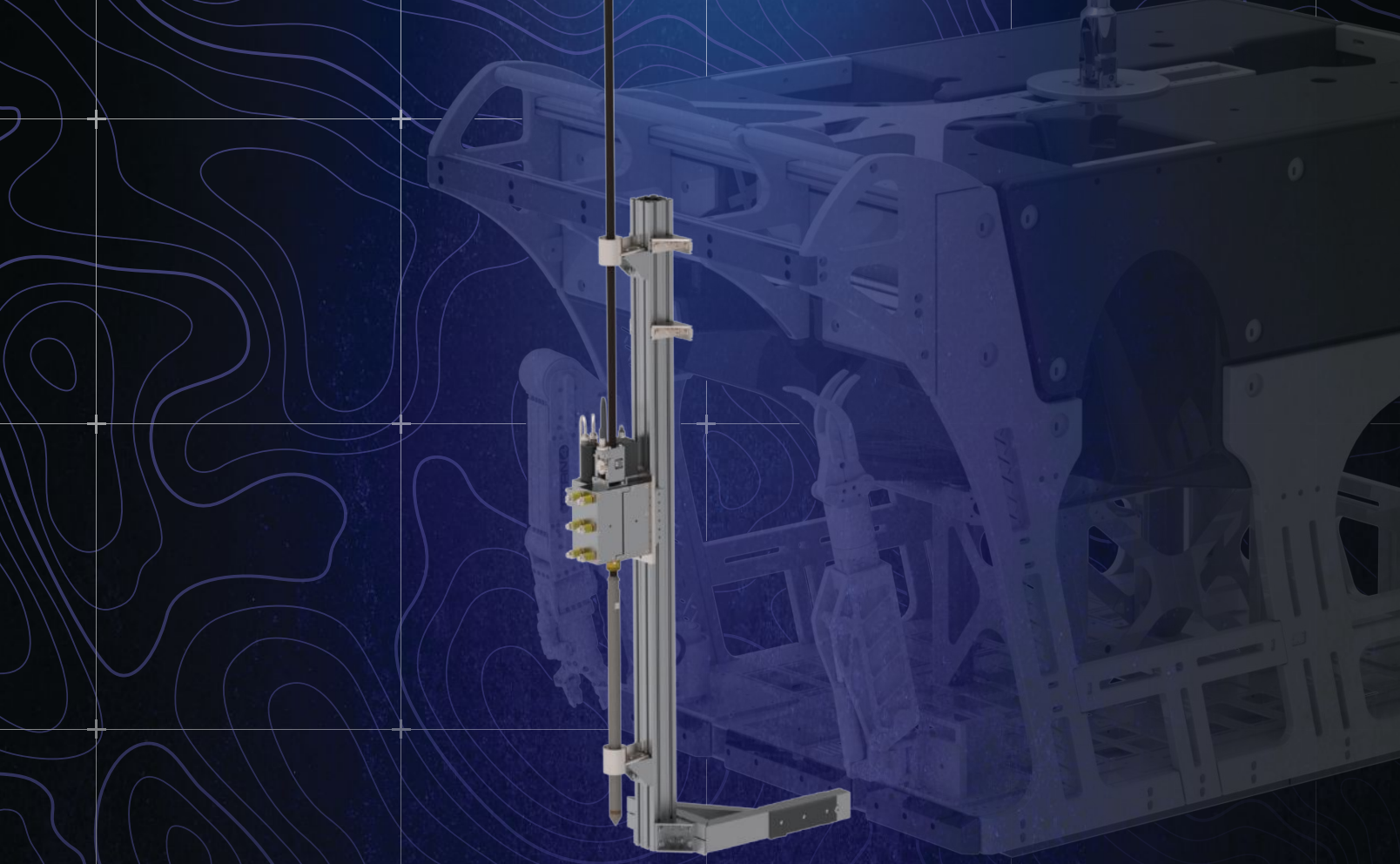
The DriX USV has accumulated several thousand hours in operation since entering service in 2016 and is able to conduct over-the-horizon supervised autonomous operations thanks to its AI powered CortiX software and state-of-the-art sensors.

The USV's shape and stability allows for continued operations alongside Oceaneering's AUVs in poor sea conditions found offshore (up to sea state 5), without compromising data quality.

The USV's speed and endurance also reduces transit downtime and enables high speed nearshore survey to be conducted obtaining optimal data quality, harvested in a fraction of the usual times. It offers a lower environmental footprint at only 2 liters of fuel usage per hour, when compared with a crewed vessel, thereby reducing carbon emissions.



» *The USV service will directly support IMRGE™, an integrated and customizable Inspection, Maintenance and Repair (IMR) strategy. (Image credit: Oceaneering)*



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Ocean Specialists, Inc. (OSI) is a system development and advisory firm for undersea cable projects and technology with global capabilities. OSI works with clients during all project phases of subsea network development, from planning and design to procurement and implementation. Our customers, primarily representing Oil and Gas, Telecommunications and Ocean Observing, recognize the value of fiber optic networks to their field and services solutions, and look to OSI to deliver the skills and experience that developing these networks require.

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Bluefield Geoservices was established in 2018 to provide the ocean industries with a fresh approach to offshore geotechnical survey. Our mission: to leverage the team's 100 years of combined offshore geotechnical engineering and geosurvey experience to devise and deliver innovative solutions to the most persistent problems in offshore developments. We develop and deploy progressive in situ seabed investigation methods and custom technologies that deliver best-quality geotechnical and related site data and analysis.

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Kongsberg Discovery develops, manufactures and delivers innovative technology to enhance knowledge, surveillance and sustainability in the ocean space. From the deepest sea to outer space, our unique offering allows our customers to understand complex environments, mitigate risk and achieve ambitious objectives. The Kongsberg Discovery portfolio spans hydro acoustics with sonars and echo-sounders, marine robotics, inertial navigation, communication, and underwater and above surface position reference systems using laser, radar and GNSS technologies. Our technology, combined with deep application knowledge and software expertise, provides significant value for our customers.

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CSA Ocean Sciences Inc. brings more than five decades of experience in marine environmental assessments in the U.S. and internationally, with offices in the United States, the Eastern Mediterranean, Trinidad, Suriname, Brazil, and Australia. CSA's expertise in coastal, marine, and deep ocean surveys is built on the integration of science, operations, and an understanding of environmental data collection, management, and analysis within geospatial domains.

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Morgan & Eklund provides accurate and reliable hydrographic and geophysical survey services in support of marine and coastal infrastructure projects, beach restoration, and large-scale water management projects. M&E clients include engineering firms, government entities and construction contractors. We own and operate state-of-the-art land and hydrographic survey equipment including RTK/GPS, digital levels, invar rods, bathymetric charting equipment, electronic total stations and data collectors.

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Marine Ventures International, Inc. (MVI) provides high quality, marine environmental and technical experts to conduct coastal and offshore field operations worldwide. We leverage our wealth of talent and resources to bring you a customized team of independent contractors, subject matter experts and specialized equipment to get the job done. Our professionals work in a variety of sectors from submarine cable projects and engineering services to protected species observation and environmental consulting.

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EvoLogics provides the world's most advanced spread-spectrum underwater communication systems (S2C) with multi-channel data management, networking capability, built-in tracking and positioning functions with USBL. Data loggers, acoustic wake-up module and releasers optionally included. Deployments in offshore platforms (FPSO, ABS), environmental monitoring, defense systems, ROV and AUV operations and more. Applications include simple positioning and sensor information to transmission of underwater photos.

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OCEANOGRAPHIC INSTRUMENTS/SERVICES

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- **Manufacturer's Representative:** Teledyne RD Instruments, Deep Water Buoyancy, WERA Northern Radar.

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ROPE

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SONAR SYSTEMS

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Amy LaRose

EdgeTech designs, manufactures and sells industry-leading side scan sonars, sub-bottom profilers, bathymetry systems and combined sonar systems. Additionally, the company produces world class underwater actuated and transponding solutions including deep sea acoustic releases, shallow water and long life acoustic releases, transponders, reliable USBL acoustic tracking and positioning systems, and custom-engineered acoustic products.

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Imagenex Technology Corp. is an innovative company that was founded in 1988 by pioneers in the development of high resolution sonar. With thousands of systems in use on imaging and profiling projects all over the world, Imagenex has developed a reputation for products that break new ground for depth capability, size, cost, imaging quality and functionality. Each system in this growing product line integrates the latest in sub-miniature electronics into industry proven, robust underwater housings for a total package that is small, rugged, and will provide years of maintenance-free use. Products include multibeam, mechanical scanning, and sidescan sonars.

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Massa Products Corporation designs, engineers, and manufactures sonar and ultrasonic products for use in ocean, air, and fluids. Founded by Frank Massa, the man who pioneered the field of electroacoustics over 75 years ago, Massa is the only company that remains family owned and has continuity in the field since the dawn of the industry. With over 165 US Patents Awarded, Massa has become an Industry leader and trusted partner of the US Navy. Massa is also an ISO 9001:2015 Certified company that will tailor designs to fit customer needs. Challenge your perception of what's possible with Massa Products Corporation!

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SUBSEA TECHNOLOGY

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AIRMAR Technology is a leading developer and manufacturer of acoustic and ultrasonic sensing solutions. We push the boundaries of ultrasonic technology to develop advanced products that withstand the harshest ocean environments while reliably facilitating data gathering from surface to full ocean depth. Our comprehensive suites of marine, oceanographic and survey transducers, plus our WeatherStation® instruments, deliver performance that meets the most challenging mission requirements. Ideal applications include shallow and deep-water survey, sub-bottom profiling, navigation, fisheries research, aquatic habitat assessment, underwater scientific applications and more. Customization of transducers for specific marine applications is available.

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General Dynamics Mission Systems' family of Bluefin Robotics products consists of autonomous unmanned underwater vehicles (UUVs) and related technologies for defense, commercial, and scientific customers worldwide. Their core autonomous product line includes Bluefin®-9, Bluefin®-12, Bluefin®-21, and subsea power technologies. General Dynamics offers a full range of modular, free-flooded UUV platforms and products, integrated with over 70 different sensors on more than 100 vehicles. We design, develop, deliver, and provide operations and sustainment support for UUVs worldwide to research institutes and industry, providing UUVs and auxiliary equipment to the United States' and International Navies for various defense applications.

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International Submarine Engineering Ltd. (ISE) is a world leader in the design and integration of autonomous and remotely operated robotic vehicles and terrestrial robotics. Over our 40+ years in business, we have accumulated a great deal of expertise in the design, manufacture, and maintenance of: Autonomous Underwater Vehicles (AUVs, Remotely Operated Vehicles (ROVs) for subsea operation, Human Occupied (HO) submersibles, Customized systems for the offshore oil industry, Customized systems for the Military-Naval sector, Hydraulic, pneumatic, and electric robotic manipulators, Teleoperated and autonomous robotic systems, Robotic systems for nuclear Industry applications, Communications and real-time control system.

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L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains. L3Harris develops autonomous, lightweight Unmanned Undersea Vehicles (UUV). L3Harris has established itself as the leader in man portable UUVs, providing highly capable vehicles to a wide array of military, commercial and research customers. With over 15 years experience in the underwater field, our engineers have developed a reliable and easy to use platform that is trusted to complete marine missions all around the world.

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SeaRobotics Corporation, headquartered in Stuart, Florida, specializes in the design and manufacture of intelligent marine robotics, including a line of Autonomous Surface Vehicles (ASVs) for commercial and defense markets around the world. Applications for SeaRobotics vehicles range from bathymetric and hydrographic coastal surveys to, harbor, and riverine inspection and surveillance. From ground-breaking ASV design through to custom manufacturing for theme parks, SeaRobotics designs, engineers and manufactures smart solutions for complex marine challenges. In addition to our ASV line, SeaRobotics also designs and builds hull and tank bio-inspired underwater grooming and cleaning systems.

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Jeff Orlowski

VideoRay is the world's leading manufacturer of portable underwater robotic systems. VideoRay Mission Specialist Systems have redefined the "inspection class" category. Much more than underwater cameras, they deliver industry leading power and maneuverability and are rugged enough to work anywhere, handling tough jobs and applications. They are used around the world in demanding underwater missions to support national security, first responders, object search and recovery, infrastructure examination and science and research. VideoRay is available on the General Services Administration (GSA) Schedule.

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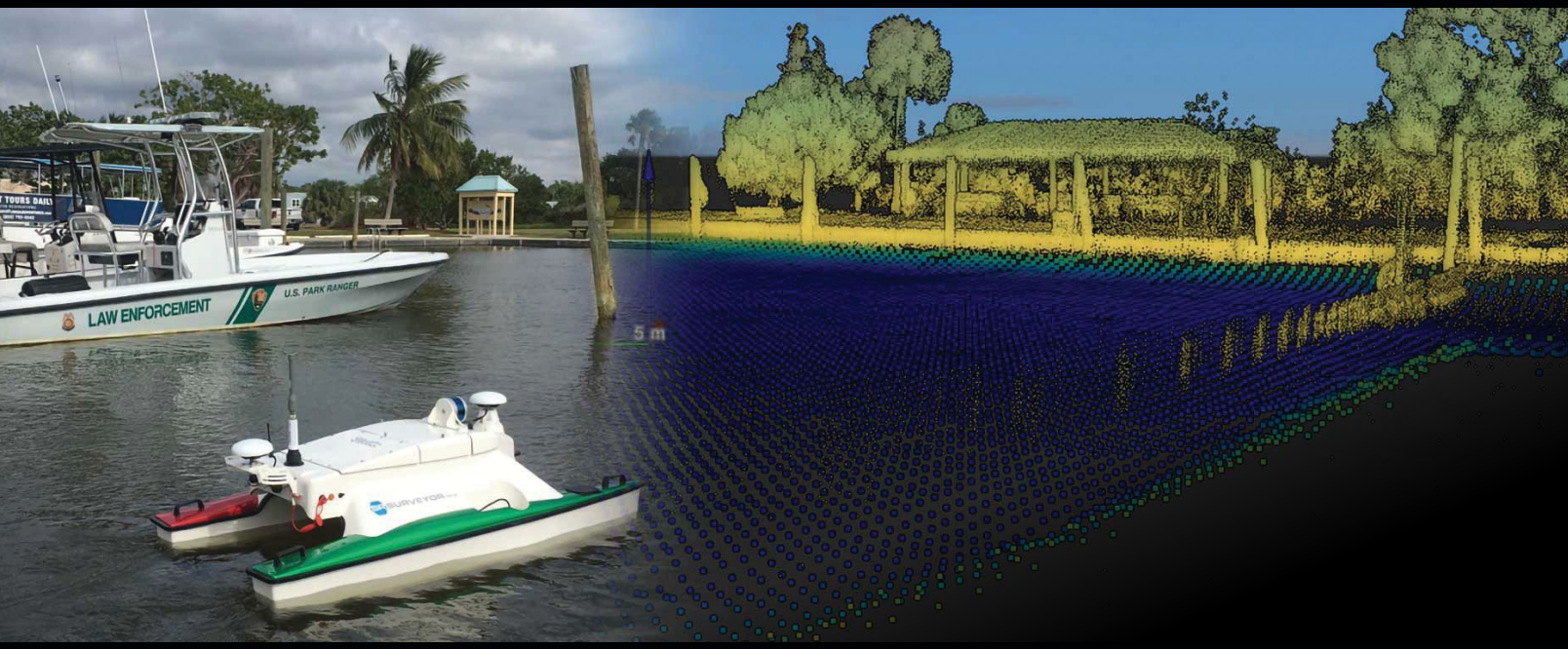

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Photos: Aft deck and control room of CSA's R/V Dolphin

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