UNDERWATER ROBOTICS

ISSUE 11

SUT Society for Underwater Technology

MTS marine technology society

SUT
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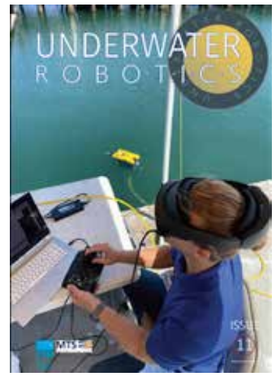


BlueRing's latest VR and piloting environment, OctoView, bring tested on a VideoRay ROV

Boxfish Robotics

Boxfish Research has been officially renamed Boxfish Robotics. The decision reflects the company's evolving focus and product line, emphasising its commitment to underwater exploration and robotics technology.

As Boxfish product portfolio advanced, the company recognised the need for a name that better represented its current scope and aspirations. The original name was rooted in ties to scientific exploration. At that time, it focused on offering 360 cameras, ROVs and custom solutions, catering to clients in marine research.

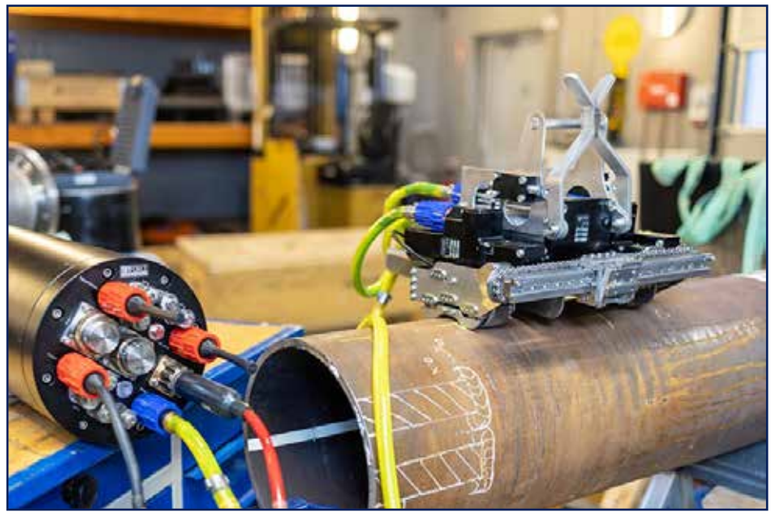
As Boxfish Robotics, its mission is to "lead the underwater robotics revolution with unparalleled innovation, excellence clarity in underwater imagery, and a commitment to sustainable ocean exploration," according to co-founder Craig Anderson.

Its ROVs include the inspection class Boxfish Alpha, the expeditionary class Boxfish ROV and the versatile cinematography drone Boxfish Luna. In collaboration with Norwegian company Transmark Subsea, the company developed the autonomous underwater resident vehicle, ARV-i, tailored to continuously monitor and inspect underwater assets for offshore industries. ARV-i, is powered by advanced Artificial Intelligence and sensor integration, facilitates automated and remote operations, while ensuring efficient and precise data collection.

P-SCAN 5.

P-scan is a computerised ultrasonic system inspection tool It was originally developed by FORCE Technology back the 1980s but over the years, it has undergone continuous improvement. Recently, the company completed development of the latest generation system, P-Scan 5.

The P-scan system is a computerised ultrasonic system, developed for the automatic, mechanical or manual ultrasonic examination of welds and materials. It enables the operator to examine objects from a distance by a remote controlled scanner device and simultaneous collection of data from more transducers and/or different types of data from the same transducer.



Subsea P-scan 5 bottle with magnetic wheel scanner

The new P-Scan-5 tool encompasses phased array, pulse echo, time of flight diffraction (TOFD) and creep wave ultrasonic techniques. All parts in P-scan 5 are designed for operation down to 3000m water depth.

The system consists of:

• P-scan 5 ultrasound system bottle, with connectors for two phased array transducers (32/64) and eight conventional transducers, scanners, and communication either through SM fibre or Gb Ethernet.

• Motor controller with connectors for three motors, controllers can be put in parallel allowing for more motors.

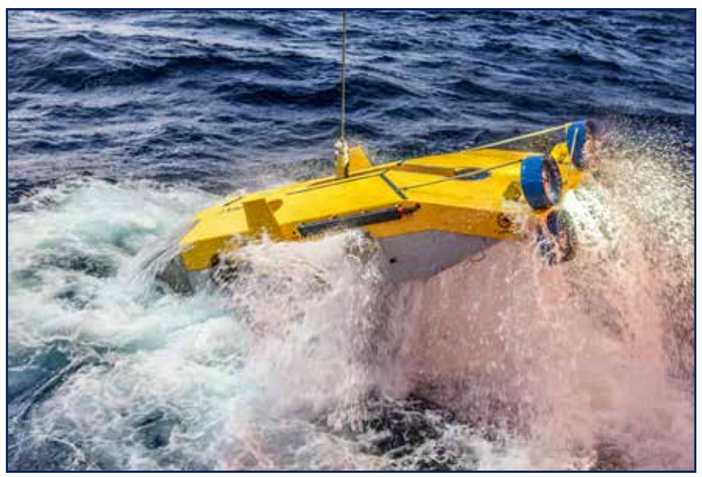
The P-scan 5 software collects and stores A-scan, allowing the original data to be re-evaluated at a later stage. It incorporates use of artificial intelligence and machine learning AI/ML to aid the evaluation of data.

REACH CONTRACT

Reach Subsea has received a notice of contract award, subject to successful contract negotiation, from a major European energy provider.

The potential contract has a duration of approximately 75 vessel days and is scheduled for execution in the fourth quarter of 2023.

The project will utilize one of Reach Subsea's DP2 subsea vessels and the onboard high-speed survey ROV, the Surveyor Interceptor.



UTV670

Pharos Offshore Group's surface-fed trenching vehicle UTV670 has completed its most recent cable burial installation campaign on a European Offshore Windfarm.

The UTV670 successfully buried 5 replacement inter array cables to the client's specified burial requirements whilst facing challenging weather.

This season, UTV670 has worked on a variety of projects covering power cable infrastructure, an O&G umbilical and inter array cables. The vehicle has been operating with x2 570hp diesel driven surface water pumps, providing an unmatched capability for its size of over 1100hp of water power.

UTV670 surface fed trenching vehicle

The Pharos UTV670 is a ‘surface fed’ trencher. The hose seen at the top of the vehicle is the water feed hose. Located on the vessel deck are a pair of containerised 570hp Diesel powered water pumps that then feed the water down to the trenching vehicle via an 8in water hose.

This has the benefit of allowing the trenching vehicle to be quite compact by not having to house typically large and heavy subsea mounted water pumps. As a result of its smaller size, it is a very quick and efficient mobilisation, with minimal deck equipment and the ability to be launched via the vessel crane. The surface fed water pump solution massively reduces the vessel supplied power requirements, as the system only needs a small subsea electro-hydraulic power pack to power the tracks and sword deployment.

"The vessel supplied power requirements are more akin to that of a small ROV, rather than the thousands of amps typically required for a trencher with equivalent water power," said Pharos' Operations, Director Jamie Linton.

The UTV670 on deck

BATHYMETRY

Great Yarmouth company GeoAcoustics has recently introduced Artificial Intelligence (AI) to assist bathymetric interpretation. This free software update for owners of the GeoSwath 4 bathymetric sonar will further help users keen to exploit the advantages of interferometric systems as part of their shallow water underwater imaging operations.

"Bathymetry – the measurement of the depth and shape of the seabed – is instrumental in navigation and underwater mapping," said Richard Dowdeswell, CCO of GeoAcoustics.

"The boat operator may need to know if there is a rock or shoal in the direct path of their vessel for safety, it is vital to know the clearance under the keel. A hydrographic surveyor may use it to understand the seabed surface when performing environmental investigations, establishing navigational channels, updating nautical charts or determining volumes of dredged materials, etc.

"Historically, water depth was measured by lead lines but in the '20s the first Fathometer came onto the market. This worked by sending a pulse of sound into the water and measuring the time to bounce off the seabed. Knowing the speed of sound in water, it gave a readout of depth in fathoms. This was the basic working principle behind the single beam echo sounder that was to follow.

"The first multibeam echosounders were literally multiple single beams arranged together in a line but before long, the technology progressed to forming the beams and moving them electronically. That was the predominant technology until about the 80s, when an alternative technology began to appear.

"We refer to this system as Interferometric although it is also know by other names such as phase measuring bathymetric sonar, and It works on a slightly different principle.

"Instead of sending out a number of actual physical or virtual beams, it sends two pulses of sound into the water, but has a number of receivers.

"These receivers detect the reflection echoes but importantly, calculate the angle that a particular reflection came from, which gives a bearing. Knowing the time of flight and the same speed of sound in water, it is possible to calculate the distance and hence determine a point on the seabed

"This method gives a number of advantages- one of the most important to some, was that the first systems, were considerably less expensive than the multi beams but were able to provide comparable data.

"There was immediately a lot of negative publicity, principally by the traditional multibeam manufacturers who said that it did not produce measurements at the very bottom or nadir- the gap between the port and starboard beam. Which is incorrect! There are measurements – just fewer than classic multibeams but still enough to meet international standards.

"One feature of Interferometric systems is the number of data points. A good multibeam will give 512 or maybe 1,024 points while interferometric system will give nearer 10,000 to 12,000 points – an order of magnitude higher.

BEAM ENGINE

Because of the way they work, Interferometric systems have an advantage over traditional multibeams in shallow water.

"A multibeam generates a cone of sound that spread somewhere between maybe 120 and 160 deg," said Dowdeswell. " In water depths of 5m, the swath is not a particularly wide. Interferometric systems, however, have wider beam opening angles, with a GeoSwath for example this is 240 deg and consequently, can ensonify a considerably wider part of the seabed- possibly right up to the waterline. As such, it resembles a side scan.

"This is ideal if the user is carrying out a survey in a river or dam or harbour where they want to image right up to the waterline. This is not really possible with a multibeam unless the user physically reorients the echosounder body."

"This could cause problems with commercial hydrographic software packages like Caris, Hypack, Quincy and Evia, because they are set up for multibeams. Suddenly, they are being asked to receive 10 times more data than they are used to. The result is that they have to sub-sample and discard 90% of the data. It is this issue that the new AI system for GeoSwath sonars addresses."

AI SOFTWARE

In mid-2023, GeoAcoustics officially released GS4 software v1.0.25 for its GeoSwath bathymetric sonars. This added several upgrades including an Artificial Intelligence data processing system.

"I was working with neural networks and artificial intelligence 30 years ago," said Dowdeswell, "and when I joined GeoAcoustics

AI

"AI applied to sonars is not new. Caris, part of Teledyne, brought out a system a few years ago called Mira. It is a sonar noise classifier, which works outside of the sonar itself.

"It operates in a supervised approach where large volumes of labelled data is used to train a neural network that is used to map between the raw data and the labelled outputs thus removing an unwanted sonar noise.

Supervised AI approaches are very good when the data to process fits with in the examples it has been trained on. "I sometimes use the analogy of having pictures of dogs and rabbits and training the AI system to tell the difference. If you then gave it a picture it a of a pug wearing a pair of stuck on rabbit ears it may well struggle to classify it.

"We went down a different approach which is unsupervised. We don't provide labelled training data-– we have designed the system so it learns itself, so it's more adaptable.

Geoswath 4

in 2017, I looked at the raw data and was able to perceive that it was essentially a, pattern recognition problem. So AI was well-positioned to provide the solution.

"We have developed a very good working relationship with the computer science department at University of East Anglia and the result of this is a little button labelled 'AI' on the software GUI, although it has taken two professors, a post doc and two master's students four years to make it happen.

“The traditional approach to processing much larger volumes of data has been to engage a series of filters, to set user defined parameters such as only looking at parts of the water column or ignoring anything with a lower amplitude return.

"By this method, the user effectively draws a box with the filters in the data but if this box is set too tight, it may chop off the top of structures such as rocks or wrecks which needed to be retained. “

"The new AI processing augments the existing automated filtering in the GS4 software by removing surplus and undesired data autonomously."

During acquisition, the system is designed to log clean data in practically real-time, without any user intervention in the cleaning process, enabling better operational agility and decision support as the surveyor on board can make decision based on a live data stream, while cutting the time to final data in post-processing.

Because the processing happens in real-time, users only need to oversee data quality and coverage during acquisition, while at the post processing stage, the focus can be purely on georeferencing the bathymetric data using deterministic calculations.

The final, noise free and high-resolution bathy products will be fully reproducible with minimal human intervention.

"While the AI optimises surveying and subsequent data quality, the fact that it is a free upgrade for GeoAcoustics customers that are on the last version of the software makes it a very attractive proposal. It carries out the processing in real time on the boat. The user only has to feed in the corrected height, to account for the tide, and maybe some sound velocity profiles. It is very simple. We have compared our output with multibeam soundings and the result is virtually identical."

SONAR RANGE

"We have sonars in three frequencies," said Dowdeswell, " which are suitable for rivers, lakes, dams, harbours, coastal areas, t

"The lowest frequency is 125 kilohertz and is used for water depths down to 200m.

"The mid size is 250 kHz which works down to 100m although this is not a strict limit. We have a customer in Switzerland that surveys hydroelectric dams and they go down to 120 meters with a 250 so it's 20 meters deeper than we specify.

"If you think of the beam as a sphere. There is a point where the bottom of your circle gets narrower with depth.

"The smallest is the 500 kHz transducer and designed for use down to 50 meters With a depth resolution of 1.5 mm

"The selection, however, isnt always made on water depth. If the user is surveying a river which is very, turbid and there is a lot of sediment loading, lower frequency sound waves tend to travel a bit better than higher frequency.

"So for example, in Bangladesh where the rivers have a lot of silt in them. We would typically use 250 kilohertz even though it's operating down to 10-15 meters water depth, as the operator can actually see the seabed better."

Nexum Engineering has developed an ROV skid with two heavy-duty drawers. This unit is designed by in 2022 and first units were made spring this year.

It has been developed to be used on the compact work class ROVs such as the Shilling HD and Kystdesign Supporter or similar types. It is 2400mm long and 1580mm wide. Height is 517mm. It is delivered with 3000msw buoyancy and is app 100kg buoyant for payload. It is lifting certified according to DNV 2.7-3 Dry weight is approximately 800kg.

It is designed with interfaces for camerabooms, dredge shelf and backpacks It has drawers in both ends that are interchangeable. The drawers are simply to change out and to be fitted with special tooling, dirtywork packs and other equipment.

The materials used is mainly GRP, PEHD and aluminium. All parts are symmetrical and there is no welding in the unit. This simplifies and reduces spare parts required while making it simple to repair the units on deck. It also make the unit stiff and square as warping from welding is not an issue.

In all four corners the are plates for mounting lights, camera or other equipment with cable hole through the buoyancy to ensure safe routing of cables. In the drawer there is a knife sheet suited for the Nexum Swordfish knife

Swordfish Knife

Skid

NetFix

ROV-DEPLOYED SYSTEM FOR IMMEDIATE REPAIRS ON FISH FARM NETTING DAMAGE

Underwater Contracting (UCO), a leading provider of underwater services to the offshore energy, inspection, construction, and aquaculture markets has developed a unique ROV-deployed system to repair small holes in fish farm nets.

The UCO NetFix repair system places plastic patches over holes in cage netting. Held firmly in position by pegs, the patches remain in place until the hole is permanently repaired by a dive team or when the nets are lifted to the surface.

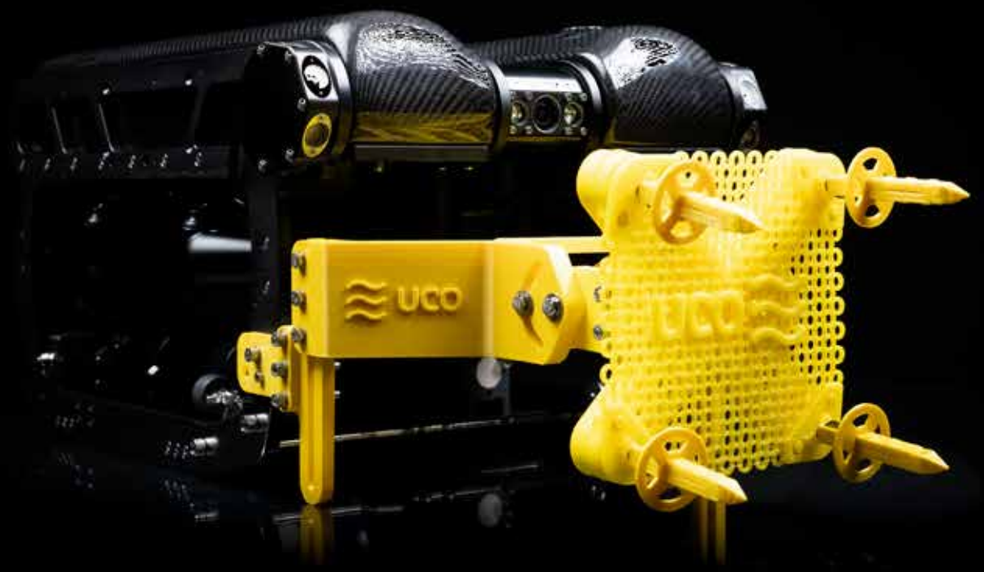
Small holes, which can be made by predators or if equipment becomes snagged during operations, are identified during routine containment checks by ROV or during net washing.

Until now, these would require calling out a dive team at short notice to carry out repairs, a time consuming and expensive process. NetFix uses the onsite ROV to carry out an immediate repair, ensuring containment of all stock.

Deployed using a frame attached to the inspection class ROV, the semi-permanent repair is compatible with on-going net washing activity as the patch sits flush with the inside of the net. Planned permanent repairs by the dive team can then be scheduled. The patches and plugs, which are easily removed by a diver, are reusable.

The deployment frame can be made to fit any regular inspection ROV. Patch size is 200mm x 200mm with peg size dependent on netting size.

The Scottish Government's recently published Vision for Sustainable Aquaculture, which sets out its long-term aspirations for the sector, highlights that innovation across a wide range of disciplines has driven the development of Scottish aquaculture.



360 DEGREE DEFENDER

VIDEORAY AND BLUERING ARE DEVELOPING A NEXT-GENERATION UNDERWATER IMAGING SYSTEM FOR THE DEFENDER ROV

A new imaging system is being developed that will provide an unprecedented level of situational awareness for both autonomy and teleoperations, thanks to a multi-camera sensor package.

The US Navy, a vital partner in this venture, intends to use the 360/multi-camera payload for mine warfare and EOD operations, but will greatly enhance situational awareness during all everyday underwater tasks.

Small ROVs have the inherent advantage of being highly effective in tight and confined spaces. Their limited size,however, means they often only carry cameras with basic tilt or zoom functions. Typically, images from these cameras are displayed on a small screen that's part of a portable control console.

The new system from VideoRay and BlueRing offers a fully-immersive 360deg view around the ROV, allowing operators to monitor underwater surroundings in real-time.

"This is the latest in a series of 3D underwater camera systems we've developed," explained Jake Easterling, Chief Technology Officer at BlueRing. "Initially, we positioned multiple static cameras around the ROV. Now, we've transitioned to a more adaptable setup where camera placement varies based on mission needs.

"We could opt, for instance, to place a wide-angle fisheye lens on one side of the vehicle while using different lenses on its other sides, all depending on what's optimal for the operation at hand."

STOP PRESS

VideoRay has acquired Blue Ring Imaging. The companies say that this will unlock a whole new level of capabilities for the Mission Specialist underwater robots, making operations faster, safer, and more efficient than ever before.

Before this innovation, operators needing such imagery would rely on larger ROVs capable of supporting the weight of numerous commercial cameras. These images would be routed to a control room where a pilot and copilot would sit in front of a large array of screens that provided various views around the ROV and displaying crucial operational data.
The landscape has changed significantly, however, due to the multi-billion-dollar gaming industry's investment in developing advanced virtual reality headsets. When users wear these headsets, they find themselves in the centre of an expansive sphere, able to view any angle within that space by merely moving their heads.

BlueRing has adopted these immersive headset systems as replacements for traditional ROV screens.
Easterling illustrated this point: "Imagine the Navy needs to inspect a pier. Previously, the ROV would either tilt its camera upwards or indeed the entire vehicle, while moving along the survey path. By mounting a camera on the top and flying the vehicle straight, however, we get clear images without the need to fly at an angle. In a virtual reality (VR) setting, operators don't even need to look upwards at the overhead pier – the virtual display can be right before them."

But how simple is it to fit these advanced imaging systems onto smaller vehicles?

Easterling highlighted the VideoRay Defender's modular design as a significant advantage.

"It's designed to support multiple Ethernet-based devices connected to the same network without interference. For our camera system, we connect to their hub, providing the necessary power and data links without extensive integration."

Andy Goldstein, Chief Technology Officer at VideoRay, shared a similar sentiment: "The Defender's design ethos is centred on ease of integration. We've equipped it with a power density that surpasses any comparable vehicle. This design allows the Defender to support a sizable payload, meaning placing cameras throughout doesn't significantly affect its dynamics, buoyancy, or even cabling."

Easterling pointed out a challenge: "Many smaller ROVs possess 100Mbit tethers, sometimes even a gigabit but the limited bandwidth, especially when compared to larger ROVs, can make it challenging to run all the systems. To address this, we've incorporated compression techniques, reducing operational bandwidth to the bare minimum. We can also selectively deactivate video feeds from certain cameras to further optimise bandwidth."

VideoRay's Defender ROV with BlueRing's camera system

AWARENESS

360-degree cameras on unmanned vehicles like ROVs significantly enhance situational awareness. This comprehensive view ensures that autonomous systems can make informed decisions based on their entire surroundings, leading to more effective and safer autonomous missions.

STEREO CAMERA IN UNDERWATER EXPLORATION

Many years ago, the world witnessed the birth of stereo cameras in the underwater camera market. This technological marvel arrived alongside the introduction of 3D televisions in mainstream retail. One of the most significant advantages of stereo cameras is their ability

to allow an appreciation of depth of field.
With such cameras, a pilot could instantaneously distinguish between objects and their relative distances.

Over time, however, the charm of stereo cameras began to fade. One major setback was the need for control room operators, and even the general TV-viewing public, to wear specialized glasses to benefit from the 3D imagery.

Despite this, one group that maintained a keen interest in stereo vision was the US Navy. The Navy discerned that for close manipulator work, stereo vision would always hold an edge over a standard mono camera projecting onto a 2D screen. Their vision was to incorporate this technology into virtual reality headsets.

Easterling, an expert in the field, elaborated on the differences between 3D imaging and a 360-degree view.

> *As the automotive industry has demonstrated, building autonomy capabilities without complete 360deg situational awareness is nearly impossible.*

"The VR headset encapsulates the user in a mono bubble, granting them a full 360deg situational awareness. A simple head turn can give a glance at the surroundings, making manoeuvring in tight environments smoother."

Seamlessly integrated into this spherical environment is the stereo camera, typically aimed forward. By projecting the left camera's image into the VR headset's left viewport (and the right camera's image into the right), users can concurrently view and interpret the stereo vision.

Easterling also highlighted the specific stereo camera design tailored for the Defender, named hyper stereo. "This innovative design brings the two cameras closer than a user's eye spacing. The proximity facilitates a depth of field in the precise 6-24 inch range, matching the Navy's requirements for manipulator arm operation on their vehicles.more than just visual displays. It can represent telemetry data, such as altitude from the seabed, in a visual format within the headset.

These cameras are far from ordinary. Each camera is embedded with the latest in video computing, facilitating algorithms for target recognition and generating point clouds for underwater environmental mapping.

The vision for these innovations is clear. "By introducing imaging systems, once exclusive to work-class vehicles, to smaller and more nimble defenders, we anticipate a significant shift in underwater mission approaches," said Easterling.

Currently, the team is undergoing in-water testing with the first prototypes. This phase will soon lead to user evaluations in San Diego with the Navy, scheduled for early next year. Every feature, including the number and placement of cameras, needs validation through empirical data.

The Navy's ongoing projects also hint at a shift in operational methodology. Easterling describes the difference between 'human in the loop' and 'human on the loop."The former represents passive human awareness, while the latter suggests a supervisory role where humans command vehicles within set parameters."

DEEPTECH

Deepwater services and intervention specialists, DeepTech, has expanded its fleet with three work class ROVs, bringing its total number to 26 vehicles.

The Triton XLS ROVs, which operate at 150 horsepower and a depth rating of 3000 meters, add diversity and flexibility to allow DeepTech to continue to support its worldwide portfolio and expand its business further in the Eastern Mediterranean.

The company forms part of the MCS Group and, as well as work and inspection class ROVs, the fleet includes MiniSpector mini-ROVs which are designed and built in-house from its shared Innovation House.

Managing Director of DeepTech, Ahmed Soliman, said: The addition of these work class ROVs add to our overall fleet capacity and balance, which allows us to be even more responsive to our customers' needs.

"As well as these additional work class vehicles, we are currently building a further two MiniSpector systems, which will bring our total of these mini-ROVs from 8-10.

Triton XLS ROVs

"Innovation is in our DNA and our ROV services and intervention can be enhanced by our group's ROV software, including our state-of-the-art Photo Realistic 3D Cloud (PRC) technology, which is built-in to the MiniSpector, and provides underwater imagery as accurate as the human eye but without the human risk."

This gives us a further competitive advantage to enhance inspection and maintenance."

MOHICAN CONTRACT

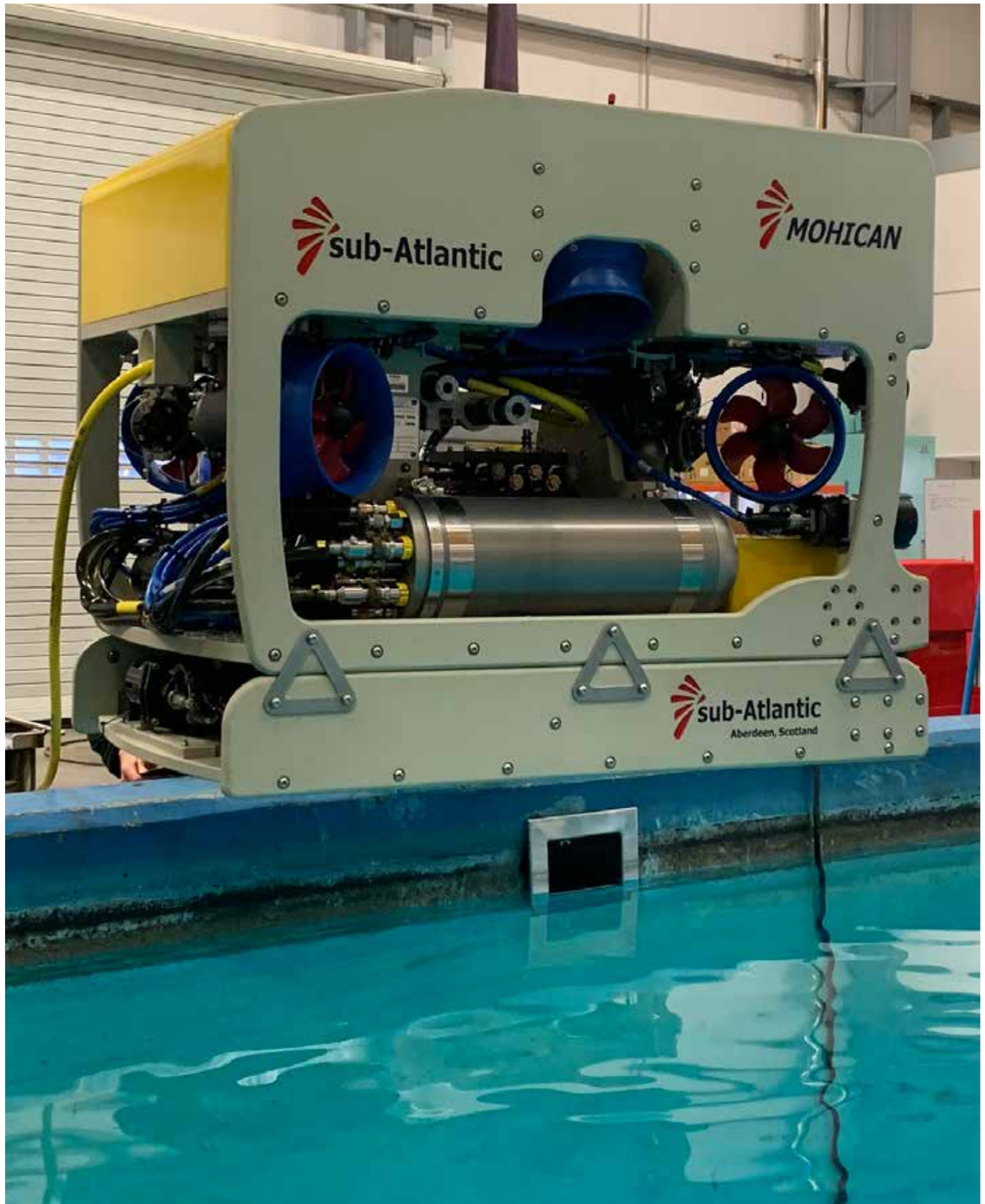
Forum Energy Technologies (FET) secured a contract from the Memorial University of Newfoundland to supply an electric observation-class remotely operated vehicle (ROV) to its Fisheries and Marine Institute (MI), School of Ocean Technology.

The primary function of the Sub-Atlantic Mohican ROV system will be to support ocean research, while it will also be used for pilot technician training. For ocean research operations, the ROV will be required to carry a payload skid for navigation, equipment and sensors, as well as be capable of manipulation and intervention.

The Mohican is equipped for inspection tasks, non-destructive testing, (NDT), light intervention, pipeline/cable/seabed survey, diver assist/safety, harbour and port security, scientific survey and data collection, renewable energy projects, civil engineering, long tunnel excursion and for inland waterways.

The ROV was manufactured at FET's UK facility at Kirkbymoorside, North Yorkshire, and delivered to MI this year.

Kevin Taylor, FET vice president - subsea vehicles, said: "FET has a strong reputation as a single source for manufacturing and delivering high-quality, robust vehicles and associated auxiliary products which are suited to underwater industry applications. As well as defence, this includes oil and gas, renewables, telecommunications, mining, aquaculture and academia.



This contract demonstrates the value our vehicles can also offer to scientific research projects.

"We are very proud that Memorial University recognises our capabilities and reliability. I am looking forward to seeing our system provide the required operational resilience and performance standards expected in such an important sector."

Joe Singleton, interim Head for the School of Ocean Technology at the Marine Institute of Memorial University, said: "The acquisition of the FET Mohican ROV system vastly increases our capability to complete scientific observation and sampling research work up to depths of 2000 m.

The ability to add additional sensors, cameras, and equipment to the payload makes it versatile for all anticipated expeditions. For our students completing the ROV Technician program, this comprehensive system provides a great experiential learning platform for maintenance, repair, integration, and operations."

The Mohican ROV has a 2,000m depth rating and with TMS Garage system, is suited to inspection, survey repair, oceanographic research and subsea maintenance tasks. Ancillary tools and sensors can also be added to the vehicle for survey and light intervention work. The Mohican is equipped to a high specification with a four function manipulator arm for complex underwater procedures.

The ROV supplied also has precision measurement and navigation systems, HD & SD cameras, LED lighting and sonar for low visibility operations. Emergency location systems fitted include VHF beacon, combined with flasher.

The system was supplied complete with a 20' control container, Launch and Recovery System and comprehensive spares package.
FET's Sub-Atlantic range of ROVs are class leading and provide users with immense reliability and capability.

FOOVER

Owners of the world's largest fleet of Saab UK's Seaeye Falcons, Underwater Contracting (UCO), has ordered a further six Falcons, boosting their fleet to 33 vehicles.

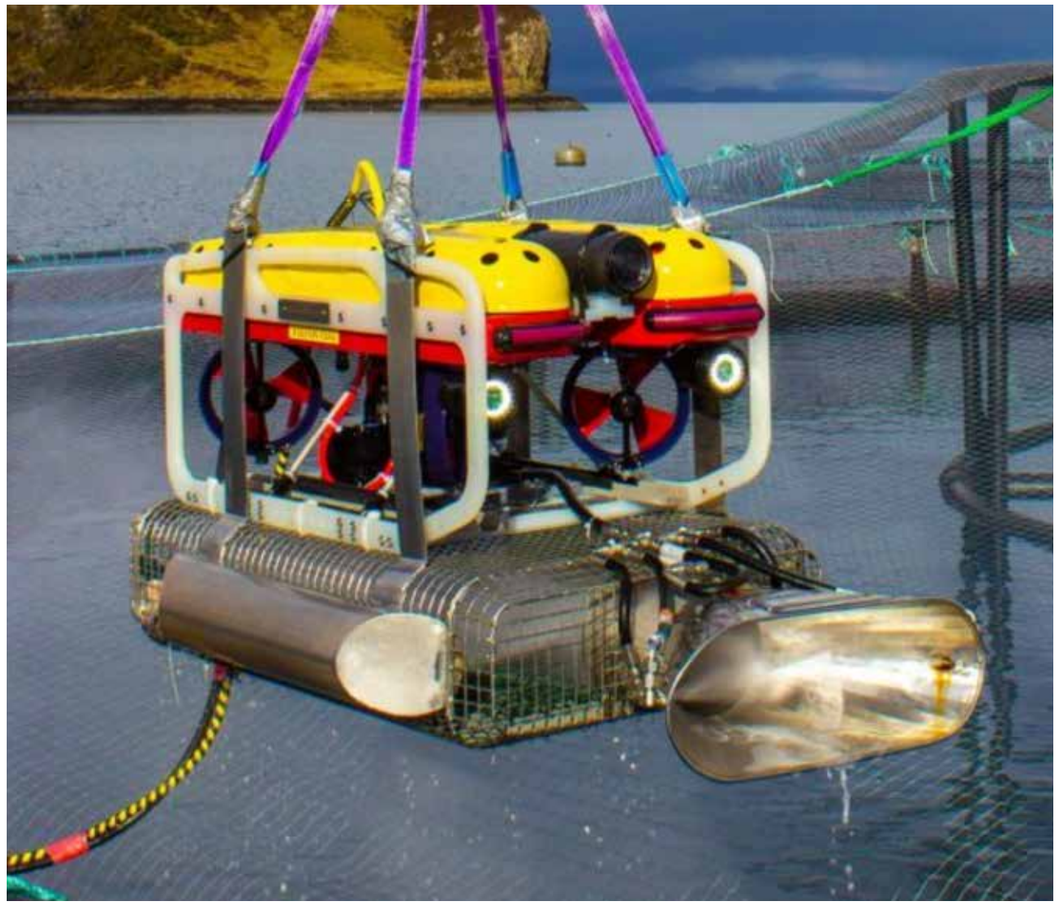
This follows the award of further major contracts in the aquaculture, renewable, and oil and gas sectors to UCO that will see the Falcon fleet working continuously over multi-year contracts providing a range of services.

Specialists in ROV operations, UCO has successfully deployed Seaeye Falcon underwater vehicles since 2018 across three continents covering various sectors of industry.

In that time UCO has productively utilised the power and intelligence of the Falcon system when designing and developing industry-leading technologies, including their FOOVER Mortality Recovery system, NETFIX Net Repair system and G-LANCE Cage Cleaning system, inspection cleaning tools.

They chose the Falcon as the world's top selling underwater robotic vehicle in its class and for its versatility.

The Falcon is designed and manufactured at Saab UK's Fareham site.



AIRCRAFT WRECKS IN TRONDHEIMSFJORDEN

Jonas Follesø / Chief Technology Officer, Blueye Robotics shared the first images and some of the history of the aeroplanes BV-222-Wiking-V2 and the HE-115 S4+DH after discovery by the 1st Minesweeper Squadron of the Royal Norwegian Navy. A team at Blueye Robotics have conducted several dives with underwater drones in the fjord to capture the first close-up images of the sea-planes in around 80 years

In the autumn of 2022 and winter of 2023, the Royal Norwegian Navy's HUGIN Team 1 discovered two new aircraft wrecks in Trondheimsfjorden. The wrecks were located with the assistance of the Hugin AUV programmed to map the seabed over a large area using sonars.

The aircraft wrecks had never been previously visited by divers or submersibles. This autumn, Blueye conducted several dives on both aircraft.

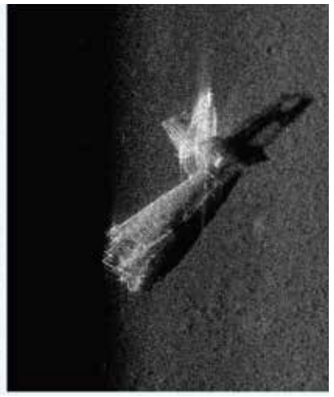
Hugin is an AUV produced by Kongsberg Maritime can dive down to the depth of 6000m and use sonars, echosounders, and cameras to map the seabed. It can be pre-programmed to search over a large area at a given altitude above the seabed.

The 1st Minesweeper Squadron has two container-based autonomous mine-hunting systems based on the Hugin, which can be loaded onto different ships as needed. In 2022, the HUGIN Team 1of the 1st Minesweeper Squadron located the BV-222 aircraft at a depth of 318m. In March 2023, they found the HE-115 at a depth of 253m, just a few kilometres from the city center of Trondheim.

HUGIN container Photo: Helene Synes / Forsvaret

Hugin needs to maintain a certain distance above the seabed to avoid the risk of getting stuck in the wrecks. The Minesweeper Squadron had not obtained close-up images of the aircrafts until Blueye was able to document the wrecks with two X3 underwater drones.

Sonar scan of the BV-222 fuselage captured using Hugin AUV.
Photo: HUGIN Team 1 / Forsvaret



Sonar scan of the BV-222 tail section captured using Hugin AUV

NTNU (Norwegian University of Science and Technology) has extensive experience with the combination of Hugin AUV and Blueye ROV. In 2022, they collaborated with FFI (Forsvarets Forskningsinstitutt) on "Mission Mjøsa".

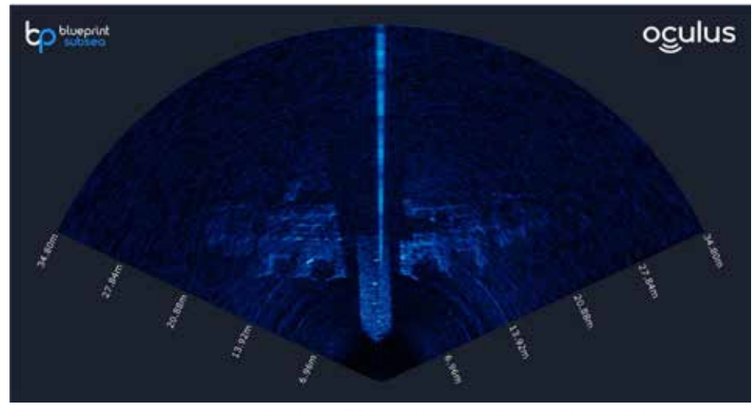
Hugin was used to map the lake bottom, while Blueye underwater drones were deployed to quickly investigate interesting findings. During the mission they discovered what could be the oldest known wreck in Norways largest lake.

The first wreck discovered by the Minesweeper Squadron, was quickly identified as the legendary Blohm & Voss BV-222 Wiking V2 seaplane. This 6-engine aircraft was the largest German seaplane operational during World War II. Originally built as a passenger plane, only 13 of these aircraft were ever produced. The massive aircraft has a wingspan of 46m, a length of 37m, and a height of 10.9m.

After Germany's surrender in May 1945, two BV-222s were found in Sørreisa. Both were flown to Trondheim in June 1945.

BV 222C-012 was transferred to the British Royal Air Force (RAF) base in England. The BV 222 V2 remained in Trondheim where the U.S. Naval Flight Test Division conducted test flights but found little use for it. After experiencing engine problems, on the British decided to sink the aircraft. It was filled with surplus material from the old German seaplane harbour in Islvika, towed out into Trondheimsfjorden, and sunk. Since then, the exact location where the aircraft went down has remained unknown.

Local diver Kaj Sjølie had been searching for the wreck for decades but in 2003, he believed he had finally found the BV-222 at a depth of 60m off Munkholmen. This, however, turned out to be the wreck of the Short Sunderland, which Blueye later visited numerous times.
The discovery of the Short Sunderland in 2003 led to new information about the BV-222 surfacing. Gunnar Bjørnshol told Adresseavisen that he had photographed the sinking of BV-222 from his home in Sverresli in 1945. He mentioned that he had tried to locate the exact spot on the sea



Sonar image captured using Oculus M750d multibeam. Photo: Blueye Robotics

chart where the aircraft went down and estimated it to be at a depth of 300 to 350m. This estimation proved to be accurate. Almost 77 years after the aircraft was sunk, it was rediscovered at a depth of 31m, approximately 1.5 nautical miles north of Østmarktangen lighthouse.

The fact that the wreck lies at a depth of 318m makes it the deepest wreck ever visited by Blueye. One of the success factors for operating at such depths is keeping the boat steady. To achieve this, Blueye installed an electric MotorGuide GPS outboard motor on the bow of its 19ft Buster boat. This motor ensures that the boat remains in the same position without the need for anchoring or using the boat's main engine.

The Oculus M750d multibeam sonar was helpful in quickly locating the wreck as ther ROV approached the seabed. Visibility can be poor, and during the 10 minutes it takes to descend to 320m.

Deep water coral growing on the propeller. Image: Blueye

The aircraft lies upside down on the seabed, submerged about half a meter into the soft sediments. The fuselage has broken in two on its way down, and the tail section is located 250m away from the wing section.

All six engines are still attached to the wings. Where the tail has broken off, it is possible to enter the fuselage using the small Blueye ROVs.

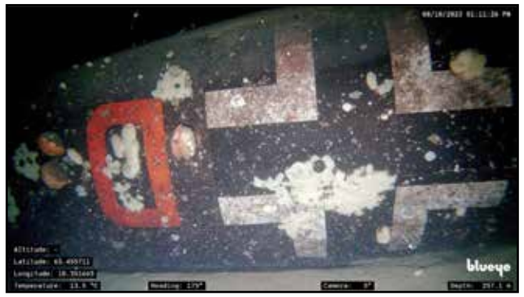
HEINKEL HE-115 S4+DH

The second new aircraft found was a Heinkel HE-115. There are two HE-115 aircraft wrecks at a depth of about 40m in Ilsvika, where the Germans had a seaplane base during World War II. However, this time, the new discovery is at a depth of 253m off Høvringen and a bit further out in the fjord. This is an entirely new find that had not been previously known.

The Justice Museum conducted a thorough investigation of the discovery and identified the aircraft as S4+DH. This was one of the 15 HE-115s that took off from the island of Sylt on the west coast of Schleswig-Holstein on April 9, 1945, bound for Trondheim. The aircraft were to operate from Trondheim as reconnaissance planes along the coast from Trondheim to Nordkapp.

In Trondheim, the 15 aircraft arrived in several groups. The Landing went smoothly for 14 of the planes, despite some damage to the pontoons due to the rough sea.

HE-115 S4+DH in air flying towards Trondheim. You can clearly see the "D" markigns on the fuselage.
Photo: Arkiv Halvor Sperbund

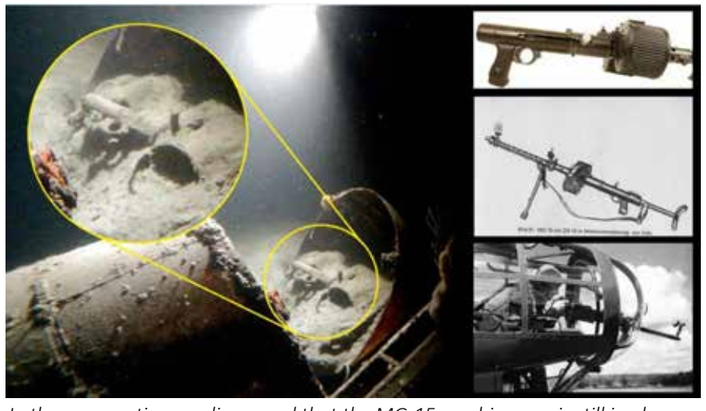


The same HE-115 S4+DH resting at 257 m depth. The "D" is clearly visible on the fuselage.
otics

Above one of the wings. Photo: Blueye Robotics

On the way north, the aircraft was fired upon by an English Sunderland flying boat from the Royal Air Force, and the aircraft sustained damage to the fuselage and pontoons, forcing the Heinkel to land quickly.

The pilot attempted to land the aircraft on the fjord northwest of Munkholmen, but the landing failed, and the aircraft went up on its end and quickly sank. Research has shown that this was not considered a war grave.



In the nose section we discovered that the MG-15 machine gun is still in place.
Photo: Blueye Robotics

The aircraft wreck lies upside down on the seabed. The wings and engines are attached to the fuselage. The glass dome at the front of the cockpit has come loose but appears to be mostly intact.

On the fuselage, you can clearly see the identifier "D" painted in red next to the beam cross under the wings. Like wrecks, a thriving marine life community has settled around and on the wreck, including jellyfish, shells, sponges, deep-sea corals, shrimp, ling, and cusk.

Since day one, exploring what lies beneath the surface has been a driving force for the Blueye team.

"As our technology has matured, we have expanded our reach to go deeper and operate longer," said Mathilde Holand COO, Blueye. "The integration of additional payloads such as underwater positioning and sonars allows us to quickly locate wrecks even at great depths. Over time, we have become well-acquainted with some of the history lying on the bottom of Trondheimsfjorden.

"It has been nearly 80 years since World War II. Above water, most traces have disappeared. Underwater, however, we can still see the ship and aircraft wrecks as tangible reminders that Norway was once occupied and at war not too long ago.

Saltwater and the forces of the sea are taking a toll on these wartime relics, and their condition is rapidly deteriorating. Documenting and sharing local history is an exciting and

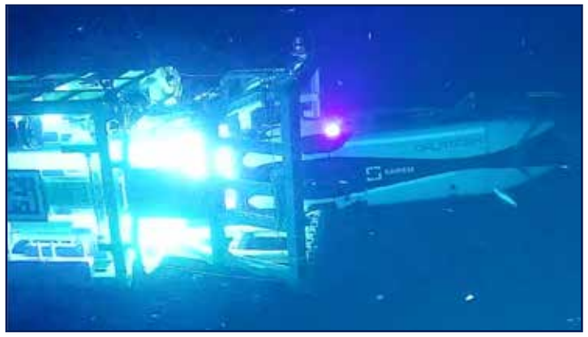
SAIPEM MILESTONE

Saipem's resident subsea vehicle HYDRONE-R has entered into operations for the first time. Following an extensive testing campaign, the company has obtained full acceptance from Equinor to commence subsea inspection and intervention services in the Njord-A field.

This is part of a 10-year contract signed with Equinor that provides for the use of the Hydrone-R and the electric Hydrone-W Work Class ROV on Njord. It will provide ROV and UID services to support drilling operations, as well as a complete plan for inspections and interventions on Njord Field subsea structures (such as pipeline end manifolds (PLEM), flow lines, umbilicals and riser bases, etc.).

The Hydrone-R and Hydrone-W will be controlled from both Njord-A and from an onshore control station using Sonsub proprietary remote control technology.

● One part of the Hydrone family is FlatFish, the ground-breaking subsea robotics system conceived to support remote, vessel-free operations conceived to reduce costs,



Flatfish

risks and environmental impact of offshore activities (90% fewer CO2 emissions compared to conventional ROV services). This won the 2023 Spotlight on New Technology Award by Offshore Technology Conference

It can work in 3000m water depth at speeds of 4kts with up to 48hrs autonomy. Horizontal inspection range is 180km.

Hydrone-R

MANTARAY

There are two main ways of collecting seismic data used to images structural geology underneath the seabed.

Up until recently, perhaps the most commonly used way has been to employ seismic streamers towed behind a boat. A *source* such as an air gun sends acoustic energy down through the sea and into the seabed. Some energy is reflected from the strata and back up to the seismic streamer. Other packets of energy pass through to be reflected by deeper layer boundaries. The transit time related to the depth of the reflection.

Towing the streamers in a two-dimensional grid at the surface results in a three dimensional image. If it is possible to return later shoot exactly the same seismic, so-called 4D or time-lapse seismic, this shows how a reservoir changes over time.

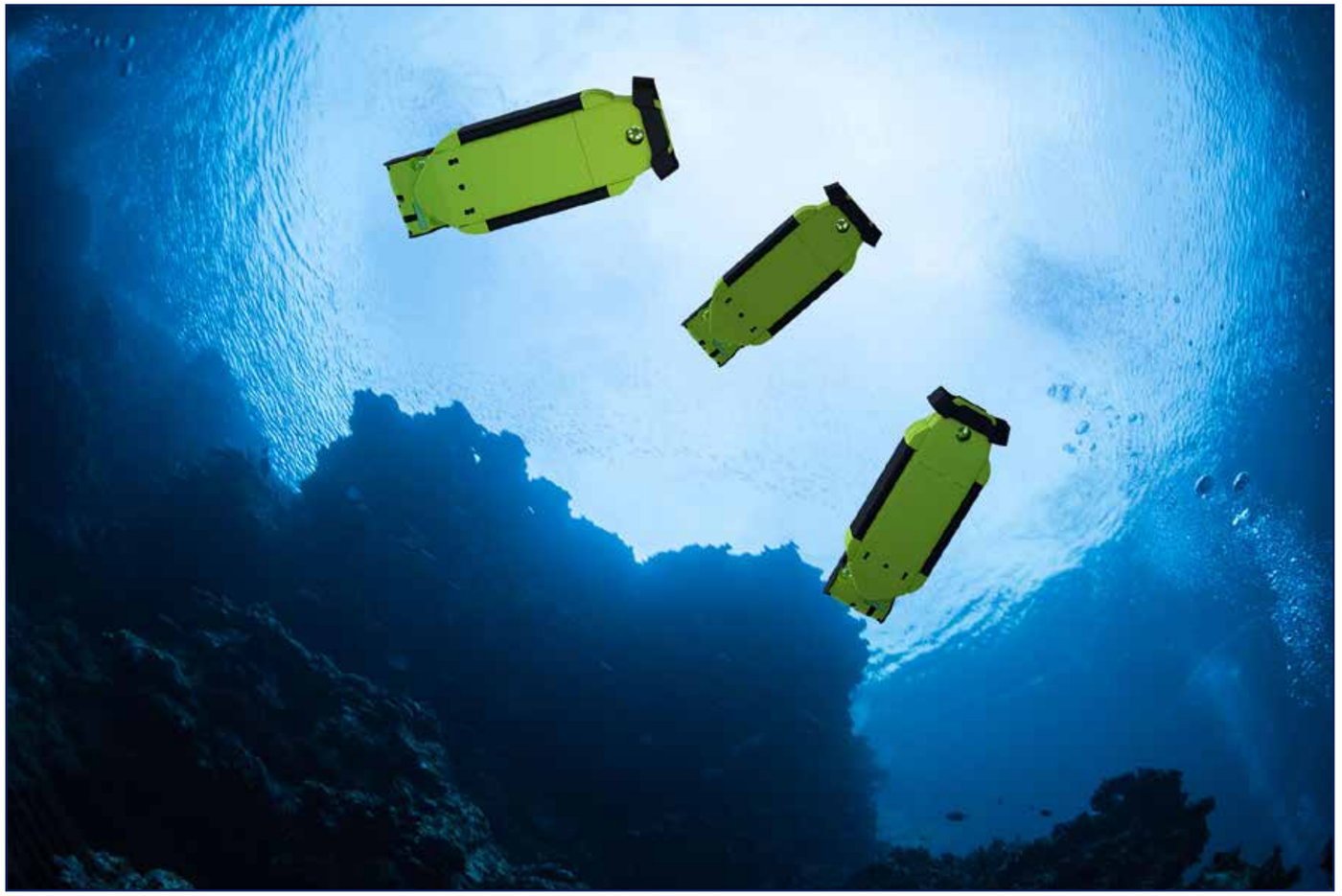
In more recent years, an alternative has emerged in which the streamers are effectively replaced by ocean bottom nodes (OBNs). Lying on the seabed, these are more accurate than streamers because the seismic signal is not attenuated by it having to pass up through the water. Importantly, when re-shooting the seismic over time, the position of the nodes do not change and so the results are considerably more reliable.

An important feature of the node, as opposed to a long streamer, is that it is possible to get a full 360deg azimuth reading.

Early OBNs were connected together by cable, the so-called ‘node on a rope’ but this arrangement was largely unsuitable for large areas because of the need for so much cable. It was also not particularly appropriate from an environmental viewpoint, because installation involved placing equipment along the sea floor. This action could damage delicate reefs or seabed habitats, and if the line was laid over a producing field, it could also impact with cables or pipelines already on the sea floor.

'Node on a rope's were efficient in the inline direction but not particularly in cross-line. This prompted the industry to look at more self-contained OBNs that could be placed anywhere although normally in a grid with an equal space between them. These nodes were installed using an ROV.

“ROVs are versatile instruments for underwater operations, but not particularly suited for placing numerous objects on seafloor because typically move at a speed of around 1kt” said Erik Burlid, Sustainability & Communication Manager at PXGEO. The deployment and especially the recovery of these OBNs, however, would be very applicable to the latest generation of hovering AUVs.



SABERTOOTH

“ For many years, we have been aware of the type of vehicles produced by the Swedish underwater vehicle manufacturer and considered that their Sabertooth, vehicle would potentially suit requirements. It was able to move fast and hover, but there was also enough space on the large hull form to attach our OBN launch and recovery skid. We started to work closely together with Saab to add some extra thrust top the baseline vehicle. We also installed a variable buoyancy system on the side in order to make the laden structure neutrally buoyant. The result was the MantaRay.

“The installation capacity of the MantaRay depends on the size and weight of the individual nodes – there are a few different nodes currently available on the market," said Burlid "Our current deep water node is called the Manta 3000 node because it can operate at water depths to 3000m. We can accommodate around 18 of these nodes in the skid.

"Alternatively, there are nodes more applicable for use in shallow waters. They are smaller and lighter and as such, the skid could carry nearer 40 of these. The vehicle is essentially node agnostic. If a customer that has a preference for one node, we can deploy and recover it with just a few modifications to the skid underneath the vehicle. The rest of the vehicle is the same."

The HAUV will autonomously deploy the full suite of nodes, closely following a pre-programmed mission with the grid formation being designed for the specific survey.

In association with Saab, PXGEO has developed an advanced obstacle avoidance system. If, during the mission, any obstacle is detected that was not already identified in the pre-planning stage, this will initiate to allow the MantaRay to autonomously navigate the vehicle around the obstacle.

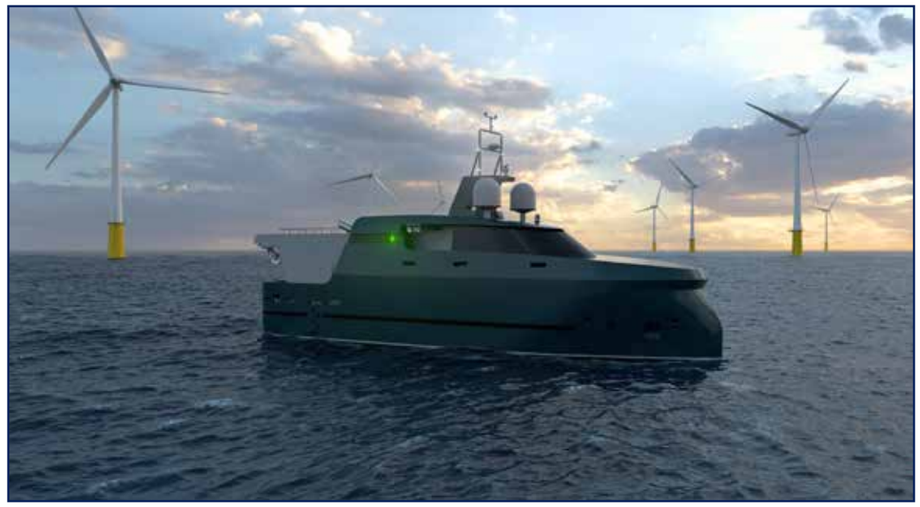
When picking up the node, a purpose-developed shape-recognition system incorporating advances in machine learning will help the vehicle identify the node and position. The physical removal of the node is carried out using a suction tool in the node skid.

"The principal advantage of using an HAUV is the speed of deployment. The vehicle moves at around 5kts but another advantages of the design we have devised is that no time, does it come into contact with the seabed," said Burlid. "The original method of using an ROV often required the underwater vehicle to land on the seabed and deploy the node from buckets at the front of the vehicle. These ROVs were also often hydraulic vehicles, which were quite efficient in operation, but there was always the fear of a leak, sending hydraulic fluid into the water. The MantaRay is a fully electronic vehicle removing any risk of leaks of hydraulic fluids.

"The efficiency of this new type of ocean bottom node deployment vehicle will significantly reduce the survey duration and in turn lower any operational exposure and lower the projects CO2 impact," said Burlid.

USV

USV AS



USV AS has contracted Astilleros Gondán shipyard to build an unmanned surface vessel (USV), capable of significantly reducing emissions and operating expenses compared to conventional vessels utilised for subsea inspection, maintenance and repair (IMR) work.

USV AS is a joint venture company established by DeepOcean, Solstad Offshore and Østensjø whose main purpose is to invest and own USVs.

It is estimated that the USV solution can reduce CO2-emissions with more than 90 percent compared to a conventional offshore vessel when conducting subsea IMR operations.

30 DAYS WITHOUT REFUELLING

The JV concept development for the USV began in 2018, and has been conducted in close collaboration with clients, Salt Ship Design, technology providers, and the relevant authorities to enhance the capabilities of the USV. Maritime Robotics will deliver the system that enables autoremote control and navigation for the USV.

The USV is 24 metres long and 7.5 metres wide. A hybrid diesel-electric propulsion system, which also includes a battery package from Seam, will allow the unmanned vessel to operate offshore for up to 30 days without charging or refuelling. It will be equipped with a work ROV that is capable of operating down to 1,500 metres water depth.

The USV will be remotely controlled from shore – but will have many autonomous features to ensure safety and integrity of the spread. It can operate in severe weather conditions. During operations, both the USV vessel crew and ROV operators will be co-located in the same remote operating centre.

“With our new USV, we are moving the captain onshore who will still remain in control over the offshore operations.

"We will operate the vessel and the ROV from an onshore remote operations centre. This is an excellent way of reducing cost, CO2 footprint and limit personnel

exposure to offshore operations," adds Øyvind Mikaelsen, Chair of USV AS and CEO of DeepOcean.

Håvard Framnes, Investment Director at Østensjø, says: "It is fantastic that we are able to provide new technology to the market that not only reduces emissions significantly, but also reduces costs and increases safety in offshore operations. This shows that the Norwegian offshore cluster is at the forefront of the energy transition. We have good experience in doing business with Solstad Offshore and DeepOcean, and we are pleased to grow the cooperation with this new winning technology."

Novel launch and recovery solution
To increase the USVs workable weather window, it is equipped with a newly developed launch and recovery system which allows for work class ROVs to be operated from relatively small vessels, such as the USV.

"Protecting the integrity of the ROV and its tooling is key to be able to deliver reliable and safe, unmanned offshore operations. This is the cornerstone in developing this launch system instead of conventional moonpool or A-frame systems," says Øyvind Mikaelsen.

In addition to the ROV, the USV will be equipped with a sizeable tool package to perform subsea operations. The USV will be capable of handling most of all subsea inspection work and a significant part of subsea intervention tasks.

Delivery of the USV is expected by the end of 2024. The plan is that the USV, following offshore testing, will be ready for operations in 2025.

DEEPOCEAN USV

Ocean services provider DeepOcean has entered into a long-term charter agreement for a newbuild unmanned surface vessel (USV) which will be utilised for subsea inspection, maintenance and repair (IMR) and survey work in the offshore renewables and oil and gas industries.

"The USV can be a game-changer for subsea inspection and intervention work, offering substantial reductions in operating expenditure and emissions. We are delighted to add the USV to our fleet of chartered vessels," says Øyvind Mikaelsen, CEO of DeepOcean.

ROV AND TOOLING

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DeepOcean has set a target to achieve a 45 percent reduction in CO_2 emissions before 2030 and become carbon neutral by 2040.

RC DOCK

RC Dock has delivered its first fully classed offshore Uncrewed Surface Vessel (USV) designed for Inspection, Maintenance, Repair (IMR) and survey operations.

The company claims that this 12m catamaran represents a new era in offshore marine automation, delivering unparalleled efficiency, safety, and sustainability. It offers flexible and sustainable inspection and survey solutions.

The USV has been proven in harsh North Sea conditions during winter 2022-2023, demonstrating over 90% less CO_2 emissions than conventional offshore vessels.

"At 25 tons, we've successfully created Europe's largest commercial and class-certified USV, providing a stable and safe platform for offshore wind farm inspections and multi-sensor deployment with a 5-ton payload capacity" said Ronald Kraft, RC Dock founder.

MODULAR TWIN HULLS
The twin hull design enables easy and low-cost mobilisation. By designing the hulls to fit within standard shipping containers, transportation becomes both efficient and environmentally friendly.

This containerised solution is recognised for providing the lowest CO_2 emissions/ ton of cargo transported, making the most efficient and environmentally form of commercial transport.

INSPECTION / WORK CLASS ROV CAPABILITY
Equipped with an in-house developed launch and recovery system, the USV can host Inspection/Work Class ROVs. This enables real-time, over-the-horizon (OTH) remote-operated underwater inspections and repair work, broadening the vessel's utility in maritime operations. It can also manage the towed sensors, specifically for ROTV (Remotely Operated Towed Vehicle) operations. This system allows for precise deployment and management of towed sensors, providing more reliable and low-cost data collection.

SURFACE AND SUBSEA IMAGERY
The vessel's surface and subsea imagery sensors facilitate detailed observation and monitoring of marine assets. Integration with AI-supported classification and 3D image technology allows the vessel to accurately identify and model above- and underwater objects. This aids in everything from underwater security, infrastructure inspection to critical asset protection.

100% BIOFUEL AND HYBRID PROPULSION SOLUTION
In line with the growing emphasis on sustainability, the USV is powered by a combination of 100% biofuel and a hybrid propulsion system. This green technology allows for carbon-neutral operations for over 30 days, with a 10kt transit speed and a 7kt survey speed.

INTELLIGENT REMOTE OPERATIONS
Leveraging RC Dock's extensive operational experience in the North Sea, the USV enables intelligent remote survey solutions and the automation of tedious manual tasks. This innovation achieves significant time and cost savings for clients while reducing offshore HSE risks and carbon emissions.

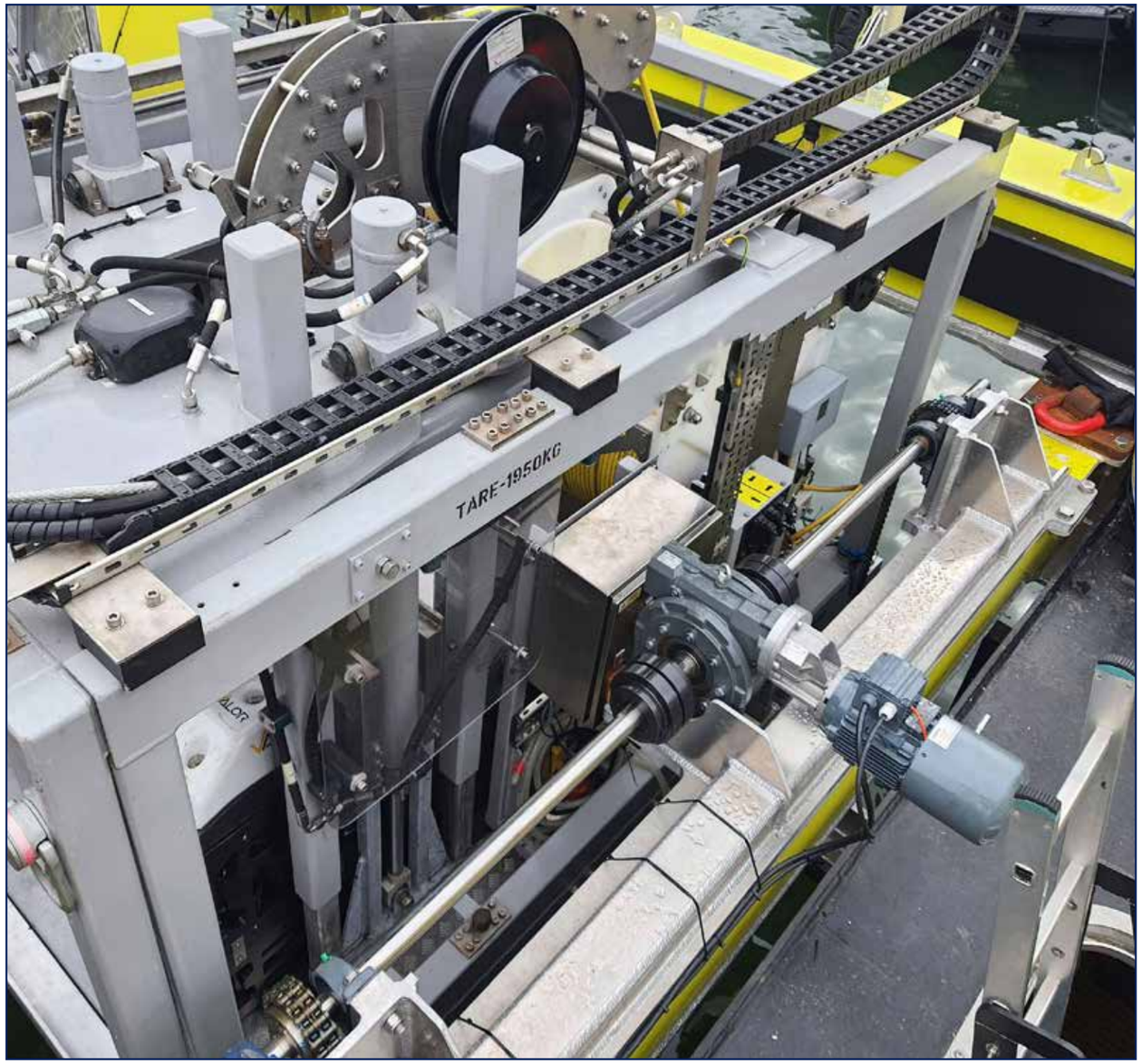
"A Master and qualified watchkeepers monitors the USV 24/7 from a control center onshore. Even by deploying different autonomous functions to the vessel control systems, such as collision avoidance and AI-supported image recognition and avoidance functionalities, RC Dock emphasizes the importance of keeping 24/7 human operators in the loop.

This approach increases safety assurance towards our customers, especially when operating in traffic-congested areas and during complex offshore projects. Rather than removing the crew, we're relocating them onshore where they can perform their tasks without risking the open seas for monotonous inspection duties," adds Kraft, underscoring the benefits of remote-controlled unmanned operations.

FUTURE PLANS AND PARTNERSHIPS

RC Dock's first offshore-classed USV was built for Middle East-based Sovereign Global Solutions. Additional units are on order and planned for delivery in late 2023. A larger 23mr sister vessel USV is set to debut in 2024.

This force-multiplying USV will have the capability to operate multiple units from a mother vessel, even under the challenging weather conditions of the North Sea.



SAILDRONE SAILS BACK INTO THE EYE OF THE STORM

In the early morning hours of Sept. 30, 2021, the Saildrone team, along with science partners at the National Oceanic and Atmospheric Administration (NOAA), watched as Saildrone Explorer SD 1045 sailed closer and closer to a category 4 hurricane. The goal was to get the vehicle inside it.

Battling massive waves and winds over 100 mph, SD 1045 not only survived Hurricane Sam intact but collected important data about the physical interactions between the ocean and atmosphere that revealed new insights about hurricane intensification.

This summer, SD 1045 has been redeployed for the 2023 Atlantic hurricane season to continue its mission at the forefront of cutting-edge hurricane research.

OCEAN ROBOTICS CONTRACTS

NOAA (National Oceanic and Atmospheric Administration) has chosen Open Ocean Robotics, in collaboration with the 1stMission Team, as one of the awardees for all three Multiple Award IDIQ (Indefinite Delivery, Indefinite Quantity) contracts.

These contracts, through NOAA's Office of Marine and Aviation Operations (OMAO) Uncrewed Systems Operation Center (UxSOC), encompass three critical areas: 1) Meteorological and Oceanographic Observations, 2) Living Marine Resource Surveys and Research, and 3) Ocean Exploration and Characterization.

The contracts mark a significant milestone, enabling Open Ocean Robotics to provide Uncrewed Maritime Systems (UMS) Services to NOAA, enhancing their capacity for efficient and effective coastal and open ocean monitoring.

This partnership will allow the simultaneous collection of oceanographic and atmospheric data over vast areas, supporting various initiatives, including research, exploration, maritime domain awareness, environmental protection, and weather forecasting. The three-year ordering period, commencing on September 1, 2023, and concluding on August 31, 2026, holds the potential to generate millions of dollars in revenue for the Team. These contracts underscore Open Ocean Robotics' commitment to advancing ocean science and environmental stewardship through innovative UMS solutions.

"Open Ocean Robotics is excited to embark on this collaboration with NOAA,"" said Andy Ziegwied, Director of Sales at Open Ocean Robotics. ""This award reflects NOAA's confidence in Open Ocean Robotics and its strategic partnership with the 1stMission Team. Together, we aim to further NOAA's mission of understanding and conserving the nation's vital marine resources."

OCEANEERING DRIX

Oceaneering will purchase its first DriX USV from Exail 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 litres of fuel usage per hour, when compared with a crewed vessel, thereby reducing carbon emissions.

RAMPUS

Turkish company Sonitus has unveiled Rampus, a versatile underwater reconnaissance vehicle designed to conduct its operations up to a depth of 1000m. It can operate along a predefined route, controlled remotely. When out of the range, however, it is designed to work autonomously.

It can be used to perform various missions, such as mine detection, intelligence and surveillance, seabed mapping, pipeline and subsea structure inspection, oceanographic and hydrographic surveys, debris area mapping and search and rescue operations.

With its deep-water sealed hull structure, the AUV is designed to operate in harsh sea conditions. It incorporates energy systems optimised for long-term missions and is capable of covering long distances.

AUV

REMUS 620

The National Oceanic and Atmospheric Administration (NOAA) recently ordered two REMUS 620 unmanned underwater vehicles (UUVs) from Huntington Ingalls Industries (HII).

The customized, medium-class UUVs will be built by HII's Mission Technologies division in partnership with W.S. Darley and delivered in 2024.

The REMUS 620 has a battery life of up to 110 hours and a range of 275 nautical miles, providing unmatched mission capabilities for mine countermeasures, hydrographic surveys, intelligence collection, surveillance, and electronic warfare.

"The REMUS 620 is the first medium-class UUV designed to accurately deliver this range of advanced above- and below-water effects at long range," said Duane Fotheringham, president of Mission Technologies' Unmanned Systems business group. "We are excited to build these vehicles for the U.S. government, supporting the mission of our long-term customer, NOAA."

The vehicles will be customized with a synthetic aperture sonar (SAS) module, additional energy modules, and auxiliary equipment.

NOAA will use the REMUS 620 vehicles for higher-resolution mapping of the Gulf of Mexico and its effort to restore the seafloor habitats damaged by the 2010 Deepwater Horizon oil spill. The agency has previously used other REMUS models for habitat characterization, marine archaeology, and other ocean mapping and exploration activities.

THREE HUGINS FOR ARGEO

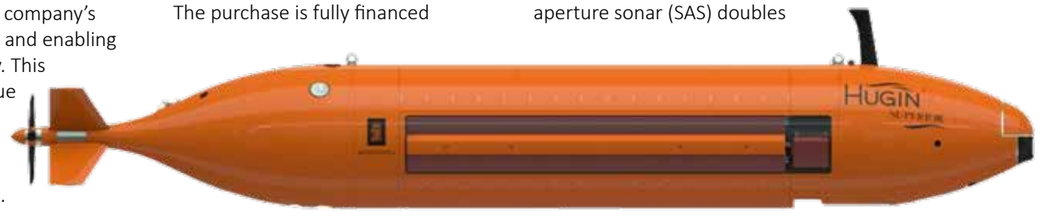
Argeo has received a letter of Intent for the purchase of two Hugin Superior AUVs and one Hugin 6000 AUV.

The first Hugin Superior is scheduled for delivery early Q4 2023, and the second Hugin Superior in Q1 2024. The full scope delivery will be finalized with the Hugin 6000 in Q1 2025. Argeo's AUV fleet will thus consist of a total of 7 units by 2025, amplifying the company's operational capacity, and enabling superior productivity. This puts Argeo in a unique position within both the marine minerals, oil and gas and the renewables segment.

"The introduction of these highly advanced AUVs from Kongsberg, with Argeo's advanced sensors systems integrated is a strategic move that propels us ahead of the competition. With this purchase, Argeo will be a leading commercial player with the Hugin Superior's in its fleet and these additions are significantly enhancing our operational capacity and reaffirming our industry leadership", says Argeo's CEO Trond Crantz.

The purchase is fully financed through a lease agreement with and international financing partner and has a lease term of 4 years. The total financing deal size is US€25m and is subject to Argeo Board approval and final signing.

The Hugin Superior brings unique capability and productivity through its increased coverage and long-range sensors. The Kongsberg HISAS 1032 Dual Rx synthetic aperture sonar (SAS) doubles the area coverage from 500m of previous systems up to 1000m range for the Superior, in the same high-resolution imagery and bathymetry data products. This allows one of our new Superiors to acquire a total of 4.5 km2 per hour of operation, that is a total of 108 km2 per 24 hrs. The Superior has a larger energy bank installed providing a total of 80 hours continuous production (dive time) and a total of 360 km^2 high resolution data acquisition per dive.



Both the Hugin Superior and the Hugin 6000 will be equipped with Argeo's state-of-the-art sensor systems including our patented electromagnetic systems, Argeo LISTEN and Argeo WHISPER.
At a routine survey speed of 3.5 to 3.8kts it can detect objects the size of an average mobile telephone over an area of up to 1000 metres (beam-to-beam). The imagery is processed in near real-time on board the AUV and can be analysed by on-board advanced target recognition algorithms to detect and classify objects against a library of known targets.

The Hugin Superior system comprises the following commercial payloads:

Synthetic Aperture Sonar: *HISAS 1032 Dual-Rx*
Multibeam: *EM2040 MKII*
Sub-Bottom Profiler: *EdgeTech*
Electro Magnetics: *Argeo LISTEN*
Electro Magnetics: *Argeo WHISPER*
Other Sensors
CTD sensor
Digital still image color camera
Laser profiler
Magnetometer and turbidity sensor
Acoustic Doppler Current Profiling (ADCPJ
Methane (CH4) sensor

The Hugin 6000 system
Synthetic Aperture Sonar: *HISAS 1032*
Multibeam: *EM2040*
Sub-Bottom Profiler: *EdgeTech DW-216 (2-16 KHz)*
Colour camera: *CathX Hunter UHD + LED panels*
Laser: *CathX Dual Mode Laser profiling*
Environmental sensors: *WetLabs FLNTU Turbidity*

OCEAN INFINITY FLOATING WINDFARM PROJECT

Ocean Infinity has announced the signing of a landmark contract with Equinor Wind US for one of the first-ever floating offshore windfarms on the US West Coast.

Under the terms of this contract, Ocean Infinity will undertake a comprehensive site investigation survey using multiple AUVs (Autonomous Underwater Vehicles) simultaneously for Equinor's groundbreaking floating offshore wind lease area (OCS-P 0563)

Shawntel Johnson, Director, Business Development at Ocean Infinity said: "The US West Coast with its challenging deep water topography presents another excellent opportunity for Ocean Infinity to deliver the value of its multi-AUV capabilities for its clients. AUVs in scale are the perfect tool for this region providing not only great data quality advantages over towed arrays, in the water depths spanning from 974 to 1317 meters (about 4,507 feet), but also huge efficiency over wide areas."

The project is set to commence in February 2024 and signifies an important leap forward in the nation's renewable energy landscape.

The survey scope encompasses a range of vital offshore surveys. These critical data acquisitions are integral components for Equinor to mature their design basis as well as inform the Site Assessment Plan (SAP) and Construction and Operations Plan (COP) for the OCS-P 0563 lease area. Ocean Infinity's high quality data sets will facilitate informed decision-making and meticulous planning for the construction and operational phases.

Ocean Infinity's AUVs

PEOPLE

MARGO NEWCOMBE

VideoRay welcomes Margo Newcombe as Vice President, Marketing & Partner Programs. She brings more than 25 years of marine industry experience to the position, having directed marketing, communications and customer development programs for many of the industry's leading underwater and subsea technology companies.

In this role, Newcombe is developing and implementing marketing strategy and global initiatives across multiple channels and platforms to drive demand for VideoRay's growing line of Mission Specialist ROVs.

She is also responsible for fostering and developing relationships and programs with partners, dealers and internal team members to ensure the ongoing delivery of VideoRay's highly regarded customer experience. She sits on the Management and Leadership teams and will play a key role in the organization's strategic planning.

NEIL MANNING

Cellula Robotics has appointed Neil Manning as its new Corporate Development Officer.

Neil Manning brings a wealth of experience to Cellula, with an impressive career spanning over 27 years in the Submarine Telecommunications and Oil & Gas industries. His primary focus has been on subsea technology and engineering solutions, where he has successfully developed and managed business strategies based on groundbreaking technological advancements to solve industry challenges.

Notably, Neil played a pivotal role in the growth of CDL, a leading subsea inertial sensor company, which was later acquired by Teledyne. He then spearheaded the establishment and global success of 3D at Depth, a world-leading LIDAR technology and offshore survey company. His unparalleled expertise in identifying market gaps and delivering innovative solutions has consistently provided a competitive edge, setting companies apart from the competition.

"Being part of this team and contributing to the company's mission is incredibly exciting," remarks Neil Manning. "Having served as a business advisor to Cellula, I am deeply impressed by the company's potential. It is clear to me that their team and technology can make significant contributions to the security and sustainability of our oceans. Traditional marine vessels used for studying and monitoring the oceans are not only limited by access points but also leave a substantial carbon footprint. Cellula's autonomous solutions operate with net-zero carbon emissions, require minimal in-field crew thanks to port-to-port operations and are ideal for long-range under ice operations.

PAUL PETANI

AVIKUS, HD Hyundai's autonomous navigation in-house startup, has appointed industry insider Paul Petani to the position of Managing Director of North America. In his new role, Petani is responsible for establishing the brand and an official U.S. entity, growing a domestic team and overseeing day-to-day operations of Avikus' efforts in the United States and Canada.

Petani is an accomplished senior executive leader well known for his ability to pioneer new markets and recruit and mentor successful management teams. He has a valuable network of contacts in the marine and powersports industries having worked at IoT startup FELL Technology, Brunswick's Mercury Marine, First Alert Fire & Safety and Polaris Industries. With a deep understanding of recreational and commercial product distribution, Petani has extensive experience in OEM sales, dealer direct, aftermarket P&A sales and omnichannel development with brick and mortar and online sales channels.

Avikus DAS technology applies an integrated cognitive system allowing a boat to dock by itself. Docking can be one of the most difficult driving skills for new and even seasoned boaters and is recognized as high-risk for accidents. Using the Avikus 3D surround view system and collision warning alarm, included with the solution, users can effortlessly cope with all situations that may occur while docking.
Petani's immediate charge for Avikus in the North American market includes opening a U.S. office before the end of the year,

growing the Avikus U.S. sales and support teams and developing a domestic aftermarket distribution network. In addition, he will oversee the continued support of recently established partnerships and the development of new collaborations, and work to secure future OEM agreements.

Avikus' technology is centered around the NeuBoat system, which leverages the power of the Avikus Navigation Assistant System (NAS) and Docking Assistant System (DAS). Avikus NAS allows a boat to recognize and assess on-the-water situations in real-time and without human intervention through deep learning and sensor fusion algorithms.

EXAIL

Exail has opened a new innovation hub that will engage in all aspects of marine autonomous operations to help meet the challenges of the growing blue economy.

Exail will be using the new center to deliver increased operational advantage to U.S. civil and government customers. This includes the U.S. production of its Uncrewed Surface Vessel (USV), DriX, the housing of a remote operation center to conduct worldwide remote autonomous operations, establishing local operations, maintenance and training facilities, and providing expertise on maritime autonomy while also training future generations on the use of autonomous vessels.

The new hub will be at the University of New Hampshire, a recognized leader in the field of ocean mapping research, and located within UNH's Olson Advanced Manufacturing Center in Durham, to facilitate collaborative work with UNH's Center for Coastal and Ocean Mapping (CCOM).

"We've been working together with UNH for the past six years pioneering uncrewed technologies, and we are now capitalizing on our common achievements with the opening of this new innovation hub." States Marine Slingue, President at Exail, Inc.

"We're very proud and excited to take this next step in our U.S. adventure, and we would like to thank UNH, CCOM and NOAA, for their great support, leadership and vision on the use of uncrewed technologies that took us where we are today. We look forward to our continuous partnership with them and all the great work we achieve together to keep advancing maritime autonomy in the U.S.".

"This exciting collaboration will not only be good for Exail and UNH students and researchers but also good for New Hampshire and the nation," said Larry Mayer, director of the Center for Coastal and Ocean Mapping at the University of New Hampshire. "We anticipate that it is just the start of bringing many of our other industrial partners and government colleagues to the state as we create a local engine for the new blue economy. "

TERJE ÅNDERBAKK

Scantrol, has appointed Terje Ånderbakk as Project Manager. Specializing in control systems for fisheries and research vessels, Terje is poised to make a significant impact with his new role.

Terje has more than 20 year experience from Rapp Marine/ MacGregor, where he was responsible for engineering, installation and support of their winch control systems. Some also know him from his role as Sales Manager Fishery& Research at MacGregor

Terje will join our Operations Team. Scantrol Operations Manager, Johannes Sletteskog, express: “Terje brings a wealth of experience and expertise to his role! with his extensive knowledge of the fishing industry and project management skills, Terje will contribute to ensure seamless integration of Scantrol Autotrawl for both existing and new trawl winches.

Scantrol's VP Fishery &Research, Øyvind Hansen, also expresses his excitement about Terje Ånderbakk joining the team, stating, "We are thrilled to have Terje on board”. His expertise and dedication to delivering high-quality solutions align perfectly with Scantrol's commitment to innovation and customer satisfaction. We are confident that Terje will play a pivotal role in driving our success in this important market segment."

EXAIL NORWAY OFFICE

Exail announces the opening of a new business office in Norway, that will support the company’s growth in the Scandinavian region. Located in the Oslo area, this new office is led by Lars Sorfang, who is acting as General Manager for Exail AS, as well as Regional Sales Manager for Scandinavia.

A former officer for the Norwegian military, Lars previously held various business development positions at Kongsberg working on strategic defense programs, and Teledyne Flir, where he was Sales Director for the European region.

“I am very proud to be part of this new adventure with Exail, as I am deeply convinced, as a previous user of the technologies the company develops, that they are the right fit for the region that requires highly innovative and high-end products.” Lars explains. “With this new office, we will be able to provide increased support to our growing base of customers in Norway, and more generally, Scandinavia.”

Exail has won major contracts in the region over the past years, both in the civil and defense markets. This includes the sale of Inertial Navigation Systems for Norway’s U212 submarines and Coast-Guard vessels, Finland’s Multi-role corvettes, as well as Sweden A19 and A26 submarines. Exail has also established strong partnerships with civilian Scandinavian companies such as Teledyne Gavia, Nortek and RTS.

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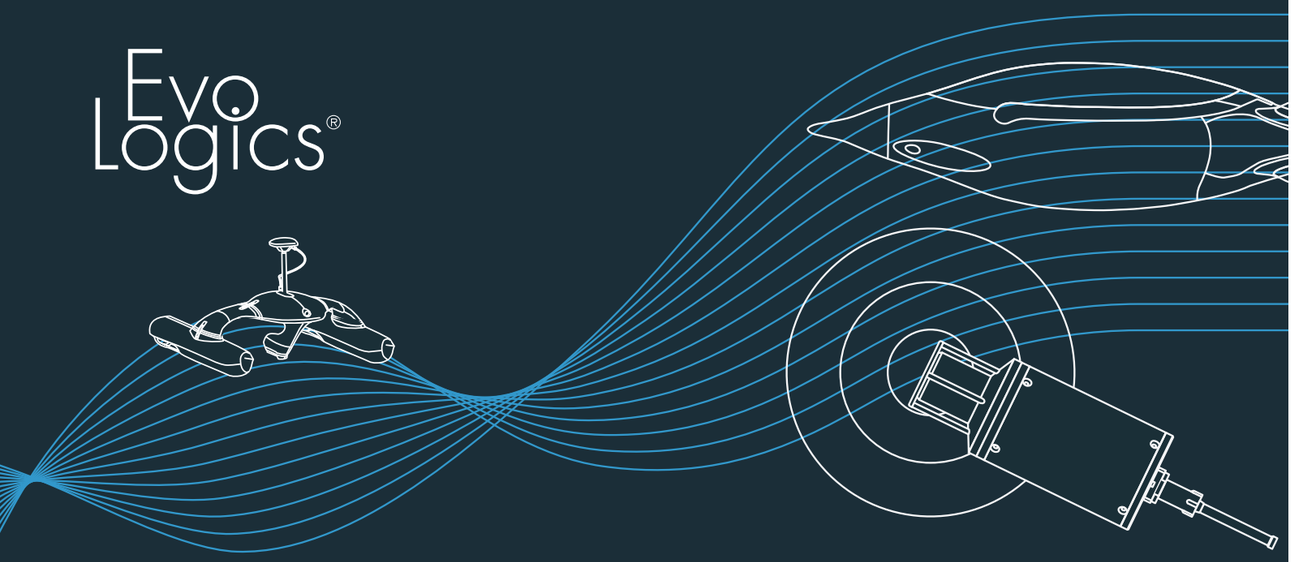

SMART SUBSEA SOLUTIONS

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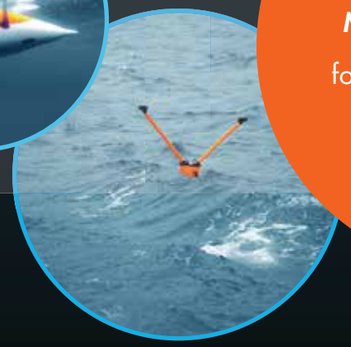

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