Ocean Robotics Planet

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32

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The magazine of choice for Ocean Robotics focused Professionals

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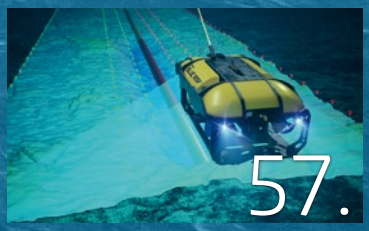


Front Page Cover Image: Courtesy of 3D at Depth
Poster Photo: Courtesy of U-Boat Worx

EVENTS CALENDAR 2022

For more information about all events visit WWW.OCEANROBOTICSPLANET.COM

SEPTEMBER

WINDENERGY
Hamburg, Germany (27–30 September 2022)

UNMANNED MARITIME SYSTEMS TECHNOLOGY – USA
Arlington, VA, USA (28–29 September 2022)

OCTOBER

FLOATING OFFSHORE WIND
Aberdeen, UK (12–13 October 2022)

SUSTAINABLE OCEAN SUMMIT – SOS 2022
Barcelona, Spain (17-18 October 2022)

MTS/IEEE OCEANS 2022
Hampton Roads, VA, USA (17–21 October 2022)

EURONAVAL
Paris, France (18–21 October 2022)

GLOBAL BLUE FINANCE SUMMIT – BLUEFIN 2022
Barcelona, Spain (19 October 2022)

NOVEMBER

REUTERS EVENTS: EU OFFSHORE & FLOATING WIND
London, UK (2-3 November 2022)

MARINE AUTONOMY TECHNOLOGY SHOWCASE (MATS)
Southampton, UK (8–10 November 2022)

OFFSHORE SOUTH EAST ASIA (OSEA)
Singapore (15–17 November 2022)

OFFSHORE ENERGY
Amsterdam, The Netherlands (29–30 November 2022)

FEBRUARY

OCEANOLOGY INTERNATIONAL
San Diego, CA, USA (14-16 February 2023)

SUBSEA EXPO
Aberdeen, UK (21–23 February 2023)

MARCH

U.S. HYDRO 2023
Mobile, AL, USA (12-16 March 2023)

APRIL

SEA AIR SPACE
National Harbor, MD, USA (3–5 April 2023)

OCEAN BUSINESS
Southampton, UK (18–20 April 2023)

WINDEUROPE 2023
Copenhagen, Denmark (25–27 April 2023)

MAY

OTC 2023
Houston, TX, USA (1-4 May 2023)

UDT 2023
Rostock, Germany (9-11 May 2023)

My name is Richie Enzmann. Allow me to welcome you all to the latest issue of Ocean Robotics Planet!

WELCOME TO OCEAN ROBOTICS PLANET!

Dear Reader,

We have an exciting edition lined up for you, so let's crack on. We spoke to the team at 3D at Depth, who recently debuted their new Cuvier DEEP system. It's been designed for shallow and deep-water inspections, primarily for the offshore wind market. We discuss the real-life inspiration for their modified Saab Sabertooth Hybrid AUV/ROV, and exactly how deep it can travel.

In this issue we also have plenty of content about Unmanned Surface Vessels (USVs). In recent years the development of USVs has really taken off as the technology has matured. We have several articles covering the different types of USVs specifically designed for the offshore wind and defence.

In addition to that, we'll hear from Fugro, who have integrated their Blue Essence USV with their Blue Volta eROV, all of which is controlled from a remote operations centre. And then we have a feature on the Hyper Sub Platform, a cross between a manned vessel and a submarine. It's designed mainly for military applications and looks like something out of a James Bond movie. Very cool stuff!

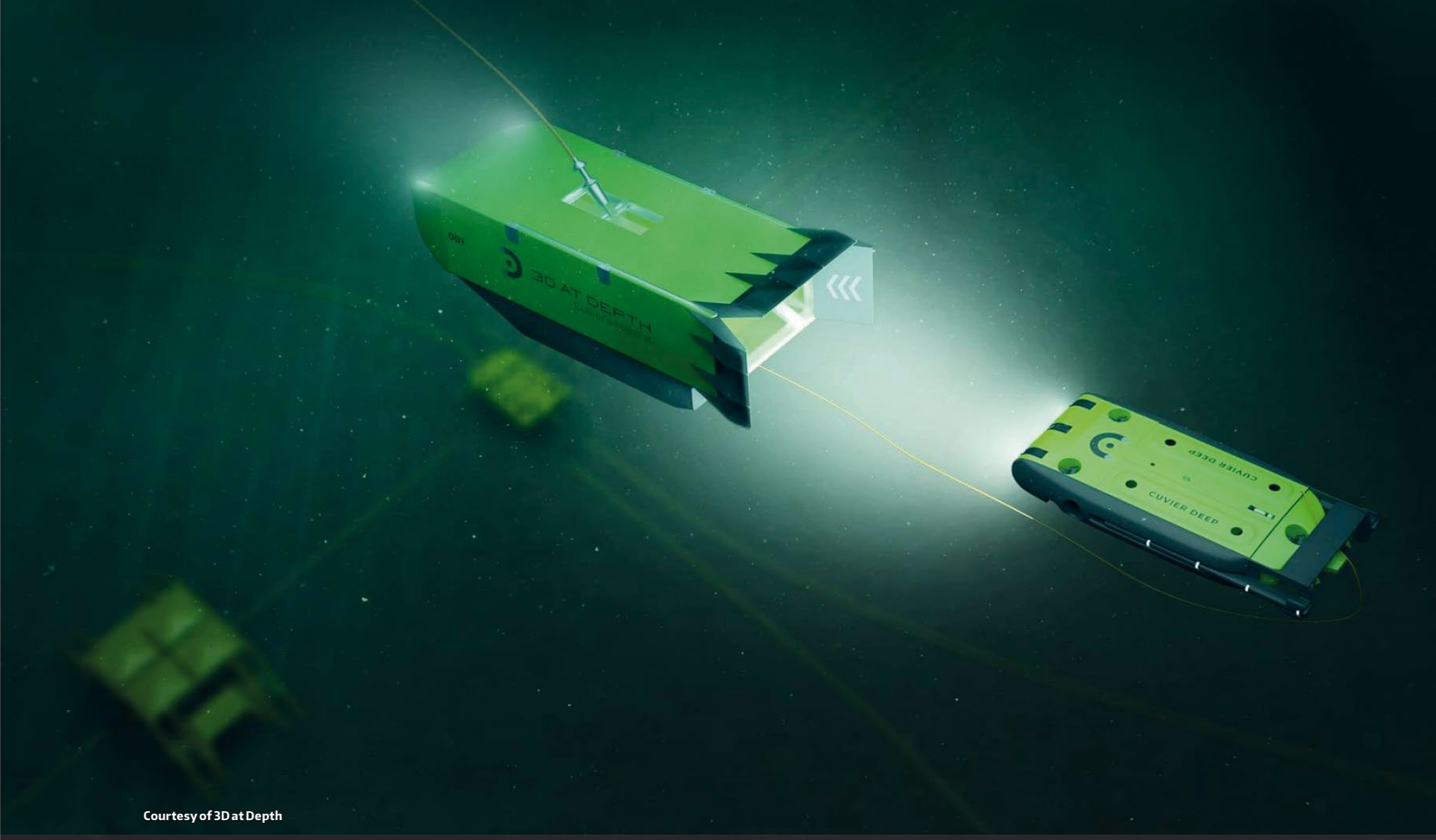
I also had a chat with Commander Timothy Hawkins, a part of the U.S. Navy's 5th fleet and Task Force 59. He tells me about their trialling of commercially available USVs in real life military applications. So, if you have a great idea or solution that you think could be implemented, you can get in touch with them.

Also in this issue, our North American correspondent, Marc Deglinnocenti, has put together a list of some interesting USVs that are currently hot on the market. Marc also shares his experiences and what he learned from working with oceanographic instruments from research vessels.

Finally, I would like to say a special thanks to U-Boat Worx - a leading manufacturer of manned submersibles - for being kind enough to host me at their Curacao Sub Center in the Caribbean. They showed me around their state-of-the-art facilities and took me on an unforgettable dive in their Super Yacht Sub 3 to explore a nearby reef.

We hope that you enjoy reading this issue and look forward to meeting many of you at upcoming conferences and exhibitions. As you can see from our editorial calendar, we will have a busy show season ahead of us this autumn. Hopefully we'll see you out there!

Best regards,
Richie Enzmann



Courtesy of 3D at Depth

THE FUTURE IS GREEN

3D AT DEPTH

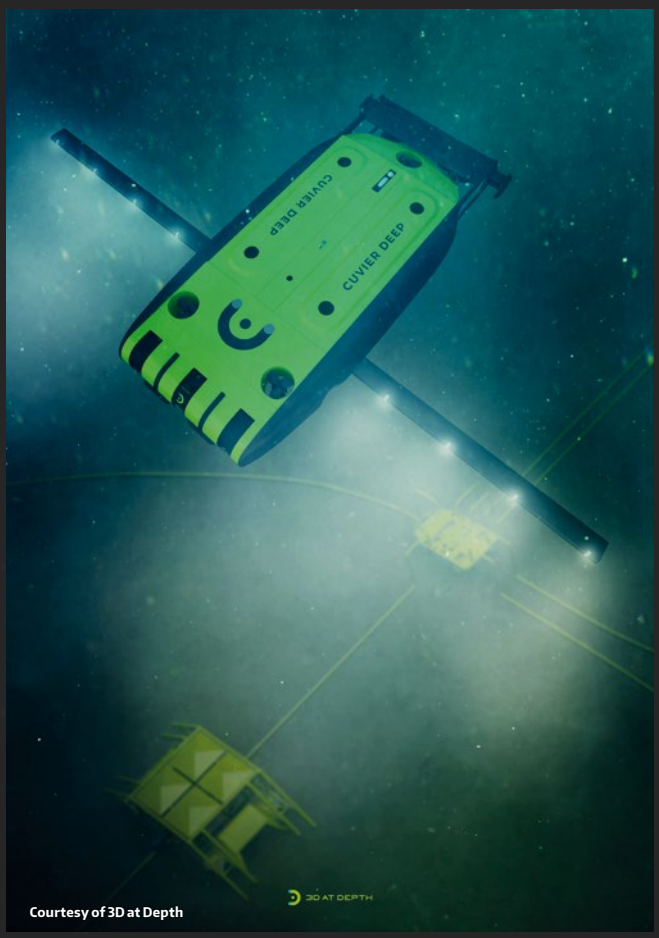
The Cuvier DEEP™ Autonomous Underwater Vehicle System and its associated products address underwater inspection needs for both deepwater energy and shallower water depths, targeting the offshore wind sector. This autonomous underwater solution combines class-leading sensors and high-end system performance, with operational efficiency and unparalleled data quality in one place: leveraging 3D at Depth's new SL4 Subsea LiDAR. This complete package goes beyond measurement and offers an end-to-end solution, from acquisition to answers.

HABITAT™

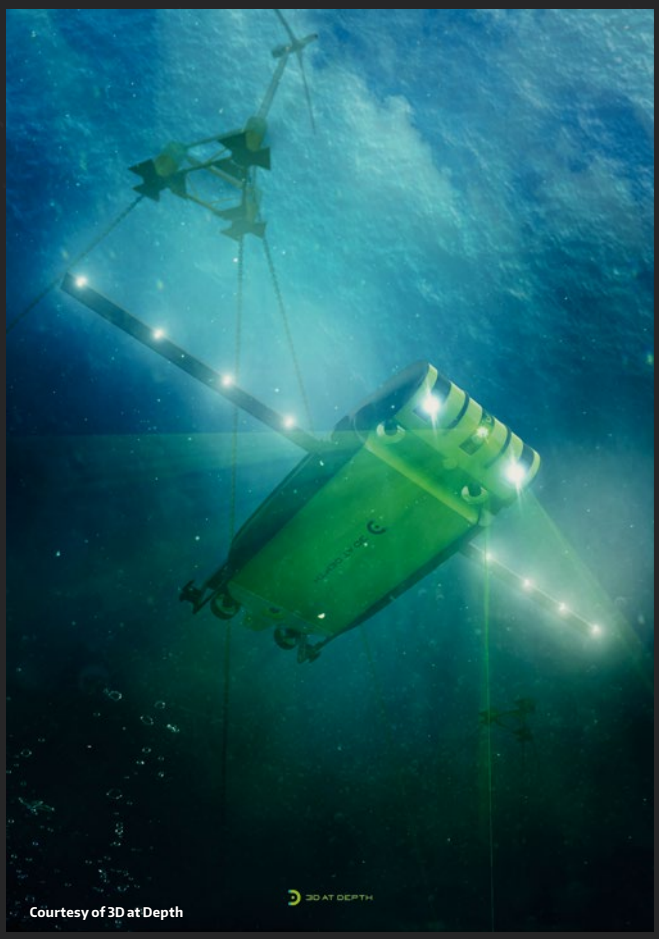
The Cuvier DEEP™ has an impressively low-drag hydrodynamic subsea garage solution called Habitat™. The low drag profile is designed for in-water towing. Water transit or inspection speeds can be up to 4 knots, allowing for reduced deployment and recovery timings, all of which minimize risks and unnecessary emissions.

Habitat™ works in a multi-functional capacity, with the ability to host power distribution, sensors, and wireless communication options - including optical and acoustic modems - all of which allow for supervised in-water operations. Positional information is obtained from resident inertial navigational sensors interfaced with market standard Ultra Short Baseline (USBL), or Long Base Line (LBL) aiding options.

Habitat's removable front nose section hosts a constant tension winch, with up to 4km of fiber optical tether, power and sensor interfacing, and Habitat's brain. The extended optional tether allows for high-speed data to be delivered from the Cuvier DEEP™ to the vessel with deep-water long layback touchdown monitoring applications. Up to a 3.5km offset can be achieved depending on operational conditions via the optical tether solution, thanks to the thin fiber lines' outer diameter of 4mm.



Courtesy of 3D at Depth



Courtesy of 3D at Depth

The Habitat™ expanded functionality follows the principle of an underslung remotely operated vehicle skid, with a bottom-mounted optional sensor payload, or 600m power communications tether winch system for unlimited endurance. The Habitat™ also impressively allows for semi-residency and multi-vehicle deployment operations. A quick release top section with load-bearing structures allows for multiple vehicles to be safely launched, recovered, or serviced on deck. When used with the rotating Launch and Recovery System™ (r-L&RS™), Habitat™ can provide charging, data downloads, and in-water transits from the deck to water depths of up to 3,000m.

REMOTE, ROTATING LAUNCH AND RECOVERY SYSTEM™ (R-L&RS™)

r-L&RS™ is a combination of a rotating deck-mounted solution with several design aspects tailored to the in-water systems deployment and recovery requirements, r-L&RS™ has an integrated heave compensation and Habitat™ auto depth or altitude control. Amazingly, the entire solution is remotely controlled onshore via a satellite uplink.

This future-proofing allows for supervised or tethered deep water operations. The r-L&RS™ can rotate its electrically driven main lift winch and overboard A-frame an impressive 310 degrees allowing for flexible deck mounting options and an overboard reach of distances of up to 5.5 meters. Having the flexibility to mount the r-L&RS™ adjacent or perpendicular to the vessel's side increases the vessel footprint and deck design solutions. Transit speeds of up to 4 knots are possible by using a high departure angle snubber solution. This also hosts an auxiliary shorter lift line for on deck vehicle rotation or maintenance.

Depending on the vessel or offshore work platform, this total solution can be complemented with deck-mounted class-certified workshops and control cabins for bare boat charters. It can also be separated offering only what's required and leveraging current vessel tooling such as over boarding cranes or workspaces for the control room. The entire spread is designed to fit onto standard ISO containers, allowing for easier international shipping and road transport, without the need for loading or permit restrictions.

CUVIER DEEP™ – LIKE NO OTHER

Cuvier DEEP™ is truly in a class of its own. It offers a fully integrated marine robotics solution, enabling the harvesting of high-quality data from the SL4 Subsea LiDAR and other geophysical and electromagnetic measurements and inspection data, providing efficient decision-making solutions.

Cuvier DEEP™ evolved from the remote-controlled, 3000m deep-water, dual-hull SAAB Sabertooth Underwater System. The system design has been modified to enable greater endurance and more diverse sensor payload integration, meaning both better in-water operational time and higher data capture accuracy. This innovation has been heavily influenced by years of marine design and operational experience to unlock an operationally unique platform with incredible

agility. The result is a highly adaptive work platform that greatly reduces the on-deck turnaround time due to a modular power solution.

Furthermore, the increased endurance of up to 30 hours (depending on the mission requirements) exceeds all comparable solutions currently operating in the market space. Cuvier DEEP™ is supported by impressive communication options connecting it back to the Habitat™, including fully untethered supervised autonomy. Rather than conventional underslung ROV payload skids, which are often seen as cumbersome and costly, Cuvier DEEP™ uses hydrodynamic side pods which are removable depending on the mission. These pods can include widespread sensors, foldable wing innovations, or multi-function electric manipulation.

All of these solutions are set to rock the blue economy "norm". Cuvier DEEP™ delivers a new level of efficiency, alongside the data quality standards expected by 3D at Depth's clients, at much lower in-water operational times.

INSPIRATION

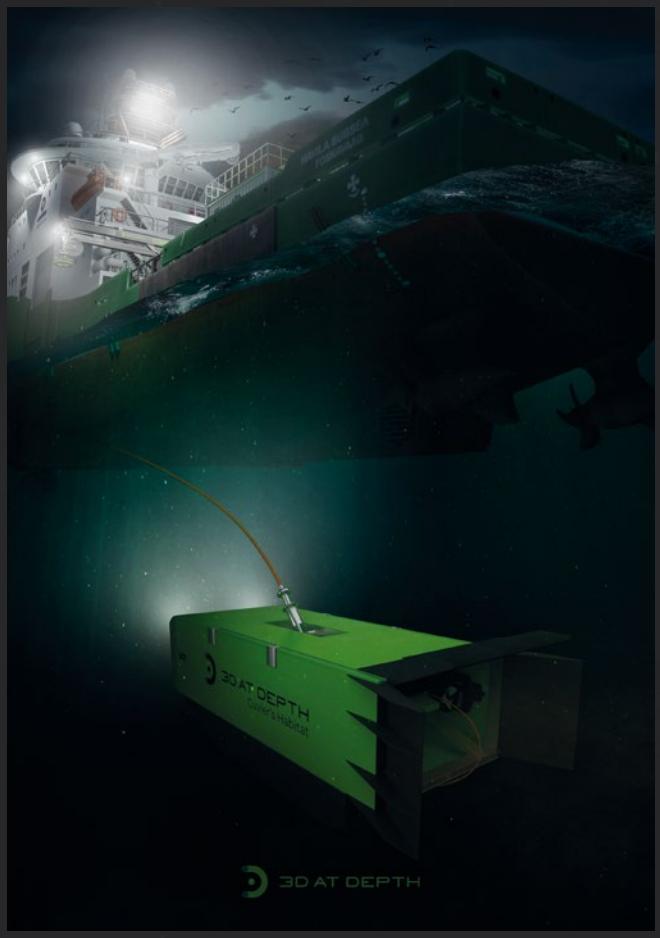
Cuvier DEEP's name is inspired jointly by George Cuvier (1769-1832) and the Cuvier's beaked whale. French-born academic Cuvier had many accolades and areas of study during his career; one particular focus of his was on establishing proof that many species like dinosaurs had become extinct in ages past. Cuvier, therefore, proposed, that after each series of major ecological events, new species would have been created. In the case of Cuvier's beaked whale, a highly adaptive marine mammals' performance is - in many aspects - like the specification of the Cuvier DEEP™. With a similar size and a diving depth of around 2,992m, the beaked whale holds the record for the longest and deepest diving mammal on Earth.

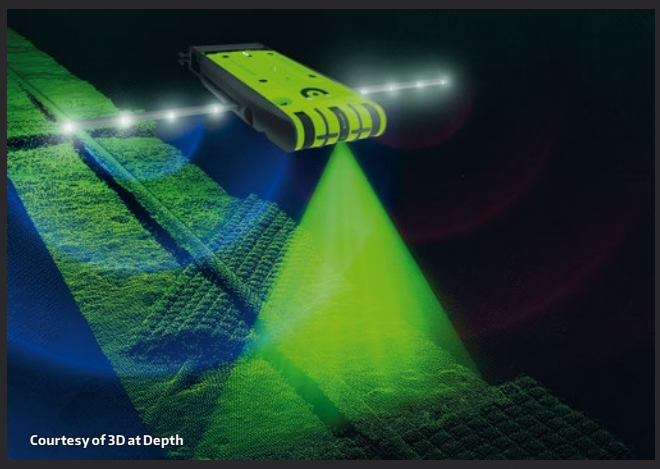
For the blue economy, global climate change and the energy transition have created an impact as major ecological events. Cuvier's work on extinctions was incorporated into Charles Darwin's theory of natural selection and survival of the fittest. Cuvier also expressed that multiple evolutionary changes would happen at the same time following a catastrophic event, stimulating forced evolution in species.

3D at Depth has been inspired by Cuvier with the multiple modifications to the SAAB Sabertooth hybrid AUV/ROV. The end-to-end approach to a complete solution has offered flexibility, lower emissions, allowing inspection in deeper water depths from smaller vessels with lower mobilization footprints, spanning shipping, lifting and deck fastening.

We at 3D at Depth are focusing on business growth through innovation, with a target on lowering carbon emissions and vessel time savings from crewed and un-crewed surface vessels. We have a highly specialized and dedicated team with many years of experience in subsea LiDAR and Marine robotic solutions. Our ethos is based on respect and innovation, and we truly believe that this will be the key to our success in the future.

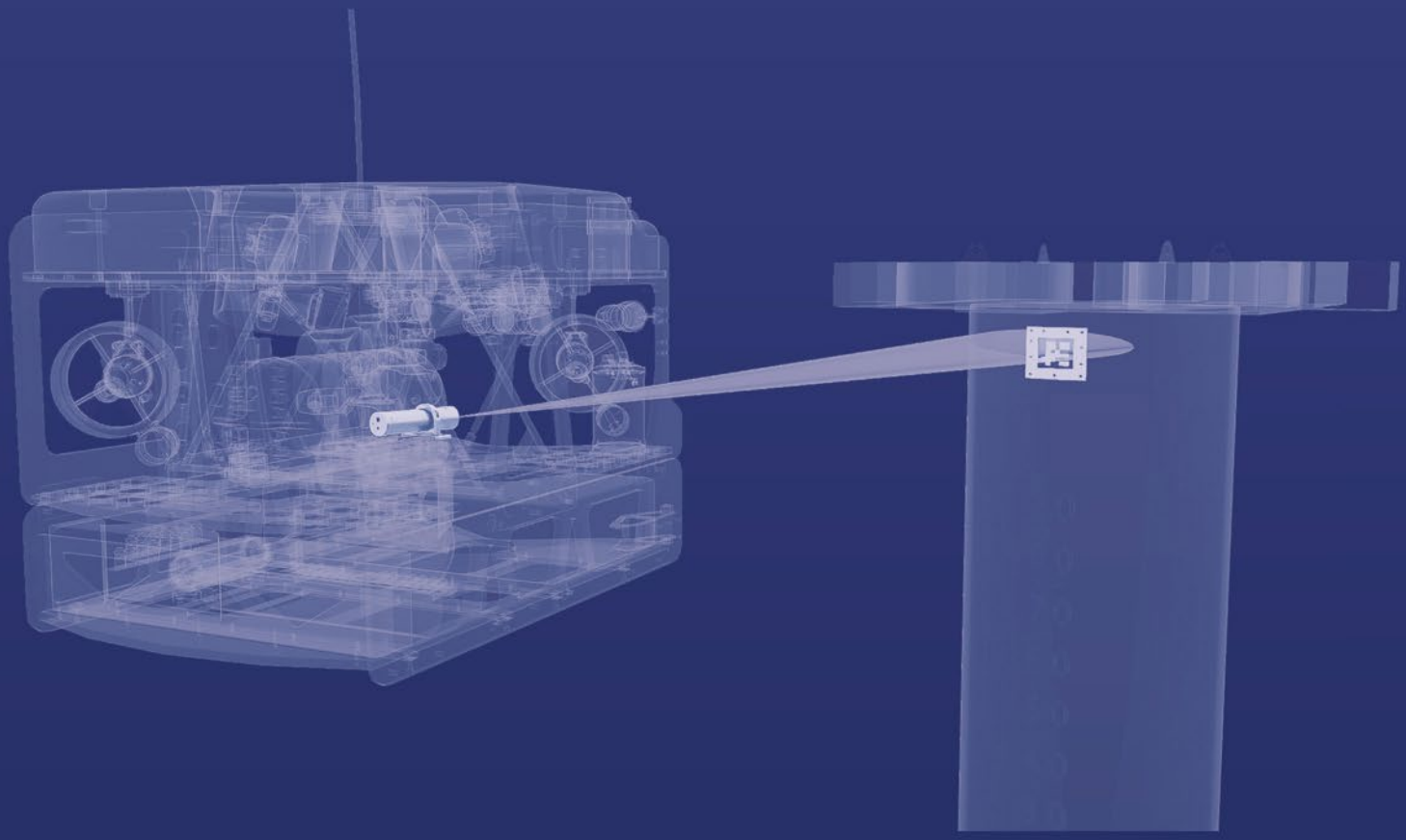
Courtesy of 3D at Depth





Courtesy of 3D at Depth

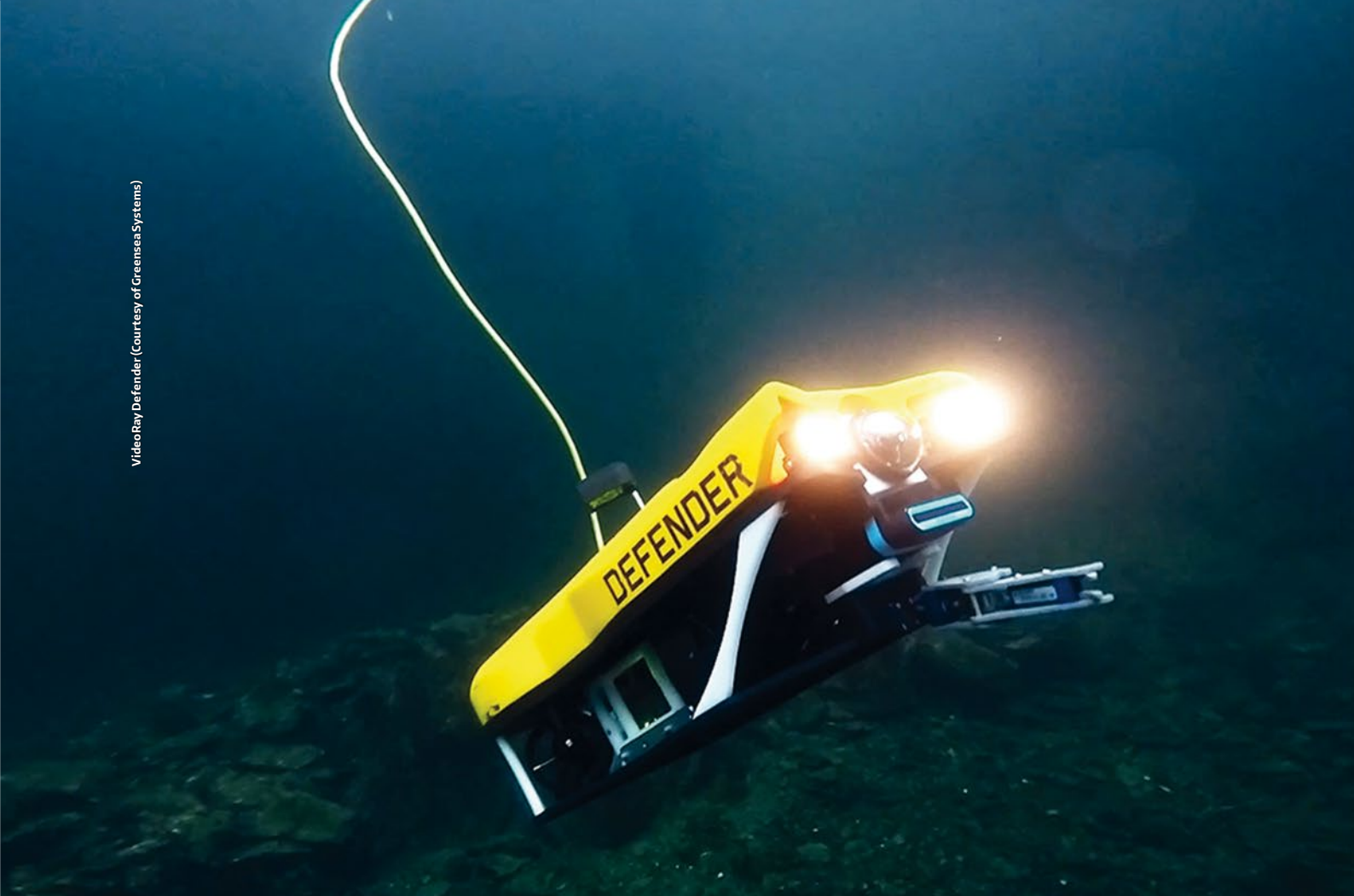
Inclination Monitoring Has Never Been So Easy



Ready-to-use & Service Free Technology for Marine Construction

V-LOC calculates your assets real-time coordinates thanks to open-source tags which are affixed to them. Our technology is embedded inside a calibrated camera which exists in both air and subsea versions for highly accurate marine surveys.

FORSSEA ROBOTICS

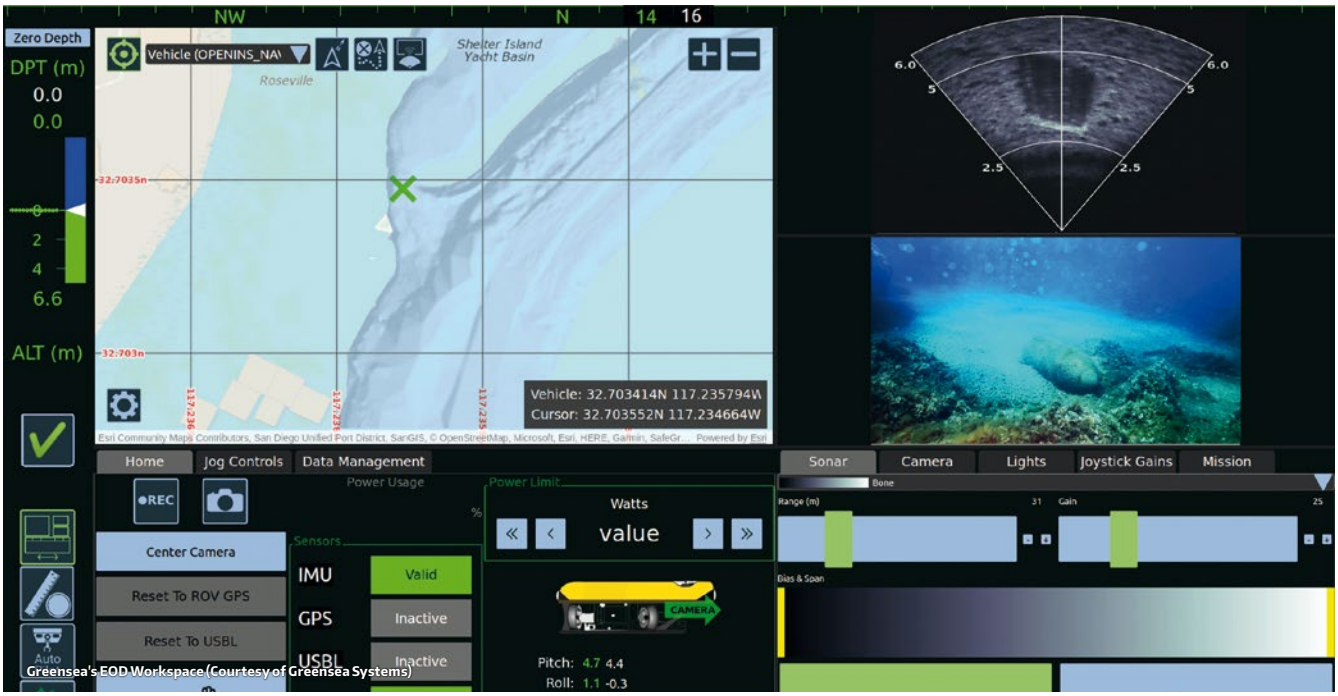


VideoRay Defender (Courtesy of Greensea Systems)

OPENSEA OPEN ARCHITECTURE

ANYTHING IS POSSIBLE ON OPENSEA

Marine robotics technology specialist Greensea Systems Inc. (Greensea) is the only provider of a software suite that enables true autonomy and advances underwater robotic systems and vehicles. The company was founded in 2006 by current CEO and President, Ben Kinnaman, an entrepreneur with experience in marine robotics, whose vision it was to help deliver reliable and precise integrated navigation and control systems for offshore vehicles. This, together with improving the relationship between operator and machine, was to be achieved through an open architecture software platform, OPENSEA.



Greensea's EOD Workspace (Courtesy of Greensea Systems)

Ben Kinnaman is passionate about open architecture and is always keen to set the record straight on the frequent misconception that open architecture comes with the openness associated with open source. Unlike in open source, open architecture ensures the protection of the company's intellectual property right, and still comes with an amazing spectrum of capability and power. It offers an expansive field of collaboration and an exciting future for ROVs.

ANYTHING IS POSSIBLE ON OPENSEA

OPENSEA was designed and developed by Greensea's team of engineers and offers an open architecture software platform with a modular framework that enables quick and easy integration of robotic systems. This provides the end-user with an easy solution to deliver precision and accuracy to ROVs, AUVs, and marine robotics, whilst being operator friendly, reliable, and easy to maintain.

The capabilities of today's robots are defined by a combination of two elements. The manufactured and designed hardware for physical functionality, and the operational software that delivers the control, navigation, and autonomy of the unit.

An open architecture platform like OPENSEA, allows for easier, quicker, and cheaper addition, upgrade, or replacement of components in marine robotics, providing flexibility and adaptability for continuously changing requirements, drivers, pressures, and opportunities in the market. It encourages development and innovation, and supports collaboration with end-users' hardware that is ready to deploy.

The OPENSEA Platform provides a robust technology framework for a range of applications. Because OPENSEA is a modular framework onto which applications can be built, the end-user is assured of a degree of futureproofing, with the core software development and maintenance resting with the experts at Greensea. This allows end-users to focus on their field of expertise, and not have to resource for developments to the core operating software, ultimately helping OEMs lower their non-recurring engineering. Instead, they can prioritise meeting the demand of their market and reduce time to market of new cutting-edge robotic solutions.

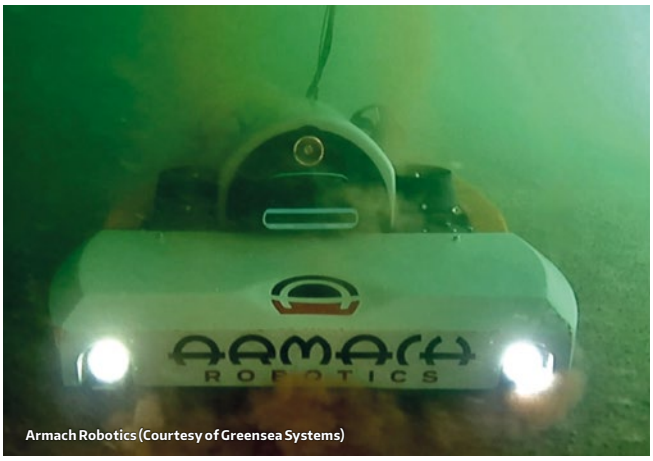
Since the start of Greensea in 2006, more than 2500 systems are running on OPENSEA, with the last few years seeing an increase in adoption of open architecture.

A number of software platforms are available for robotics, including ROS – Robot Operating System and JAUS, software libraries built on open source – note open source, not open architecture. Open source platforms represent a different type of collaboration. The collaboration here refers to a community of contributors all having access to, and working on, the open-source software, making changes to meet their needs and requirements. Possibly the biggest challenge with open source is security, followed by the question of licensing to fully understand the IPR in commercial activities. The open architecture of OPENSEA provides a platform infinitely scalable while protecting the intellectual property between the developers.

GREENSEA CONTROL AND COMMAND SYSTEM-INTEGRATION

Greensea has developed its own range of products built on OPENSEA which can integrate with external robotics.

Greensea's EOD Workspace human-machine interface, for example, combines vehicle control, navigation, payload sensors, diagnostics, and data management within a single screen. It leverages supervised autonomy to allow explosive ordnance disposal teams to concentrate more fully upon their critical subsea work. Described as a 'smart robotic partner', the EOD Workspace essentially enables EOD technicians to hand



Armach Robotics (Courtesy of Greensea Systems)


Bayonet Ocean Vehicles (Courtesy of Greensea Systems)

over as many or as few automated tasks to an ROV itself in any given mission. Accompanying this is the EOD Workspace Simulator, a powerful training tool to develop and maintain user skills without the need to utilize an operational ROV.

Greensea's SafeC2 provides 'over the horizon' technology for long-range command and control of subsea assets operated on OPENSEA, many miles away from the offshore deployment vessel.

RNAV2 provides navigation, control, communication, and autonomy for the Diver Propulsion Device, one of the most widely used underwater mobility platform in the world. An integrated system operability framework that supports complex tasks in hostile conditions.

PROJECTS BUILT ON OPENSEA

Leading OEMs across the world have built their innovative technologies on the OPENSEA platform, trusting in a stable, adaptable, and well-proven operating system in marine robotics. To date, the platform is being used as the basis for thousands of systems across the subsea, surface, manned, and unmanned sectors, performing a wide range of objectives requiring accurate subsea navigation, precise control, and reliable autonomy. The open architecture enables OEMs to rely on a flexible, scalable, and maintained software solution, thereby saving on resources in terms of personnel, financial investment, time and risk, and paralleled assurance of the protection of the intellectual property between developers.

ARMACH ROBOTICS

One such technology built on OPENSEA is Armach Robotics (Armach), a company launched as a spin-out company from Greensea, when Ben Kinnaman saw an opportunity to fill a gap in the market for hull cleaning in conjunction with hull intelligence.

Armach offers an autonomous in-water robotic hull cleaning and surveying subscription service. OPENSEA provides the precision navigation, autonomy, and long-range command and control to Armach's Hull Service Robot. Through using OPENSEA, as opposed to developing its own in-water robotic operating software, Armach was able to enter the market in a timeframe otherwise impossible to achieve.

Integrating Armach's robotics system with the established operating platform, the hull cleaning service not only operates for cleaning purposes but delivers post service data. This hull data provides intelligence and insights for shipowners to analyse and evaluate, supporting efforts of inspection, fuel saving measures, sustainability objectives, operational efficiency, and fleet readiness.

BAYONET OCEAN VEHICLES

C-2 Innovations Inc (C-2i) had developed a range of amphibious crawling vehicles built on the OPENSEA platform, that operate in the surf zone, on the floor bed, in rivers and marshes.

In 2022, C-2i agreed to an acquisition by Greensea, and Bayonet Ocean Vehicles was launched. Two key figures from C2-i joined the team to help support programs and engineering, providing continuity of engineering skills and know-who.

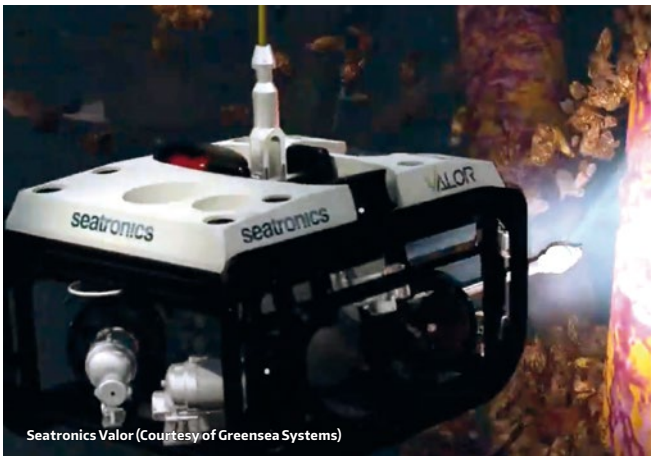
Bayonet Ocean Vehicles product range is now operational, built on OPENSEA, with precise navigation, payload integration, autonomy, and over-the-horizon command and control, a combination unique to the market. The vehicles cover a wide range of possible payloads and applications and can be fitted with a variety of environmental, oceanographic, hydrographic and industry specific sensors to accommodate the numerous commercial and military applications of the vehicles.

VIDEORAY

VideoRay partnered with Greensea for their ongoing development of their Mission Specialist Series ROVs. The collaboration resulted in updates to OPENSEA's add-on Workspace to support VideoRay's Expeditionary Splashproof Controller, ensuring user interactions are intuitive and natural, meeting the needs of the VideoRay Defender technician.

OCEAN INFINITY

OPENSEA is the platform for the Armada Dynamic Payloads Control by Ocean Infinity. Through collaboration with Greensea, Ocean Infinity was able to create advanced capabilities for robotic control and supervision for the Armada fleet's payload. The DPC provides a framework for supervising and controlling a remotely operated vehicle system, including the deck gear and launch and recovery system by



Seatronics Valor (Courtesy of Greensea Systems)


Ben Kinnaman, CEO & Founder of Greensea Systems (Courtesy of Greensea Systems)

operators located at any of Ocean Infinity's remote-control centers through SafeC2's over the horizon command and control suite. Through the OPENSEA API and OPENSEA SDK interfaces, any partner can easily plug into the Armada DPC to add functionality to the fleet.

OCEAN POWER TECHNOLOGIES

Ocean Power Technologies chose OPENSEA to facilitate the development and launch of their next generation PowerBuoy®-based Maritime Domain Awareness Solution (MDAS) to provide intelligent maritime solutions and services.

KRAKEN ROBOTICS

Kraken used OPENSEA to develop autonomy and software control for the Thunderfish AUV vehicle, combining both AUV and ROV capabilities into a single platform and can operate as a subsea resident, perform hovering manoeuvres for inspection, and carry significant payload for long-range survey missions. Kraken and Greensea later entered into a partnership for on-going collaboration for the advancement of capabilities of marine robotics.

ATLANTIC LIONSHARE

Atlantic Lionshare developed an ROV, the Reef Sweeper, designed to harvest lionfish that pose a threat to the marine ecosystem. Utilising real-time camera feeds and laser guides, the ROV is able to support more traditional methods of lionfish-cull in depths and/or habitats which are impossible or dangerous to operate in.

THE FUTURE OF OPEN ARCHITECTURE

It is easy to see how open architecture, and the collaboration it enables, creates new opportunities, drives design and innovation, and can lower time to market for new products. Some may see this as the future of technological advancement, others perhaps less so. The biggest challenge, according to Ben Kinnaman, is twofold. It involves both a technical and a cultural ask, a paradigm shift, as he likes to refer to it.

With technological advancements comes progress in operations. Efficiencies are being maximised and, in turn, are increasing the demand on technology to evolve further. Operators need to remain competitive, pushing them to offer the latest in technology, reliably, timely and sustainably. Here, open architecture facilitates the speed and reliable quality required.

However, to maximise the open architecture software platform, it requires collaboration. Collaborating has historically been fraught with challenges over perceived risk, with the technical industry having spent decades in siloed planning and development, trialling, and testing. This is where the cultural ask comes in. Collaboration will require a rethink of the definition of working together. Collaboration will have to come with the willingness and vision to openly work together to help the industry develop and field solutions quickly, with the use of open architecture.

Collaborating on open architecture will create opportunities. Anything is possible when the power of OPENSEA combine to bring vehicle autonomy, long range command & control, through water communications, and ROV perception capabilities together through an open architecture and vehicle agnostic software solution only available from Greensea today.

SUBSEA ROBOTICS TECHNOLOGY

Ben never took his eyes off the long-term goal of building Greensea into the leading global supplier of subsea robotics technology it is today, with OPENSEA as its revolutionary open-architecture software platform. He can now boast decades of experience in developing agile and adaptable software solutions that seamlessly integrate with OEMs' products that operate in and withstand the harshest ocean environments.

Prioritizing collaboration and welcoming the input of partners and developers has delivered results. Barriers are being removed, allowing multiple companies to collaborate through open architecture such as OPENSEA.

OPENSEA has enabled Greensea and those who collaborate with them, to quickly field novel technologies and advance operational capabilities throughout the subsea industry, ensuring solutions are future-proofed and can easily be scaled to meet the demands and challenges of the subsea sector.


BAYONET
OCEAN VEHICLES
ACROSS SEA AND LAND
Bayonet Ocean Vehicles are easily customized with environmental, oceanographic, and industry specific payloads for commercial and military applications.
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SEPT 28-29, 2022

The Hilton Arlington, Virginia, USA

KEY REASONS TO ATTEND THE CONFERENCE:

- Listen to **keynote briefings** from **leading U.S. military leaders** driving the development of unmanned maritime systems
- Hear updates and guidance from **allied** UMS program managers
- Delve into the latest topics and trends **shaping the future** of unmanned maritime systems and learn how to **integrate these new technologies** to enhance your operational effectiveness
- Discover the latest **cutting-edge technology** at the exhibition hall and explore opportunities for **greater coalition interoperability**
- Benefit from the **extensive networking opportunities** and meet your fellow peers at dedicated networking lunches

U.S. SPEAKERS INCLUDE

- **Captain Michael Egan**, Mine Warfare Branch OPNAV N952 Branch Head, **Office of the Chief of Naval Operations**
- **Captain Thomas Remmers**, Unmanned Systems Strategic Team Lead, **U.S. Coast Guard**
- **Captain Ben Van Buskirk**, Director, **NavalX**
- **Colonel Brad Green**, Unmanned Aircraft Systems Branch Chief, **U.S. Marine Corps**
- **Commander Brian Conlan**, Commanding Officer, Unmanned Patrol and Reconnaissance Squadron 19 (VUP-19), **U.S. Navy**
- **Dr Ayodeji Coker**, Autonomy Portfolio Manager, Office of Naval Research, **U.S. Navy**
- **Dr Jason D. Strickland**, Maritime Staff Specialist, Platform & Weapons Technology, **Office of the Under Secretary of Defense for Research and Engineering**
- **Ms Dorothy Engelhardt**, Director for Unmanned Systems DASN Ships, **U.S. Navy**
- **Ms. Schuyler Moore**, Chief Strategy Officer, Task Force 59, **U.S. Navy**
- **Mr Adam Outlaw**, Subsea and Seabed Warfare Branch Head, N97, **Office of the Chief of Naval Operations**
- **Mr Michael Stewart**, Unmanned Task Force Executive Director, **U.S. Navy**
- **Mr Jason Strickland**, Technical Director, Unmanned Surface Warfare, NAVSEA, **U.S. Navy**
- **Mr Samuel Bendett**, Associate Research Analyst, **Center For Naval Analyses**

INTERNATIONAL MILITARY SPEAKERS INCLUDE:

- **Rear Admiral Rhett Hatcher**, National Hydrographer and UKHO Deputy Chief Executive, **UK Hydrographic Office**
- **Colonel Tom Ryall**, Head of NavyX and Navy BattleLab, **Royal Navy**
- **Commander Filip Clauwaert**, Director, **NATO Naval Mine Warfare Centre of Excellence (NATO NMW COE)**
- **Commander Paul Hornsby**, Operational Requirements Sponsor – Autonomous Warfare, **Royal Australian Navy**

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A Saildrone Explorer unmanned surface vessel and amphibious command ship USS Mount Whitney (LCC 20) operate in the Red Sea in support of the newly established Combined Task Force 153, April 21. CTF 153 focuses on maritime security and capacity building in the Red Sea, Bab al-Mandeb and Gulf of Aden. (U.S. Army photo by Cpl. DeAndre Dawkins)

TASK FORCE 59

INTEGRATION OF UNMANNED SYSTEMS AND AI INTO MILITARY OPERATIONS

We sat down with Commander Timothy Hawkins from U.S. 5th Fleet – the organization responsible for the U.S. Navy's integration of unmanned systems and AI in the Middle East – in Bahrain to discuss their wide array of working partnerships, and how their most recent findings will contribute to future developments.

RICHIE ENZMANN: What is Task Force 59, and how does it fit into the wider strategy of the U.S. Navy?

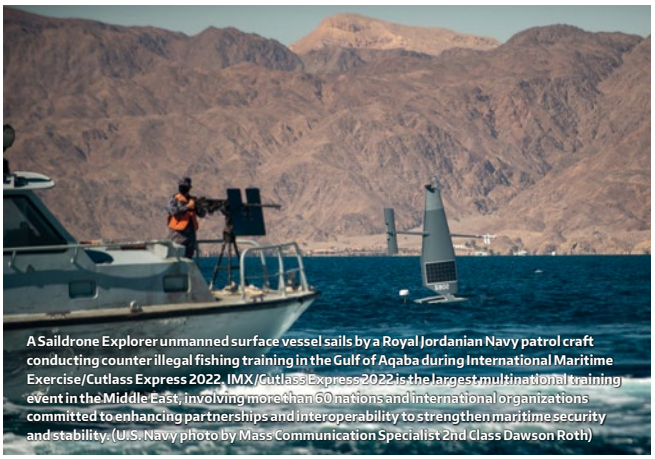
TIMOTHY HAWKINS: Task Force 59 is a U.S. 5th Fleet task force. It was established last September to focus our efforts on integrating unmanned systems and artificial intelligence (AI). The way U.S. 5th Fleet is organised, we have a number of task forces: nine to ten depending on what's going on. These task forces each focus on a specific area of operations, and U.S. 5th Fleet is the first U.S. Navy fleet to establish a dedicated staff – in the form of a task force – to lead our integration of unmanned systems and AI.

In the last 20 years unmanned aerial vehicles (UAVs) and their systems have been developed and used in various campaigns all over the world by multiple forces. In the past 10 years, unmanned undersea vehicles (UUVs) have also matured and been deployed. Where there hasn't been much past progress in terms of advancement and maturation is on the surface.

We recognised about a year ago that there had been recent progress made in the advancement of unmanned surface vessels (USVs), especially on the smaller-sized end of the spectrum. We felt it was worth exploring and accelerating their development by inviting the companies that are building them out to a forward operating environment in the Middle East where U.S. 5th Fleet has crewed ships and forces stationed.

Putting them in this environment is challenging when you look at the weather conditions, which are invariably sandy, dusty, salty and hot. Providing operator feedback and observations to innovators and entrepreneurs moves the development process forward. Companies can take their systems

His Royal Highness Prince Salman bin Hamad Al-Khalifa, Crown Prince, Deputy Supreme Commander and Prime Minister of Bahrain, center, receives a brief on the GHOST 4 unmanned aerial vehicle at Naval Support Activity Bahrain, Jan. 31. (U.S. Navy photo by Mass Communication Specialist 1st Class Mark Thomas Mahmod)



A Saildrone Explorer unmanned surface vessel sails by a Royal Jordanian Navy patrol craft conducting counter illegal fishing training in the Gulf of Aqaba during International Maritime Exercise/Cutlass Express 2022. IMX/Cutlass Express 2022 is the largest multinational training event in the Middle East, involving more than 60 nations and international organizations committed to enhancing partnerships and interoperability to strengthen maritime security and stability. (U.S. Navy photo by Mass Communication Specialist 2nd Class Dawson Roth)

Vice Adm. Brad Cooper, commander of U.S. Naval Forces Central Command, U.S. 5th Fleet and Combined Maritime Forces, right, meets with Indian Deputy Chief of the Naval Staff Vice Adm. Sanjay Mahindru at Task Force 59's Robotics Operations Center in Manama, Bahrain, July 27. During the visit, the leaders discussed opportunities for maritime cooperation after India's decision to partner with Combined Maritime Forces and the U.S. Navy's integration of new unmanned technology and artificial intelligence. (U.S. Navy photo by Mass Communication Specialist 1st Class Mark Thomas Mahmod)

back, make some tweaks and then send them out again. This entire effort is consistent with U.S. 5th Fleet's focus on strengthening partnerships and accelerating innovation. Our engagement with industry through Task Force 59 is an innovation accelerator.

RE: Can you please give us an overview of what has been done over the past 12 months since TF59 was established?

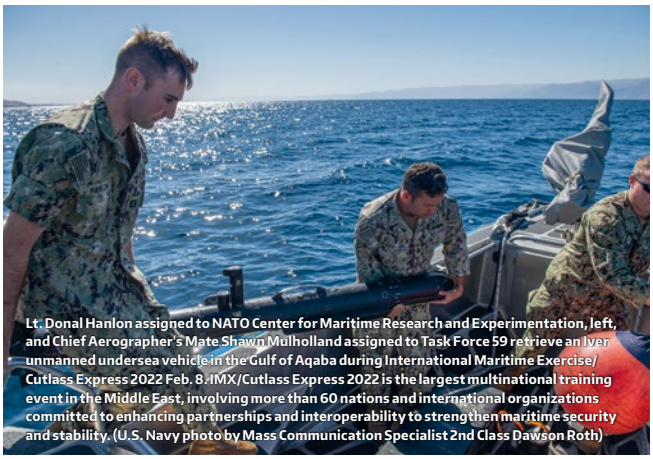
TH: We are approaching the one-year mark and we have made rapid progress. After we established the Task Force in September 2021, that very month we brought out a number of unmanned surface vessel kits. We put them in the water in October alongside our crewed ships in an exercise called New Horizon. And we did all of this with a decades-long strategic partner, Bahrain, who hosts the headquarters of U.S. 5th Fleet. The New Horizon exercise was historic. It was the first time that U.S. 5th Fleet had ever put USVs alongside our crewed ships in Middle Eastern waters.

In November, we built on New Horizon's success by establishing another operating hub to launch our drones. So, we now have two operating hubs for unmanned systems: one in Jordan, which provides access on the western side of the Arabian Peninsula, and Bahrain on the eastern side. Fast forward to January/February, and this is when we conducted International Maritime Exercise 2022, the largest maritime exercise in the region with more than 60 different nations and organisations.

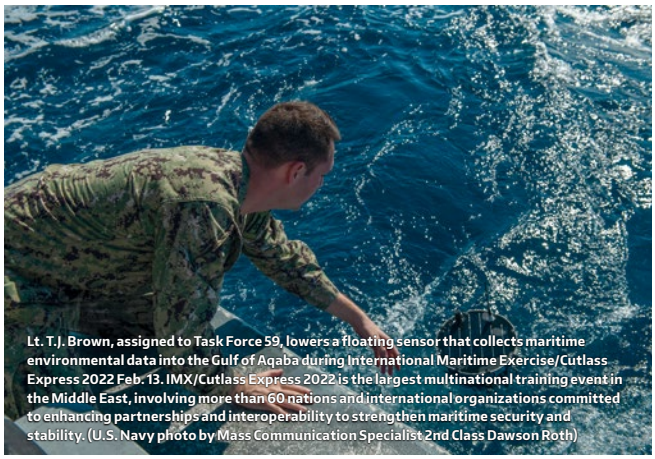
An important component of this large-scale exercise was that we established a multinational unmanned systems and AI integration team called Task Force X. This group brought more than 80 unmanned systems from 10 different countries to the region to work alongside crewed ships. The training enabled us to sharpen our skills and test concepts for using the new systems in 13 different operational scenarios.

We drew a lot of lessons that we were then able to apply from March through June. During this time, we conducted additional exercises and operations at sea with a number of partners, including Israel and Egypt. We performed an operational demonstration with Kuwait in June, followed by another with Qatar in the Arabian Gulf. And of course, we were constantly working with Bahrain and Jordan all throughout.

Lt. Donal Hanlon assigned to NATO Center for Maritime Research and Experimentation and members of the Royal Jordanian Navy lower a Slocum Glider unmanned undersea vehicle into the Gulf of Aqaba during International Maritime Exercise/Cutlass Express 2022 Feb. 8. IMX/Cutlass Express 2022 is the largest multinational training event in the Middle East, involving more than 60 nations and international organizations committed to enhancing partnerships and interoperability to strengthen maritime security and stability. (U.S. Navy photo by Mass Communication Specialist 2nd Class Dawson Roth)



Lt. Donal Hanlon assigned to NATO Center for Maritime Research and Experimentation, left, and Chief Aerographer's Mate Shawn Mulholland assigned to Task Force 59 retrieve an Iver unmanned undersea vehicle in the Gulf of Aqaba during International Maritime Exercise/ Cutlass Express 2022 Feb. 8. IMX/Cutlass Express 2022 is the largest multinational training event in the Middle East, involving more than 60 nations and international organizations committed to enhancing partnerships and interoperability to strengthen maritime security and stability. (U.S. Navy photo by Mass Communication Specialist 2nd Class Dawson Roth)



Lt. T.J. Brown, assigned to Task Force 59, lowers a floating sensor that collects maritime environmental data into the Gulf of Aqaba during International Maritime Exercise/Cutlass Express 2022 Feb. 13. IMX/Cutlass Express 2022 is the largest multinational training event in the Middle East, involving more than 60 nations and international organizations committed to enhancing partnerships and interoperability to strengthen maritime security and stability. (U.S. Navy photo by Mass Communication Specialist 2nd Class Dawson Roth)

RE: It sounds like a busy year with a lot of progress on the technological front. What were the main benefits?

TH: Not only did we establish a task force to integrate unmanned systems and AI, but Task Force 59 is also serving as a vehicle to strengthen our partnerships, to do it in a way that allows us to work more closely with our regional partners. Why? Because the true purpose and value of integrating unmanned systems and AI is to really enhance our ability to monitor the surrounding seas. These new systems give us more eyes out there in a persistent and networked way that we otherwise would not have.

We have already seen some of the platforms we are observing stay out to sea for six months at a time with no refuelling, no stops for maintenance, and no resupply. It is very uncommon for any of our crewed ships to just be out there for that length of time without significant logistical support.

The platforms we have out there are equipped with radar and sensors not only for navigational purposes, but also for data collection. And it's not just about having sensors on the unmanned surface vessels themselves. When you combine those vessels and their sensors with other systems we have under, on or above the water, networking all of that together really allows us how have a much clearer picture of what is happening. The reason why it's important to have a clearer picture is if we can see something sooner then we can respond sooner. Or if we can see something from further away, then we can respond to the left of the problem, if you will.

The other thing is what we call "deterrence". An easy way to understand deterrence is as the "security guard effect." If a shoplifter knows that someone is watching when they go to the mall, they will likely be less inclined to commit a crime. The same principle applies at sea. By having more eyes out there through unmanned systems technology, coupled with AI, someone that has ill intent is more likely to think twice before engaging in destabilizing activity out of concern for being seen and getting caught.

Having greater awareness of what's happening at sea also puts us in a better position to send assets and direct resources where they need to be. A clearer picture with more data helps us identify what's important and what requires our attention. Using AI and machine learning to process and sort

A Saildrone Explorer, Devil Ray T-38 unmanned surface vessel, littoral combat ship USS Sioux City (LCS 11), and U.S. Coast Guard cutter USCGC Baranof (WPB 1318) sail in the Arabian Gulf, June 26. U.S. naval forces regularly operate across the Middle East region to help ensure security and stability. (U.S. Navy photo by Chief Mass Communication Specialist Roland A. Franklin)

A Devil Ray T-38 unmanned surface vessel, littoral combat ship USS Sioux City (LCS 11), and U.S. Coast Guard cutter USCGC Baranof (WPB 1318) sail in the Arabian Gulf, June 26. U.S. naval forces regularly operate across the Middle East region to help ensure security and stability. (U.S. Navy photo by Chief Mass Communication Specialist Roland A. Franklin)

A Triton unmanned surface vessel (USV), left, and a Devil Ray T-38 USV operate in the Red Sea, Aug. 19. U.S. 5th Fleet is rapidly integrating new unmanned systems and artificial intelligence into U.S. naval operations across the Middle East to enhance vigilance of the surrounding seas. (U.S. Navy photo by Lt. Cmdr. Ray Miller IV)

through vast amounts of data to illuminate what's important for our decision makers can help them make smarter decisions faster. So, this has proven very promising and we are very excited about it.

RE: Did you have any maintenance crews from the companies on board your crewed ships?

TH: It depends on the type of platform. When we're talking about unmanned surface vehicles (USVs), Task Force 59 is primarily integrating two types: high endurance and high speed. High endurance refers to the persistent intelligence, reconnaissance, and surveillance (ISR) capabilities that gives us the ability to collect data over long periods of time. Our crewed ships can do that already. But when you send multiple unmanned systems out there and you can do that without maintenance, refuelling, resupply, or giving the crew needed time off, it really gives you capabilities that you wouldn't have otherwise. As for high speed USVs, the focus is on getting somewhere quickly, and we have the fastest USVs in the world out here with us.

But to your question, the type of USV and its mission are key factors for what a maintenance cycle looks like, or what kind of support team you need nearby – whether ashore or at sea on a ship patrolling in the vicinity. We are in an innovative environment that enables companies to test their systems and understand what level and frequency of maintenance is needed in very challenging operational conditions.

RE: Are there advantages in using these COTS equipment?

TH: Yes. Commercial-off-the-shelf or dual-use technology – as we also call it – offer us solutions that exist today rather than years from now. These platforms have enabled us to make very significant progress in such a short time span. The traditional U.S. military budgeting and acquisition process is designed for big hardware like aircraft carriers and fighter jets. Acquiring software and the latest commercial technology is much different. Many of these emerging technologies evolve and update every few months or even weeks. So, we're able to remain on the cutting-edge of new advancements through this approach, which is a tremendous advantage for both us and our regional partners.

Task Force 59 is taking technology that exists today and applying it in a way that can be scaled up over time. In fact, we believe that what we are doing here in the Middle East can serve as a bridge to what lies ahead for the U.S. Navy as a whole: a future hybrid fleet of hundreds of manned and unmanned ships deployed globally. Task Force 59 currently has 20,000 hours of hands-on experience with new our systems. This equates to 10-years' worth – Monday through Friday, nine to five – of figuring out what works and what doesn't. Our feedback helps rapidly move the development and innovation process forward.

RE: Are you still looking for other companies that provide unmanned systems solutions?

TH: Absolutely! We plan to bring out additional companies in the next few months and are working through the process of formally inviting them. Innovators and companies who meet criteria announced weeks ago will have an opportunity to come out and bring their systems along too. We don't talk about future operations and exercises for security reasons so I won't go into specifics, but the bottom line is that our exploration process for new partners, new technology solutions and innovative ideas continues. We want to build on what we have already achieved.

"The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement."

Courtesy of Hyper-Sub Platform Technologies

HYPER-SUB PLATFORM TECHNOLOGIES PRESENT THE FAST BOAT (DRY CABIN) SUBMARINE

HISTORY

Hyper-Sub Platform Technologies Inc. was founded in 2016 in Lake City, Florida by marine engineering entrepreneur and subsea visionary Reynolds R. Marion. His obsession – first sparked in his bedroom as an 11-year-old boy in West Virginia – was to invent and build a highly capable and powerful, long range, shallow draft speed boat that could seamlessly convert to a fully functioning, long duration, pressure tolerant dry-cabin, electric mini-submarine. Additionally, it would be capable of carrying multiple passengers in comfort alongside a large payload of mission equipment to be used for a multitude of tasks while ranging hundreds of miles on and below the surface of the ocean. And so, the Fast Boat (Dry Cabin) Submarine – or FBS – was born.

The FBS is equally capable and adaptable for use as a private pleasure craft, commercial eco-tourism platform, subsea engineering and recovery craft, or ocean science and exploration vessel. For the purposes of this article, however, we will explore its wide-ranging capabilities in the Defence and Security Sector.

BACKGROUND

FBS is fully engineered and provisioned for a range of littoral, green or brown water sea to shore connector operations. Not only can it successfully navigate in extremely shallow waters, with its 2.7ft (0.8m) draft option, but it can also operate fully submerged and undetected in less than 15ft (4.5m). Also, unlike its competitors, FBS does not require that crew and passengers wear dive gear for flooded cabin operations during the dive phase. This is thanks to the fully dry, 1 atm. pressure barrier cabin which unlike any competitors allows for superior, extended submergence capability in dry comfort and without the dangers of decompression sickness.

FBS comes with twin 480HP diesel engines capable of a top speed of 26kts on surface with a 525 gallon / 1,987-liter fuel tank. Alternatively, using its electric over hydraulic subsea thrusters it's capable of 5-7kts submerged. FBS can operate over several hundred miles (dependent on payload, choice of battery packs, and operating speeds, etc.)

Since the end of the Cold War and the subsequent three decades, there has been a well-documented increase in localized political tensions and armed conflict around the world, including the coastal regions of the Eastern Mediterranean, the Middle East, the South China Sea, and of course, the current conflict between Russia and Ukraine. This has heralded an increased occurrence of littoral zone incidents.

This is actively being addressed in the USA through the formation, this year, of the first of three Marine Corps Littoral Regiments.

Additionally, an article in the United States Naval Institute News of May 20th 2021, quoted Vice Adm. Keith Blount RN, Commander of NATO's Allied Maritime Command (MARCOM) who stated that there is "(A) required focus on command and control (C2) and networks in the littoral environment... whereby navies can project power from the sea to the shore seamlessly.",

and that "All (of) the above being most useful in considering future littoral warfare in places like the Mediterranean Sea, the Black Sea, the Baltic Sea, or even the High North."

This approach to force projection in a contested littoral environment or Weapons Engagement Zone (WEZ) has led Hyper-Sub to develop the family of long-range, Fast Boat (Dry Cabin) Submarine connector vessels. The scalable and highly modular payload design approach allows for a full range of packaged mission sets, including offensive or defensive capability for blue, green, and brown water, amphibious or special operations tasking. FBS can be deployed from a Forward Operating Base, home port, slipway, estuary, or delivered in theatre by the largest transportation aircraft, Landing Craft Dock, Offshore Patrol Vessel, or other amphibious sea to shore connector solution.

Once in theatre, FBS can ingress the WEZ and roam hundreds of miles above and below the water line, covert and alone, or as part of a multi-system, multi-domain zone security force multiplier for disparate surface, subsurface, offensive and defensive, or humanitarian missions. Furthermore, it is ideally suited for anti-terrorism, piracy, narcotics interdiction, and border security patrol.

FBS DESIGN

The key to FBS unique design and capabilities is five-fold:

- SEA FRAME: Ingeniously but practically designed, this is the functional base of the entire vessel providing a low center of gravity while rigidly and robustly securing the engines, ballast tanks, battery modules, and cabin. The vessel has a low-profile design which helps to stabilize it in turbulent sea conditions and minimize detection. It also allows for a payload of approximately 3,000lb (1,360kg) for any additional mission equipment.

- DRY CHAMBER: The pressure inside the acrylic cabin remains constant (at 1 atmosphere) regardless of the operating depth, keeping the crew and passengers warm and dry, while enabling prolonged dive and deployment times, thus increasing mission capabilities. Built for depths to 500ft (150m), single and multi-cabin options are available and customizable for different missions or uses. This includes multiple, modular configurations for crew/passenger seating, equipment, electronics, or mission specific workstations. Alternatively, floodable lock-in/out chambers for dive teams can be provided.

- BALLAST TANKS: An innovative 8 chamber, air compensated, hyper-ballast tank design revolutionizes FBS safety with over 30,000lbs (15tons) of reserve lift available for rapid ascent. Additionally, the Controlled Dead Systems Submerged Recoverability means the boat can surface with all primary air, electrical, and hydraulic systems shut down in a controlled fashion. The vessel can still recover even if the cabin is flooded, there being sufficient reserve air to blow the main ballast tanks twice at 500ft (152m) depth using standard air loads.

Courtesy of Hyper-Sub Platform Technologies


Courtesy of Hyper-Sub Platform Technologies

- MODULARITY: As previously mentioned, FBS can be supplied with a combination of cabin and cargo space to fit the required use of each client. Additionally, the client can buy FBS with multiple modules for fast change out prior to or between different mission sets. It even comes as standard with 68 ft2 / 6.5m2 flatbed storage available above the engine deck, or further space available on the flat, gunwale surfaces.

- CERTIFIED COMPONENTS: As with any emerging technological solution on the market, a proven track-record can be a challenge. What FBS cleverly does is employ already established COTS components that have already individually been approved for marine and subsea operations elsewhere. For example, the acrylic cabin, engines, hull, battery packs, subsea thrusters, etc., are all proven and certified options currently being used for other commercial marine products.

All of the above allows FBS to get in close and ultra-shallow for nearshore applications, whether ISR, coastal security, riverine/estuarine or covert, dry insertion of marines and other amphibious assets. This FBS variant is outfitted with a shallow V/W hull blend that enables surface navigation in waters as shallow as 2.7ft (0.8m) and incorporates a single cabin that allows for multiple workstations, or for a team of eight. This "ingressor" platform can provide multiple mission formats in a practical and versatile way.

In swimmer delivery configuration, divers stay dry and warm until mission execution. FBS can submerge from over the horizon, covertly ingress an area, and loiter until the time is right to deploy the team and assets. FBS has been designed to address many additional payload requirements, including rapid UUV deployment. This variant features a deeper v-hull design and incorporates a forward cabin (for a pilot and copilot) plus rearward lock-in/lock-out cabin for swimmer delivery.

The dry cabin(s) produce greater mission flexibility and outcome probabilities by keeping personnel comfortable for longer, which is a significant advantage over all current "go-fast" wet sub designs.

FBS is not only ideal for the nearshore, but it can also be strategically forward deployed from blue water in place of larger assets. Multiple low profile FBS units with varied payloads can be deployed as required, to increase tactical mission capabilities with reduced likelihood of detection.

ADVANCED TECHNOLOGIES INTEGRATION

Latest surface and subsea autonomy and remote navigation capabilities are embedded into the FBS vessel. Defence and security systems are to be as standard supplied with the latest:

- SOFTWARE: A flexible and scalable SWaP-C based framework for cooperative robotic mission planning/execution, with open architecture and encryption enabled protection – as used by US Navy Expeditionary EOD UUV teams – SF diver propulsion vehicles, and hand-held navigation devices. This software also provides precise independent underwater navigation capability and referencing, using pre-set waypoints, to target location and navigation by target or object of interest, station keeping, etc. using camera or imaging sonar data.

- HARDWARE: FBS also exploits the very latest in subsea navigation capabilities via the integration of an Inertial Navigation System (INS) fed from the Attitude and Heading Reference System (AHRS), Inertial Measurement Unit (IMU) and the Doppler Velocity Log (DVL) seabed tracking device, which may then be aided and refreshed through deployable surface GPS or Ultra Short Baseline (USBL) input. This package also allows for expansion to include Over the Horizon Supervised Autonomy or pilot free, remote command and control with mission re-tasking on the fly capabilities.

FBS DEVELOPMENT ROADMAP

An ongoing program and product roadmap for continuous evolution is planned. This includes continuous review of vessel architecture and materials, both internally and in partnership with clients. Additionally, the manufacturer can work closely with relevant authorities and institutions to monitor and improve thermal, acoustic, EMI/EMC footprints, and other detection avoidance capabilities. Propulsion methods will also remain in review, including the latest emerging, alternative battery power technology sources, as well as green, alternative energy like methanol, biofuel, and hydrogen fuel cells, etc. Developments will include the increased use of the latest AI algorithms enabling ''hands-off' or full remote global control, and unmanned or supervised autonomy routines with built in machine learning capabilities for continued evolution of the product lifecycle.


Courtesy of Hyper-Sub Platform Technologies


Courtesy of Hyper-Sub Platform Technologies


Courtesy of Hyper-Sub Platform Technologies

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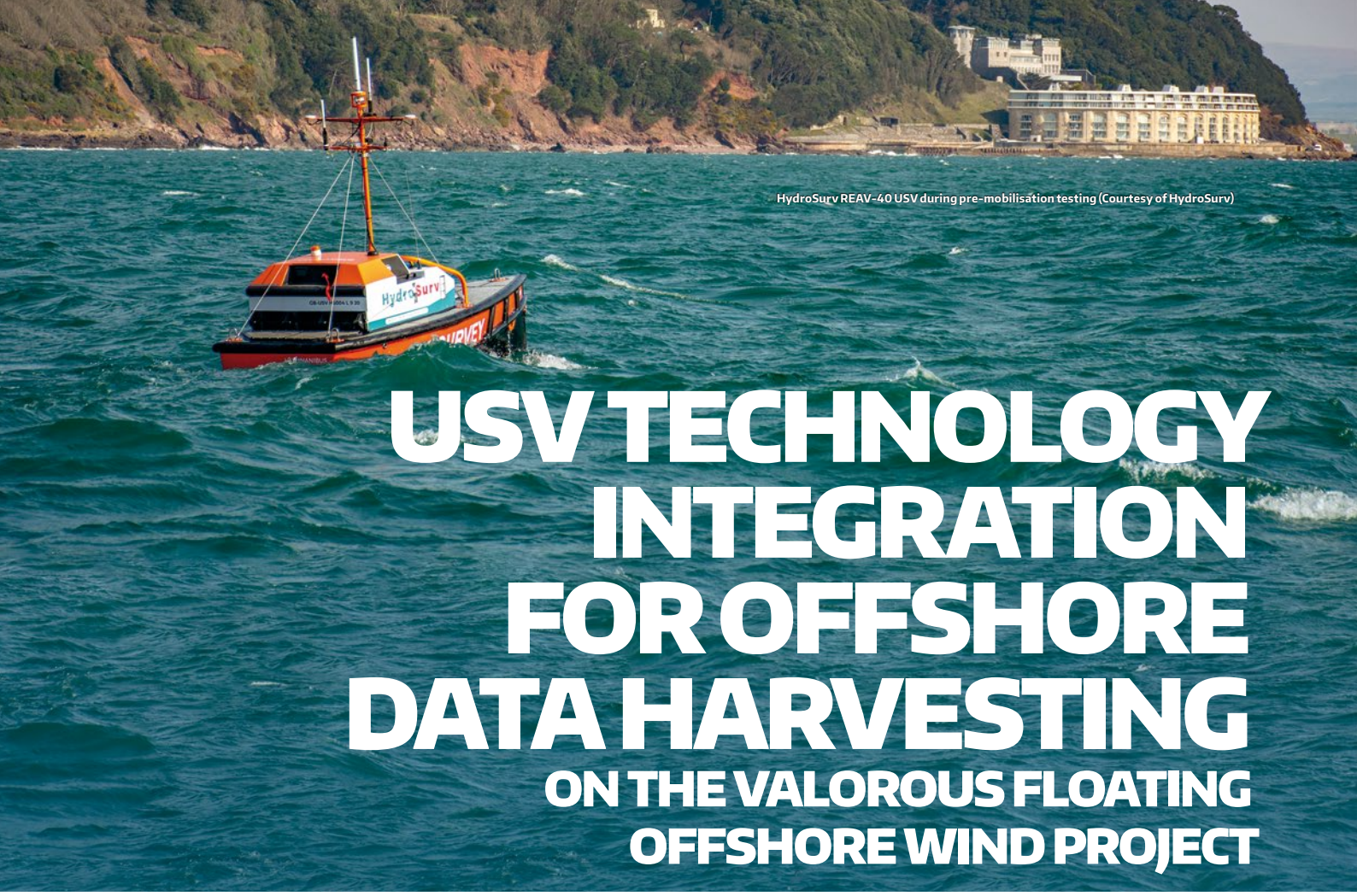

HydroSurv REAV-40 USV during pre-mobilisation testing (Courtesy of HydroSurv)

USV TECHNOLOGY INTEGRATION FOR OFFSHORE DATA HARVESTING

ON THE VALOROUS FLOATING OFFSHORE WIND PROJECT

This project demonstrated the application of HydroSurv Uncrewed Surface Vessel (USV) and Sonardyne acoustic communications technology for rapid environmental data collection to Blue Gem Wind, Simply Blue Group and Offshore Wind Consultants (OWC) focusing on the Valorous Floating Offshore Wind (FLOW) Project.

The demonstration, which took place in the Celtic Sea, was part of an extension to the 'Robotics for a Safer World' challenge, co-funded by InnovateUK.

BACKGROUND

Offshore renewable energy projects need data throughout their lifespans, including detailed surveys at the development stage. Data harvesting surveys have traditionally been carried out using conventional vessels with crew onboard. However, as project sites become more challenging and complex to access, there is growing demand for survey solutions that keep people out of harm's way in safer onshore environments.

Additionally, as the industry strives to reach its net zero emissions targets, developers need low carbon alternatives to complete these critical tasks. Cost is also a key factor, and with suitable design support for robust data collection, a wind farm can reduce failures and associated downtime and their resulting negative impacts on revenue.

Offshore renewable energy projects need to determine the most suitable landfall location to bring the export cables ashore, considering multiple factors including water velocity profiling to assess risk of cable scour. As well as this, detailed understanding of the current conditions helps offshore wind farms understand the environmental pressures that their export cables are required to withstand throughout the project's lifetime.

CHALLENGES

Accurate spatial and temporal data is a key element to the development of offshore renewable energy projects. Accessibility is often difficult however, with the required frequency of site surveys to gain sufficient data increasing both risk and cost. In addition to this, projects are being placed further from shore, exacerbating the accessibility challenges.

Developers also need to ensure that no damage is done to existing subsea infrastructure, as well as be able to monitor these assets and ensure they are operating correctly throughout the data collection campaign. Weather and sea states need to be constantly monitored, particularly if deploying a traditional, crewed vessel.

APPROACH

Exeter-based HydroSurv, an innovator in USV technology, collaborated with Sonardyne to demonstrate the benefits of USV platforms in providing rapid environmental assessments offshore. Their aim was to show integrated capability using a HydroSurv USV fitted with Sonardyne's Mini-Ranger 2 Ultra-Short Base Line (USBL) positioning system.

Testing at Smart Sound in Plymouth (Courtesy of HydroSurv)

SOLUTION

USVs can visit challenging offshore sites more frequently, at significantly lower cost and with a carbon impact reduction of over 90%. HydroSurv's zero emission, fully electric REAV-40 USV design is capable of self-transiting to nearshore work-sites, offering a day-work capability that enables new ways of collecting data for cable route engineering and more.

Sonardyne's Mini-Ranger 2 USBL system is popular for use on mid-size USVs because it provides easy to install and use capability to position, track, communicate with and health check and configure/reconfigure mobile and seafloor-based instruments. Like all Sonardyne hardware, it uses Sonardyne's 6G Wideband spread-spectrum digital signal processing to communicate, track and position any 6G-enabled instruments.

RESULT

In March 2022 the collaboration team streamed a live, online demonstration to Blue Gem Wind, Simply Blue Group and OWC audiences in multiple locations, harvesting data straight to a cloud portal and showing near real-time seabed data to desk capability.

The integration demonstrated real-world capability of USVs, as platforms for integrated systems and sensors, to execute critical data harvesting campaigns safely and cheaply for the offshore sector, providing near real-time data and information of immediate value to the customer.

This project combined the proven environmental and financial benefits of deploying USV platforms with USBL underwater positioning and Acoustic Doppler Current Profiler (ADCP) technologies. However, the approach is relevant to many other instrument types and symbiotic systems.

HydroSurv's larger, longer endurance REAV-60 USV design offers increased capability further offshore in harder to reach locations and more challenging waters for low cost, low carbon data harvesting capability. HydroSurv is now making Mini-Ranger 2 and SprintNAV Mini integration available for customers to specify for turnkey integration into its USV platforms.

Alfie Wisdom, Delivery Manager at Blue Gem Wind: "Innovation in the supply chain will play a key role in reducing the costs and risks associated with offshore wind in the Celtic Sea so we were delighted to provide feedback to local companies from the Southwest as they bring new ideas to this exciting sector."

Jagadish Vallarampara, Senior Metocean Specialist at OWC: "Understanding accurate oceanographic conditions in real-time mode reduces uncertainty and helps the engineering and scientific communities make decisions. Subsea communication for offshore data gathering is vital for upcoming offshore operations where ocean floor information is critical for informed decisions on investments and operations."

Aidan Thorn, Business Development Manager, Marine Robotics, Sonardyne: "The world is increasingly digital. We now routinely use the cloud in our homes and even the high street, for example. We have all the data we need at our fingertips. It's time we took more of this capability to our offshore and underwater operations. This project is a step towards that vision. "Working with HydroSurv, we've shown how we can create intelligent networks of sensors and uncrewed platforms. By doing this we can provide users access to the actionable information they need from seabed sensors, in near real-time, wherever they are in the world. What's more, they can even configure or reconfigure their remote sensors, all from their desktop. "Put it this way, it's like having access to your home thermostat from your smart phone, except it's on the seabed. This is a new digitally enabled way of working, bringing decision-making about operations many kilometres away and hundreds of metres beneath the sea surface, to your fingertips."

Ian Godfrey, Chief Operating Officer, HydroSurv: "This collaborative, seabed to desk data collection project provided a fantastic opportunity for us to demonstrate a new integrated survey solution for the offshore wind sector. The project has provided a real-world example of the ability to monitor subsea assets at greater frequency, at lower cost and with a significant reduction in carbon emissions when compared to survey campaigns carried out with traditional, crewed vessels. "We see this integrated solution with HydroSurv's USV technology and Sonardyne's subsea communications equipment as a real enabler for the offshore wind sector and others where a win-win reduction in cost and increased visibility of live data and subsea survey asset health provide a new level of service, well suited to the increasingly challenging environments faced by offshore wind farm developers.

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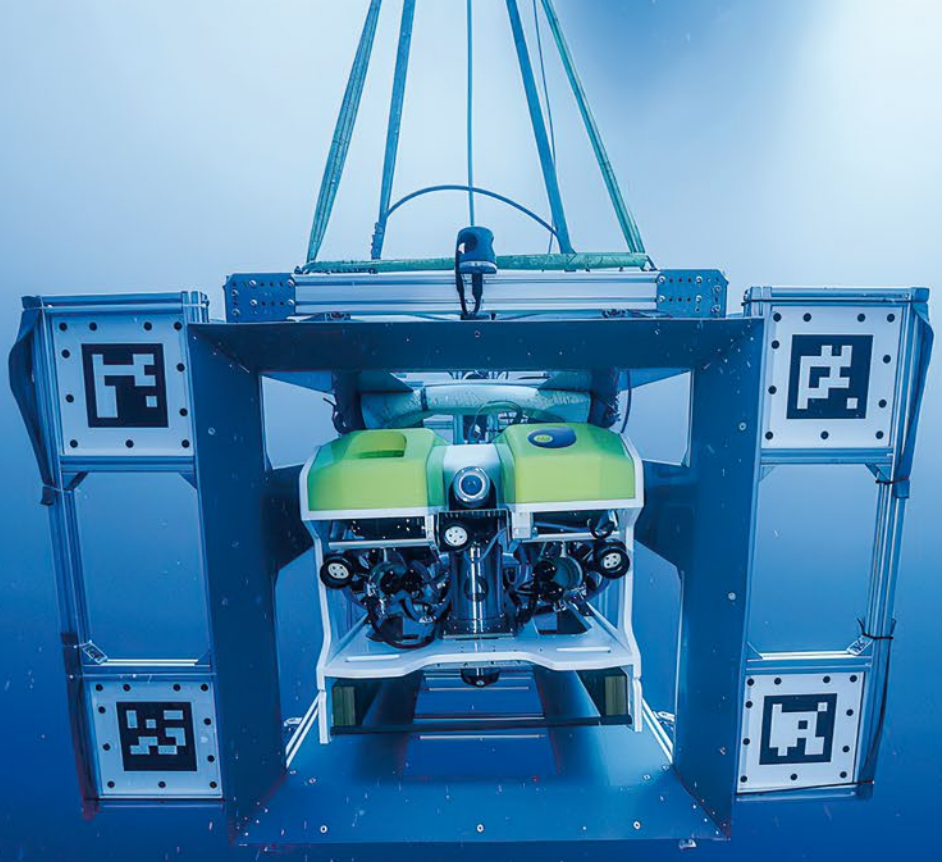
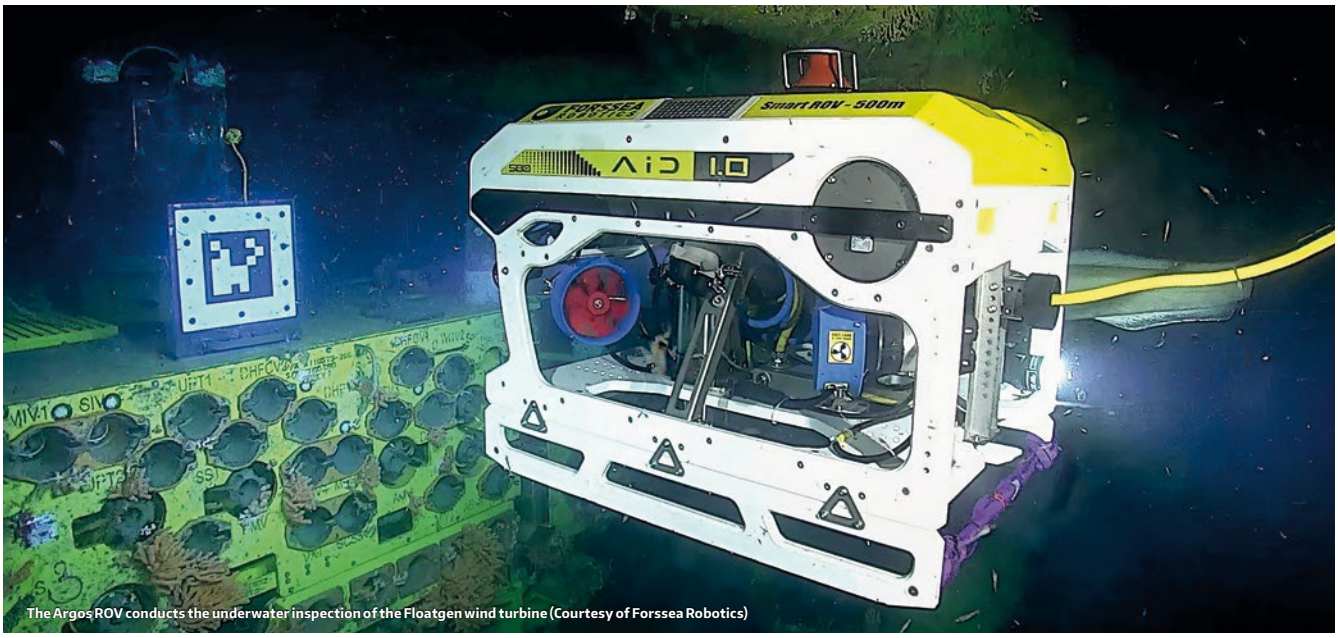


Forssea Robotics ARGOS ROV equipped with iXblue Rovins Nano/Nortek DVL tight coupling solution (Courtesy of Forssea Robotics)

POWERING AUTONOMOUS SUBSEA INSPECTION FOR OFFSHORE WIND FARMS

Back in June 2021, Forssea Robotics (a smart ROV asset and visual positioning technologies provider who aims at increasing productivity of underwater inspections and light intervention repeatable tasks) successfully completed the annual underwater survey of the FLOATGEN floating wind turbine using its advanced ARGOS ROV. Anchored 12nm offshore from the Le Croisic coast on the Centrale Nantes Offshore test site, FLOATGEN is the only offshore wind turbine to be installed in France.



The Argos ROV conducts the underwater inspection of the Floatgen wind turbine (Courtesy of Forssea Robotics)

The main goal of this underwater survey was to visually confirm the integrity of the mooring lines and dynamic umbilical system, besides characterising marine growth on the various components. To do so, Forssea deployed its smart ARGOS ROV, in partnership with Sulmara Subsea. They are an international survey services contractor, who were responsible for supplying the survey and positioning services during the subsea operation. A long-standing partner of iXblue, Forssea – who is used to relying on iXblue technology for its offshore operations – equipped its ARGOS ROV with the Rovins Nano/Nortek DVL tight coupling solution to get highly accurate navigation information. iXblue's new Gaps M5 USBL system was also deployed to precisely position the ARGOS ROV during the three-day inspection operation.

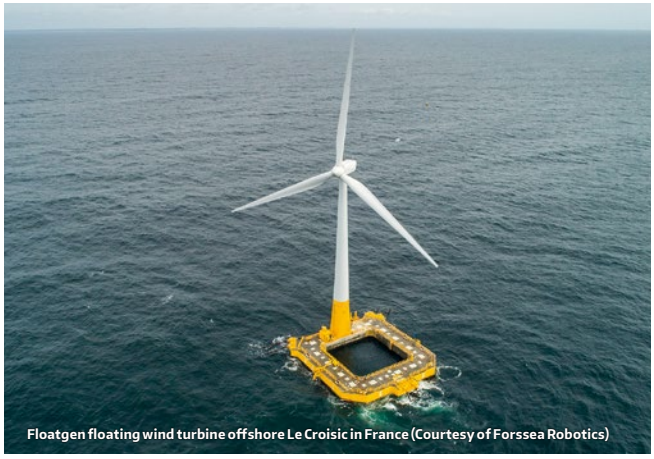
Reducing operational costs and increasing operational efficiency using Crew Transfer Vessels (CTVs) alongside other smaller opportunity vessels to conduct accurate but efficient operations in a reduced timeframe is key to wind farm developments. The use of smaller and smarter technologies that do not require big vessels and large crews to be deployed, and that reduce the hours spent at sea is therefore central to the transition of the offshore industry.

By providing autonomous survey capabilities that help automate windfarm mooring inspections and other light intervention repeatable tasks, Forssea's Light Intervention Class smart ARGOS ROV – a compact yet powerful ROV suited for IRM operations and especially for offshore wind farm O&M work – offers improved performance and greater operational efficiency to meet those requirements. But while deploying advanced inspection means is one thing, accurately positioning them is also critical to conduct successful and efficient subsea operations.

"One of the key strengths of iXblue positioning solutions, such as their Gaps M5 USBL system, is that they are compact and lightweight, and thus easy to deploy from a CTV and other small vessels used in the windfarm industry." comments Gautier Dreyfus, Forssea Robotics CEO. "And because they embed their own motion sensors, they do not require any on-the-field calibration, which provides precious time savings during operations. Combine that to their extreme accuracy in shallow waters and horizontal tracking conditions, and you get an ideal positioning solution for wind farms applications."

He goes on to say, "Globally, our client was very happy with the precision achieved by the Gaps M5 USBL system and Rovins Nano/DVL tight coupling solution. Despite challenging deployment conditions – with strong winds and shallow water depths between 0 and 30 meters – the navigation and positioning solution used, combined with the high skills of the Sulmara personnel, offered very accurate and stable positioning. This was a key requirement for the successful autonomous inspection of the FLOATGEN wind turbine.

"In the end, our autonomous subsea inspection solution, combined with the high technology we deployed and the top-notch personnel involved, enabled us to achieve substantial efficiency, conducting the inspection tasks 8 times faster than what is usually observed using traditional methods."


Floatgen floating wind turbine offshore Le Croisic in France (Courtesy of Forssea Robotics)

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Courtesy of Film-Ocean

CREATING THE PERFECT SET UP

FOR INSPECTING SPACES TOO SMALL FOR INSPECTION CLASS ROVS

In 2022 Film-Ocean successfully delivered the perfect ROV setup for a subsea Gravity Base Tank (GBT) inspection. This impressive endeavour was achieved thanks to the expertise built through year-on-year delivery by the Film-Ocean team, who have refined and enhanced their innovative flyout system over the past seven seasons to complete annual inspections of a GBT.

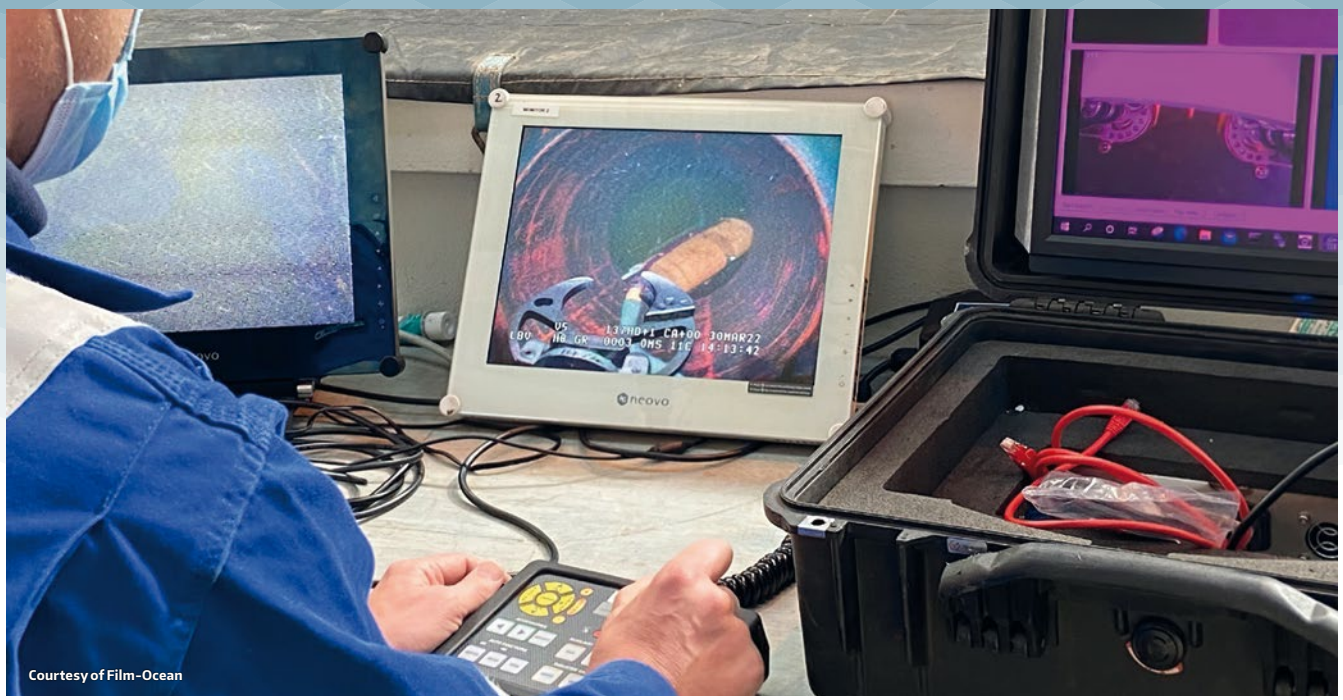
OVERCOMING COMPLEX REQUIREMENTS

For the latest inspection, the GBT is divided into sections; it has a small entry hole on the top of one of the compartments, with internal, smaller port holes between each subsequent section. As a result, only the smallest of micro ROVs can gain access.

An added complexity for the micro ROV gaining access is that it's interfaced with a weld inspection tool. Due to the multiple snagging hazards for the tether and the navigation required within the GBT, only the most experienced ROV pilots would be able to complete this complicated task.

In 2016 Film-Ocean provided an ROV solution to carry out inspections of conductor welds inside of a subsea gravity base. The scope of work was for close visual inspection, general visual inspection, and NDT (Non-Destructive Testing) of the conductors. The campaign was delivered using a Seaeye Falcon ROV alongside a VideoRay micro ROV. To gain access to appropriate locations, a protective armour wrap had to be removed from some of the conductors. This was accomplished with the assistance of the VideoRay operating inside of the gravity tank. The VideoRay was then used to complete as found surveys, followed by Alternating Current Field Measurement (ACFM) testing using an ROV mounted probe.

The campaign was successful achieving an overall uptime utilisation of 94%, with the remaining time being used to create innovative solutions in order to complete the inspections.



Courtesy of Film-Ocean

3D MODELLING AND A MORE POWERFUL SYSTEM

Following the 2016 campaign, Film-Ocean made further advancements. A 3D model of the GBT was created, enabling the team to run each scenario and plan for more efficient and practical movements for the ROV. For the 2017 season, a Sub-Atlantic Super Mohawk was selected, offering a more powerful system with a steadier platform and increased weather limits. The VideoRay was replaced with an LBV ROV, a skilled installation with an independent TMS (Tethered Management System) for the LBV.

In addition, the Super Mohawk was modified to allow for a suitable AC power supply to reach the LBV, which could be switched via the ROV's software. The 2017 campaign was hailed as a success for the second year running.

The next three subsequent campaigns used the 2017 setup with revisions to the assets, including enhanced LBV slip rings, telescopic legs fitted to the A-frame, and an optimised release mechanism for the NDT tool.

THE PERFECT SETUP

Using experience gained from the previous five campaigns, in 2021 Film-Ocean decided to create the 'Perfect Setup'. The objective was a system that offered maximum power for both the main ROV and the micro flyout ROV. The LBV has a relatively high-power consumption, which was a limiting factor when running directly from the mother system. The optimal setup would be to have an independent power supply to the LBV while ensuring the data transfer speeds were high enough to allow for the required results from the NDT inspection.

Film-Ocean selected a Seaeye Cougar-XT system with a garage tether management system. A unique skid was manufactured for the system to allow for an enhanced LBV tether configuration. They also modified the Cougar-XT TMS to increase the height. This meant that all items could be housed with enough space to operate efficiently, while continuing to launch and recover safely within the system's limitations.

Topside, the control container had an independent power supply installed for the LBV, allowing both the Seaeye Cougar and LBV to be run at full power if needed. A test tank trial was completed successfully, and Film-Ocean mobilised the equipment spread.

Using all of the lessons learned over the years meant that Film-Ocean were able to complete the project in the quickest time ever. They were also able to conduct inspections on those conductors that were inaccessible in previous campaigns. The ROV flyout solution deployed was deemed 'close to perfect'.

THE 2022 CAMPAIGN

For the 2022 inspection campaign, the same ROV solution was deployed with no changes to the setup. A full-scale mock-up of the GBT was replicated in a test tank. The offshore team were fully trained on what to expect; Film-Ocean achieved this by working through various scenarios ahead of the project itself. As a result, on completion of the campaign it was hailed as the most successful to date.

As you can see, Film-Ocean can support your inspection campaigns. Even where there is a requirement for a micro class ROV to access areas of subsea infrastructure that an observation class or work class ROV is too large to manoeuvre safely, Film-Ocean have solutions available for you.

Ocean Robotics Planet

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Please check out our website on:

www.oceanroboticsplanet.com

EXPLORING THE SUBSEA WORLD WITH U-BOAT WORX SUBMERSIBLES

Richie Enzmann, Ocean Robotics Planet

Many of us working in the subsea and offshore industries may have wondered just exactly what the underwater world looks like up close. Some may have experienced it first-hand while scuba diving. But for others - those not keen on swimming around in wetsuits - there is now an alternative option. U-Boat Worx, based out of the Netherlands, have recently opened a manned submersible base in Curaçao, in the Dutch Caribbean, that can make this dream come true. And luckily enough, U-Boat Worx gave me the opportunity to visit their new submersible training center. While there, I took a dive in their slick looking Super Yacht Sub 3 manned submersible to see what all the fuss was about.

www.subcentercuracao.com

Founded by Bert Houtman, the U-Boat Worx story began in 2005 in the Netherlands, the place where it still has its design and manufacturing base. The company offers a range of manned submersibles that can accommodate from one to eleven people, and operate at depths from 100 to 3,000m. The fleet of U-Boat Worx submersibles includes the C-Explorer series, the Super Yacht Sub 3, the C-Researcher series, the Cruise Sub series, and most recently the NEMO.

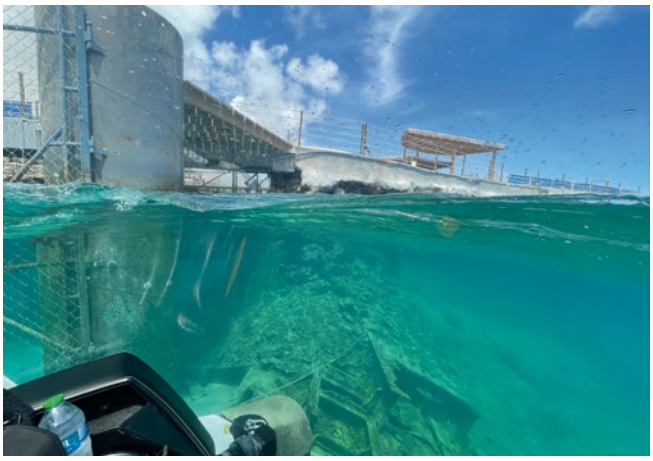
Every U-Boat Worx submersible is designed, engineered, and built to the highest possible standards, and registered with the leading classification society, DNV. In addition to U-Boat Worx's stringent internal quality control and assurance procedures, every submarine is subjected to extensive and exhaustive testing, including hydro-static pressure tests and material qualifications prior to in-house bench testing, followed by harbour then full sea trials before final delivery.

WORLD CLASS SUBMERSIBLE PILOT TRAINING

U-Boat Worx created the first submersible training center in the world to offer year-round training opportunities to submersible owners. The industry-defining, internationally recognised training programs are also available to anyone who aspires to roam the subsea world in a state-of-the-art private submarine. The land-based facility is located at the edge of a pristine deep-water reef that boasts amazing marine life, a diverse range of corals and sponges, and crystal-clear visibility.

Sub Center Curacao offer private individuals and marine professionals the opportunity to become certified submersible pilots. The courses are catered to adventurous private individuals that are looking for a unique experience that will broaden their horizons. Moreover, courses are also available to individuals who aim for a career in the yacht or cruise industry, within which the U-Boat Worx submersibles are widely used.

Depending on the selected training course, the program can be comprised of theory tutorials, hands-on walkarounds, safety implementations, maintenance programs, training dives, and surface control duties, all combined with emergency procedures and challenging training scenarios. The courses at Sub Center Curacao are taught to no more than 2-4 people at a time to ensure that candidates get the personal



attention and real dive time they need. Although training is model specific, the high level of interchangeable systems and common components between the entire U-Boat Worx range of submersibles will allow for efficient cross certification on different models.

This training is also ideal for any ROV/AUV pilot that might want to move into manned submersible piloting, or for the CEO and retired exec that might want to buy their own submersibles. It also caters to any interested professional that might want to experience a day in Curacao to see the underwater world with their own eyes, instead of viewing it via video footage captured by a camera.

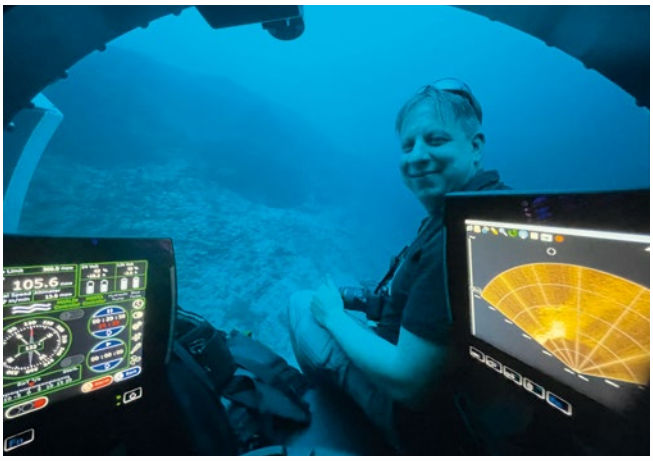
THE INTRODUCTION PILOT COURSE (IPC) EXPERIENCE

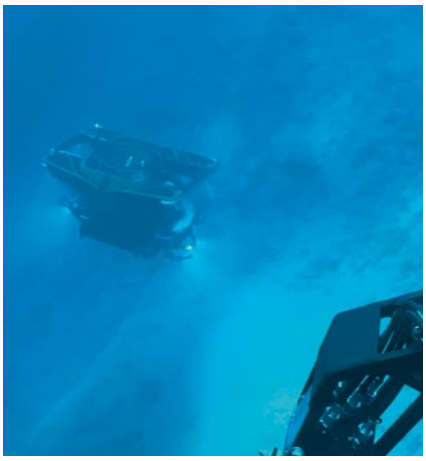
During this full-day activity, you will perform some of the steps it takes to become a certified submersible pilot. This is the perfect option if you are eager to try operating a submersible but are short on time or not quite ready for a full certification course. The program consists of a brief classroom session and introduction to the submersible, followed by hands-on diving activities.

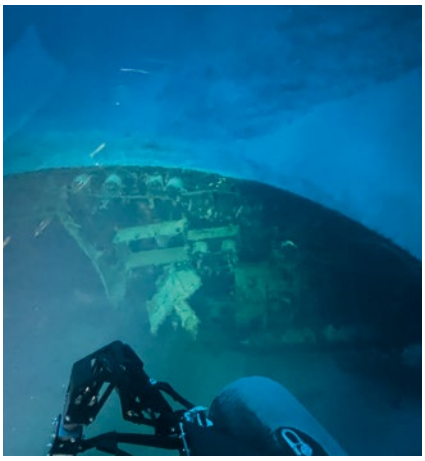
Over the full-day course the trainee pilot will cover the basics of submersible diving. Under the supervision of the pilot instructor, you will be able to control the submersible yourself, and experience first-hand what it is like to operate a submersible.

My training started in the classroom with Barbara van Bebber, the General Manager of Curacao Sub Station. She gave an overview of the company, the structure of command for dive operations, technical basics, and the principles of operating submersibles. She was an excellent instructor and a very experienced and competent submersible pilot, as I later found out during our dive. After the brief introduction to the submersible – which has many of the same components as unmanned ROVs and AUVs – we took the Super Yacht Sub 3 out of its onshore "garage" and prepared it for launch. The Surface Officer from U-Boat Worx helped us in this task by operating a crane. Once the Super Yacht Sub was floating in the water, we climbed in from the shore and got ready for the dive. Barbara diligently went through the dive check list, and once that was completed, we got permission to dive from the Surface Officer.

The Super Yacht Sub 3 is rated for 300m. It weighs just under 4 tonnes, can run up to 12 hours on battery power and oxygen for the pilot and its two passengers. It's a compact and luxurious private submarine especially designed to fit aboard superyachts. To experience the underwater world in the optimal manner, one of U-Boat Worx's design priorities has always been to offer the clearest view possible. To ensure this, the remarkably clear, fully acrylic pressure hull has been positioned at the front of the submersible, providing an unobstructed view in every direction, unimpeded by ballast tanks, batteries, and other components.







Once the hatch was closed, Barbara piloted the sub out of the lagoon towards the open water. It was amazing to be in this glass bubble with full visibility all around. It was a truly remarkable experience, especially as the sub dives under the waves. Then as it descends into the deep, the ambient light gradually lessens, and the surroundings become darker. Visibility in the waters around Curacao was up to 50-60m – much greater than the North Sea for example – so we were very lucky in that regard. My eyes got used to the dark fairly quickly, but we switched on the external lights when we arrived at a significant point of interest.

As we got deeper into the abyss, we came across a team working for a cruise ship operator doing their training dive in the 7-seater Cruise Sub. The Cruise Sub series offers cruise liners, high-end tourism operators, deep sea ocean researchers, documentary film makers, and discerning private underwater explorers a broad selection of submersibles for 5, 7, 9, or 11 people that can dive to depths between 300 and 1,700m. These unique submarines can accommodate the largest number of occupants of all U-Boat Worx submersibles, while delivering first-class performance, revolving seats, and the ultimate in safety and comfort. Thanks to the double-ended viewport design and numerous interior and exterior customisation options, these subs can be adapted to suit many different applications.

We communicated with the Cruise Sub 7 via acoustic modems and passed them as they ascended back towards the surface. Continuing our journey, we arrived at the shipwreck of the Stella Maris that lay at around 150m deep and approximately 250m from the launch location. The sight of this majestic looking 90m long cargo shipwreck was breath-taking. It was like something from the Titanic movie.

It was also interesting to see some lionfish even at this depth. The story of how the invasive lionfish population have destroyed the local coral reef is well known in the Caribbean. Outside of the Asian Pacific, the small fish species and other organisms don't recognise the lionfish as a predator, and thus can't defend themselves. When scuba divers started hunting them, the lionfish adapted by moving to depths outside of their range. Nature behaves in remarkable ways.

Our overall dive was around 3 hours, which we spent investigating sunken tugboats, anchors, and corals. The deepest point we went down to was around 192m.

I recommend that everyone working in the subsea industry try a manned submersible dive at some point in their lives. With U-Boat Worx, this is now more feasible than ever before. It's a truly unique experience. We were lucky enough to see so many beautiful sea creatures and points of interest. Sharks are not guaranteed, but I was told that sometimes they also appear for lucky divers. Maybe next time that could be you!

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RESEARCH VESSEL QUIPS AND INSTRUMENT MOORING TIPS

By Capt. Marc Deglinnocenti, U.S. Merchant Marine (Ret.), oldarmada@gmail.com

Snap! There goes a small fortune of scientific data collecting instruments, sophisticated buoys, cables, anodes, anchors, and other expensive parts of your marine instrument mooring system. Scientific data collection moorings are becoming more and more common these days, because they allow for onsite around the clock data collecting. Losing them at sea can sometimes be traced back to many scientists and many mariners not being experienced in the more practical aspects of constructing, deploying, and recovering their instrument mooring systems. There are some general rules that you can follow right now that might help you while you're handling them. Learning what they are and what they do is a good first step toward that end. Mariners should at least know what they're supposed to be handling does. Maybe they don't need to know how each instrument specifically works at an electrical schematic level, but a little bit of knowledge can help the scientists on board a research vessel meet their goals. Those goals should be the crew's goals too. Most of these moorings basically consist of a weight at the bottom of a long line or cable and a float at the top. There are three general types of scientific instrument moorings.

The surface buoy mooring is probably the least expensive and simplest of the three. It consists of a buoy or float visibly riding on the water surface. A steel cable or common line leads from the buoy to a weight or anchor that rests on the bottom. The data collection instruments are then attached along that cable at different depths. It's sort of like how a crab pot is set up. It's a simple mooring, but it can become a bit more complicated if we submerge the whole setup including the buoy. The next general type of mooring takes the first type of mooring and shortens the cable so that the buoy is now under the water and out of sight. These mid water column moorings need radio or sonic receivers and batteries to release the moorings from their anchors when recovering them. That can get a bit more expensive with the addition of these release mechanisms, but even more so if you want to transmit the collected data in real time. That real time data transmission can get even more complicated and difficult with the third type of mooring. The third type of mooring is a benthic or bottom mooring. It sits on the sea floor in a mount without any cable attached. It usually takes the shape of a miniature pyramid. Naturally, it will also need a sonic release device to recover the scientific sensors when the time comes. These bottom pyramid mounts are usually deployed from ships using a release trip line. You can use a long trip line to carefully lower it to the bottom for shallow depth waters. The other way is to release them when they are just below the surface of the water for greater depth deployments. They have to descend in an upright position all the way down though. Unfortunately, that doesn't always work as planned.

Benthic mounting systems rely mostly on their proper placement on the ocean floor in the first place. The smoother and more horizontal the bottom, the better it is. Uneven or sloped bottoms can affect the upward scanning devices and therefore skew the data. It is recommended that weighted gimbal mounts be used for upward scanning instrument mounts. Acoustic Doppler Current Profilers (ADCPs), which are scanning sensors, are usually installed in these benthic mounts. ADCPs are used to record how fast the current is moving at

The proper way to deploy the mooring system is when the scientific buoy gently goes over first, then the mooring cable is carefully payed out so as not to tangle up, and then the steel anchor weight is carefully released via a trip line. This ensures that the mooring and its instruments are not damaged, and that everything is free and clear from your vessel and deck crew prior to release. (Courtesy of DeepWater Buoyancy)

Deploying an elliptical deep water buoy for higher current areas of research. The ADCP is mounted on top for upward scanning. Only one crew member (far left) gives the pre agreed upon hand signals to the A-Frame operator. This deep water buoy has a different foam density than a shallow water elliptical buoy. The stainless steel framework is specifically designed not to interfere with the ADCP beams. DeepWater Buoyancy of Biddeford, Maine, USA are experts at designing mooring systems. (Courtesy of DeepWater Buoyancy)

different heights up and down the entire water column. They can also record the direction of those currents using multiple sonar transducers. So, it's important that the research vessel crew have good sonar scans of the bottom. The scientists will already have a general location for these benthic mounts, but the mariners should recommend a specific deployment location to help achieve an overall success of the mission. The crew also must have accurate current datum for the time of deployment. That information can mean the difference between a successful benthic mooring deployment and a failed one. There are more ways that a professional mariner crew can help with these types of moorings. Areas of high trawling vessel traffic can ruin a benthic mooring. These fishing trawlers drag a net along the bottom to collect fish. They can also scoop up benthic moorings. Local knowledge of vessel traffic patterns can help scientists choose optimal deployment locations. The crew must learn to work hand in glove with the scientists on board. That doesn't mean that each vessel crew member must have a PHD in marine biology or marine geology, but the crew should know some simple scientific terminology as well as some of the basic functions of the equipment they are handling. There are some basic safety rules for that too.

It's essential that there's only one person in charge of the mooring deployment process. The lead scientist must also be able to signal a halt to the deployment at any time. That scientist should only be allowed to verbally halt the operation but kept at a safe distance so as not being able to rush into the operation whilst it's in motion. Having a mooring deployment checkoff list will help limit these last-minute halts. Checkoff lists will also prevent forgetting important mooring and safety equipment such as the antifouling coating for the ADCP scanning sensors. Deploying the ADCP without it might be reducing your three-year mooring lifespan down to six months of data collection due to marine growth on the transducers. Jim Culter of the MOTE Marine Laboratory & Aquarium says that a mixture of petroleum jelly and chili powder to keep barnacles from clinging to the ADCP transducers is a good fix.

Another procedural rule is to deploy the mooring weight last. If you dump a one ton weight overboard, you immediately run the risk of it dragging everything along with it in one fell swoop. This can damage the entire mooring including the instruments, the buoy, and the cable. This violent pull can snap the connectors between the instruments too. It can also very easily injure the deck crew. Deploying the buoy first avoids this potential catastrophe. I used to have just enough way on my vessel to keep the buoy line from wrapping around the propellers when I captained a research vessel. While slowly towing the buoy along the deck officer can then payout the mooring in an orderly manner. For larger buoys or rougher sea states you can always use stopper lines attached at key locations along the mooring. This will give you even more control of how much mooring line is deployed at one time. The heavy anchor weight can then get released last after you can see that the towed mooring looks straight, untangled, and undamaged. There's more than meets the eye when it comes to these mooring weights too.

Many moorings have been lost, because both scientists and crew members alike have failed to understand the importance of utilizing the correct ground tackle. There's a simple formula for most moorings in slow to medium speed currents areas. Jon Wood of Ocean Data Technologies, Inc. says that a good rule of thumb is to use twice the anchor weight as the buoyancy used. So, if the buoy has a 1000 pound rated buoyancy, then the weight should be 2000 pounds or one ton. So, let's say that an inexperienced mooring preparer attaches a 2000 pound block of concrete to a 1000 pound float rated buoy and you deploy it. Later upon returning for the recovery that scientist finds that the whole mooring system is gone along with a very expensive instrument package. What happened? The weight to buoyancy ratio was calculated for concrete on dry land. That calculation didn't work at sea in reality, because concrete loses one half of its weight in saltwater. In actuality that scientist used a 1000 pound underwater weight to moor a 1000 pound buoyancy rated buoy. It was all soon washed away. If a concrete weighted mooring

Deploying a Trawl Resistant Benthic Mount (TRBM). (Courtesy of DeepWater Buoyancy, Inc)

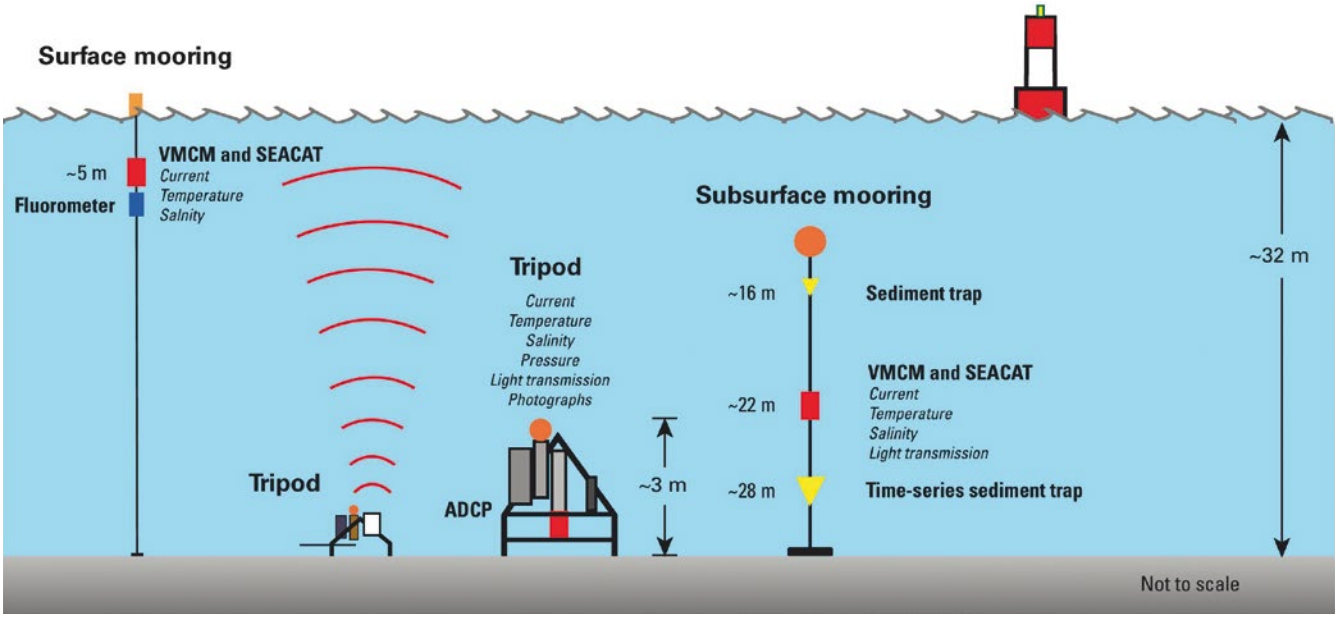
This benthic tripod mount has an ADCP (Acoustic Doppler Current Profiler) pointing upward with an inflatable buoyancy release mechanism already installed. (Photo sourced from Wikipedia)

arrives at your vessel, do not load it on board without first checking the underwater weight to buoyancy ratio. Scrap steel weights are therefore preferred for most moorings, because they are inexpensive and don't gain buoyancy in saltwater. For areas of high-speed currents, then heavy anchors must be used instead in order to utilize their superior holding shapes in addition to their dead weight calculations. Mooring materials matter.

Dan Cote of DeepWater Buoyancy, Inc. tells us that their buoyancy foams are designed to resist harsh marine environments. They also have different pressure ratings. A shallow water subsurface buoy has a different pressure rating, and therefore a different depth rating, than a deep water buoy. If you get the two mixed up, you could lose your instruments. Strong stainless steel mounts are usually used on the buoys and for the instrument attachment points along the moorings while lighter aluminum is mainly used on bottom tripod or pyramid type mounts. So, getting the materials correct, the order of the buoys right, knowing the life expectancy of the bits and pieces, and making sure that all of the shackles and swivels have their pins in place is vital. This will help ensure the safety of the instrument mooring system, but the captains can help too. Captains of research vessels that insist upon checkoff lists and that log everything are ones that succeed. You'll get a phone call months after the deployment asking about things like what the speed and wind direction was at the time of deployment. They'll want to know the sea state, time, currents, tide, and even if there was an alga bloom that day! Log everything including your speed, course, weather, locations (fixes), and even your engine rpms. This helps the scientists greatly.

I remember one case in particular when I was asked to take a more direct role in the marine biology research itself. I accepted a request to help with a bat ray study. The marine biologist set the safety parameters for handling these dangerous fish, because they were armed with sharp stingers laced with a neurotoxin. We also discussed the first aid procedures if one of us got stung. She said that after working for four years with the rays that she only got stung once. Not watching where her hand was in relationship to the ray was all it took. I obeyed her safety instructions to the letter, and I even helped her find rays after she expressed her desire to record larger ones. So, I set out an otter trawl in a deep trench to see what types of fish dwelled there. We caught a record giant bat ray as a result. She was thrilled. I anchored the ship, and we got to work weighing and measuring this monster large ray. I held down its head in the ichthyology tub while she measured its wingspan. My hand was exactly where she told me it would be safe to hold it. All of a sudden, this huge ray did a backflip right in that examination tank and swung its tail barb right at me. I reacted as best I could, but the ray was much faster. He stabbed me on the inside of my left middle finger with a theoretically impossible maneuver. I immediately grabbed the base of my sliced open finger with my other hand to form a tight tourniquet. This stopped the neurotoxin from reaching my heart where it could have shut it down. I deliberately let my finger bleed out as much of the poison it could. My blood dripped a path on the deck as I hurried below to the wet lab sink. I turned on the water over my finger as hot as I could stand it, because the neurotoxin is designed to work in cold water environments. The hot water breaks down the long chain molecules of the toxin easily and quickly. That worked very well indeed. I then bled it out a bit more and then disinfected it and bandaged it up. As a precaution I ended the day's research activities and weighed anchor and headed for our dock.

She came up to the pilothouse to see how I was doing and said that she never saw a ray do what it just did. She said that it was almost a supernatural effort to sting someone. My finger was indeed stinging a bit as a direct result of that ray's effort. The term "stingers" on these rays is really a misnomer. They look more like long thin daggers than needles. They are double edged, serrated, and razor sharp. If the poison doesn't get you then the cutting of an artery will. Fortunately for me it was only a flesh wound, and I had dealt with the poison strait away. We of course modified our safe handling procedures for rays over a certain size after that experience. So, we should all follow the safety procedures, but obviously even that's not a guarantee of total safety. Never push the limits of those safety margins,



The three basic types of scientific instrument moorings are depicted here. The surface buoy (far left) method is for easy recovery in safe areas with stable sea states. The two middle instruments packages are benthic or seabed moorings. These require radio signaled release mechanisms for recovery. The third mooring (far right) depicts a midwater column buoy. This system also requires a remote release mechanism. (Courtesy of the U.S. Coast Guard)

especially when handling dangerous marine life. That ray didn't care about what we humans thought was possible or impossible for it to do. I still have the scar to remind me of its mutinous attack upon the captain. The entire crew then committed a mild act of mutiny too. Every five or ten minutes one of them would stop working and come up to the pilothouse to see how I was doing. They would sit there watching my every move. It didn't matter how many times that I explained how I handled the situation or how I reassured them that I was feeling fine. They would watch me to see if I was going to go into convulsions or maybe collapse dead on the deck. My obstinate crew's concern for my welfare was more of a heartwarming situation than a heart stopping one.

So, if you have the heart to crew on board a research vessel it's a good idea to learn as much as you can about what's going on around you. Follow all of the safety procedures as best you can while watching out for the unexpected even if you're operating within the recommended safety parameters. Respect the scientific personnel on board and your fellow crew members. Help them out when they need it while still doing your own job well. Crew members must learn some of the scientific terminology used on board and how to safely handle the scientific instruments. Scientist must learn some basic shipboard safety rules and emergency procedures too. You'll operate as a much safer and better team that way. So, my final tip or advice is to learn as much as you can when you step on board a research vessel. My final quip or comment is that if you take my advice, you'll have a much better understanding of our marine environment and the many ways to study it after you step back ashore.

OET: COMBINING TECHNOLOGY AND OUTREACH FOR OCEAN EXPLORATION

Jamie Zaccaria, Megan Cook, and Daniel Wagner, Ocean Exploration Trust

NAUTILUS LIVE
OCEAN EXPLORATION TRUST

When it comes to ocean exploration, few names are more famous than Dr. Robert Ballard. Although he is most well-known for his 1985 discovery of the RMS *Titanic*, Dr. Ballard is now the President of Ocean Exploration Trust (OET) – a non-profit he founded to explore the ocean, seek out new discoveries, and push the boundaries of education, outreach, and technological innovation. Technology has always been at the forefront of exploration, and we at OET are committed to continuously testing emerging technologies and progressively integrating them with approaches that have endured the test of time.

Courtesy of Ocean Exploration Trust

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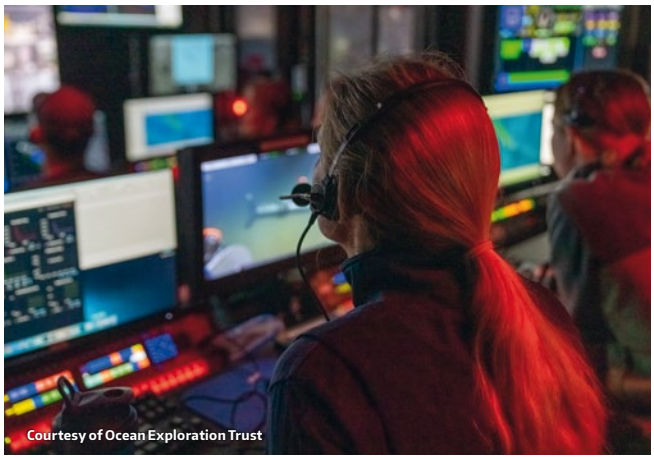
Courtesy of Ocean Exploration Trust

Since its foundation in 2007, OET has led expeditions worldwide exploring the Mediterranean, Black Sea, Atlantic, Caribbean Sea, Eastern and Central Pacific Ocean. Now, as part of NOAA's **Ocean Exploration Cooperative Institute** (OECI), we contribute to the OECI's mission of exploring, mapping, and characterizing the US vast ocean territory to develop and implement new technologies and to inspire the next generation of explorers. Throughout the planning and execution of our expeditions, we work closely with government agencies and the scientific community to ensure basic seafloor exploration is prioritized to address management and scientific needs in our dynamic ocean landscape.

Expeditions are primarily launched aboard **Exploration Vessel (E/V) *Nautilus*** – a 68-meter research vessel equipped with remotely operated vehicles (ROVs) and other state-of-the-art exploration technologies. Our team deploys ROVs, autonomous vehicles, and hull-mounted sensors to explore the ocean's depths. While collaborating with the broader research community, we aim to identify priority regions and phenomena and share our expeditions with explorers worldwide via live telepresence.

Beyond ROV exploration of the seafloor, OET's expeditions include **acoustic mapping**. The ship is equipped with a hull-mounted Kongsberg EM3020 multibeam echosounder capable of efficiently and accurately producing high-resolution maps over large areas of previously uncharted seafloor. Tuned to map depths between 100 and 7,000 meters (300 to 23,000 feet) while cruising at ship speeds up to 12 knots (14 mph), our exploration of the fascinating and complex midwater ecosystem will be enhanced by the installation of an EK80 echosounder in late 2022.

EXPLORING FOR EVERYONE

Innovation in technology empowers the central component of our education and outreach mission. High-definition video feeds are streamed 24 hours a day, seven days a week on every E/V *Nautilus* expedition, allowing anyone with an Internet connection to follow expeditions. This is made possible thanks to the **telepresence hub** at the Inner Space Center at the University of Rhode Island, which receives data from the ship via satellite dish before re-broadcasting it over the Internet for everyone to see in near real-time. This not


Courtesy of Ocean Exploration Trust


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only allows scientists from all over the world to help plan, guide, and execute missions, but is also a powerful outreach tool that allows anyone with an Internet connection to join in the excitement of ocean exploration and discovery.

SCIENTIFIC ROBOTICS

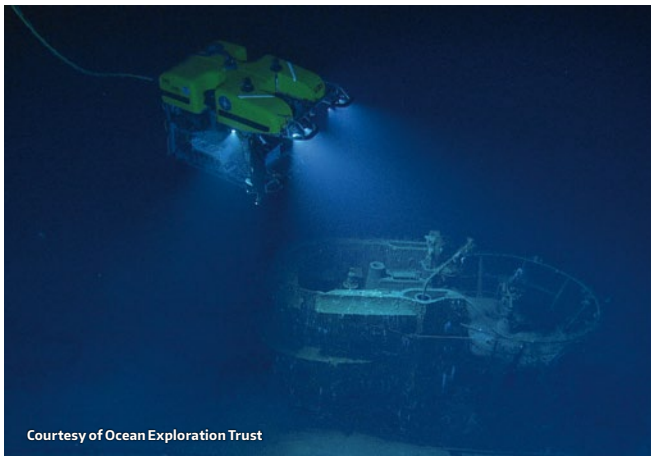
Scientific **ROV *Hercules*** is at the center of the *Nautilus* Exploration Program, working in tandem with ROV *Argus* to explore the ocean's geology, biology, archaeology, and chemistry. Designed and outfitted for delicate science sampling, *Hercules* is equipped with a seven-function Kraft Predator manipulator arm, a seven-function ISE Magnum manipulator arm, a suction sampling system, a Venturi dredge excavation system, a variety of sensors, samplers and video cameras, high-powered LED lights, and high-resolution mapping sensor suite. To power all this exploration equipment, the submersible connects to the surface through a fiber-optic cable, which also transmits data and video, allowing pilots to control the ROV remotely, and "fly" in any direction using its six thrusters.

A pair of manipulator arms allows *Hercules* pilots to remotely collect biological and geological samples with precise dexterity. *Hercules* can retrieve up to 113 kilograms (250 pounds) of samples from the seafloor and safely bring them back to the surface in specially designed collection boxes. Other sensors on *Hercules* measure pressure, depth, water temperature, oxygen concentration, and salinity. *Hercules* is probably best known for its ability to collect high-quality imagery, which is made possible through its cameras, including a high-definition Zeus camera. Video from the ROV cameras is streamed up a fiber-optic cable to the E/V *Nautilus* before being sent out to scientists, students, and the public worldwide through our round-the-clock live streaming system.

The upper portion of *Hercules* is comprised of bright yellow syntactic foam pack. Trimmed and balanced to be only slightly positively buoyant, *Hercules* is driven up or down the water column by thrusters. The ROV is built to withstand pressures at depths up to 4,000 meters (13,100 feet), where forces exceed 6,000 pound-force per square inch. *Hercules* measures 3.4 meters (11 feet) long by 1.8 meters (6 feet) wide by 2.3 meters (7.5 feet) tall. It is thus of similar size

Courtesy of Ocean Exploration Trust


Courtesy of Ocean Exploration Trust


Courtesy of Ocean Exploration Trust

to a Volkswagen beetle, but at 2,500 kilograms in air (5,500 pounds) it weighs almost twice as much. *Hercules* is housed in a 24 square meter (258 square foot) ROV hangar aboard E/V *Nautilus*.

ROV *Little Hercules* is a smaller sister to *Hercules*, designed for gathering high-quality imagery with its 4K video camera, LED lights, and navigation and situational awareness sensors. *Little Hercules* was initially built in 2000, extensively refurbished and upgraded to 6000-meter capability in 2019. Operating both ROV *Little Hercules* and ROV *Hercules*, the exploration of over 90% of the ocean is within reach.

ROV operations aboard E/V *Nautilus* typically employ a dual-body ROV system, with one ROV exploring the seafloor, and a companion ROV sled hovering above. **ROVs *Argus*** or ***Atalanta*** serve in this companion role on E/V *Nautilus* missions, and their primary responsibility is to absorb the motion of the ship above, and providing extra light and cameras that enable a "birds-eye-view" of ROV *Hercules* for situational awareness. *Argus* is typically used in tandem with *Hercules* and absorbs the brunt of ship movements so that *Hercules* can operate smoothly to provide steady live-streamed video. However, ROV *Argus* can also be capable of working solo, as it did in 2019 when it conducted over 120 consecutive hours of underwater side-scan sonar and visual surveys of the island slopes of Samoa.

FUTURE DIRECTIONS

In addition to its ROVs and hull-mounted sonars, recent E/V *Nautilus* expeditions have also worked closely with its OECI partner institutions to deploy various other exploration technologies, including uncrewed surface vehicles and autonomous underwater vehicles. In 2022 we **teamed up with our OECI partners** from the University of New Hampshire and their uncrewed surface vessel *DriX*, as well as Woods Hole Oceanographic Institution's hybrid vehicles *Mesobot* and NUI. With 210 hours in the water over the course of thirty dives, exploration robots *DriX*, *Mesobot*, and NUI were all put to the test, with E/V *Nautilus* serving as the command center and launchpad. Together, we made huge strides in how we can explore the ocean- from mapping, to sampling, to vehicle-to-vehicle communication.

"While the biggest part of our ocean remains completely unexplored, emerging technologies are increasing the pace by which we can effectively survey this unexplored realm," says OET Chief Scientist Daniel Wagner. "On our recent missions, we have worked with our partners to test and integrate some emerging technologies into our operations. These missions have demonstrated that using multiple robotic vehicles can be a powerful force multiplier in collecting ocean data."

TRAINING THE NEXT GENERATION

While telepresence technology is an indispensable tool that allows OET to share its mission broadly, we realize there is no perfect substitute for experiencing exploration first-hand. In our mission to train the next generation, students, young professionals, and educators sail on every expedition, gaining valuable hands-on experience in ocean exploration and serving as role models in their home communities around the globe. **NautilusLive.org** offers an immersive experience year-round for explorers to learn more about our expeditions, find educational resources, and marvel at discoveries. By promoting a wide variety of STEM careers, we aim to not only inspire the next generation of ocean explorers, but also promote the multi-disciplinary collaboration that is needed to better understand our largely unexplored ocean.

JOIN US IN 2023 AS WE CONTINUE OUR EXPLORATION OF THE CENTRAL PACIFIC ALONGSIDE PARTNERS AND COLLABORATORS!

Ocean Exploration Trust's program is national and international, with funding support from federal agencies as well as the private and public sectors. Since the NOAA Ocean Exploration Program was authorized into US law by Congress in 2009, OET has been partnering closely with NOAA Ocean Exploration as well as other government agencies, academic institutions, and the private sector to advance the field of deep-sea exploration and to engage the public and next generation.

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Courtesy of Fugro

FUGRO'S INTEGRATION OF EROVS INTO USVS

Mark Bruce, ROV Global Product Owner – Next Generation Systems, mw.bruce@fugro.com

The last decade has seen an increasing trend towards the development and deployment of remotely operated vehicles (ROVs) and uncrewed surface vessels (USVs) for marine operations. The benefits of these robotic crafts are clear: remotely operated from onshore, crew are removed from the potentially hazardous offshore environment and the operational carbon footprint is significantly lower as ROVs and USVs use far less fuel than traditional crewed vessels. At Fugro, we're taking these remote solutions a step further by integrating electric remotely operated vehicles (eROVs) into our USVs to provide a fully remote offering for offshore clients. This article takes a deeper look into some of the key design requirements for integrating eROVs into an uncrewed platform via a remote onshore connection which is revolutionising Fugro's strategy for acquiring Geo-data for offshore projects. Reflecting also on some of the design considerations and challenges we needed to overcome to realise next generation of remote marine robotic solutions.

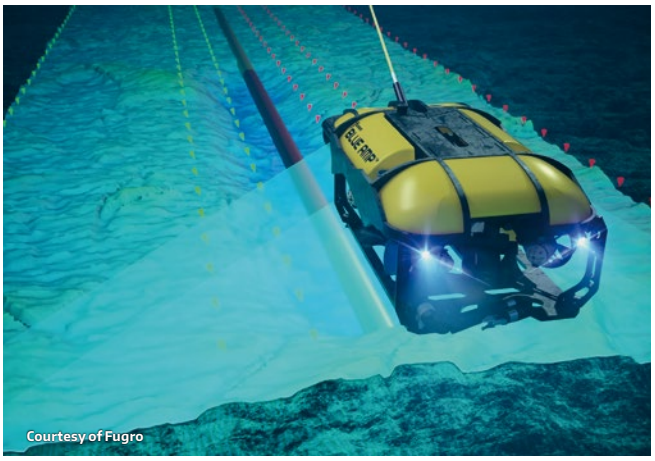
CURRENT STATUS

We're now into our second commercial year of deploying the Blue Essence™, our next-generation USV, and our integrated eROV, the Blue Volta™. Together, they've completed projects within the Dutch sector of the North Sea, which included the world's first fully remote inspection campaign, where eROV and USV both acquired multibeam echosounder (MBES) data and detailed depth-of-burial pipeline data from the same solution during the same project. In Western Australia, we used remote solutions to complete multiple inspection campaigns, including MBES, visual and cathodic protection (CP), inspection of structures, and even seven function manipulator work. All of which were again the first time these operations had been completed fully remotely in a commercial setting. By deploying remote solutions, our client received near-real-time video footage and Geo-data as they were acquired, plus they could do this from the comfort of their own home or office. This unique combination of robotic vehicles is fundamental to our vision of supporting clients to design, build and operate their offshore assets safely, efficiently, and sustainably.

DESIGN REQUIREMENTS

The Blue Volta™ was designed at Fugro's in-house innovation centre in the Netherlands and then produced from our production factory in Singapore. It is specifically designed to work with remote operations delivered from a USV. It integrates the latest electronic hardware, software, and flight control applications to carry out a range of remote inspection and light intervention tasks in subsea environments. The unique design and differentiated set-up of the Blue Volta™ means it can complete a wide range of tasks from a small platform, which simplifies operations and is more cost-effective for our clients. At the same time as increasing productivity, this fully remote solution also lowers HSSE exposure by removing any need for offshore crew.

Nonetheless, to start with, there were some initial design constraints that we had to work around. The nature of the USV solution being at only 12 metres in length, meant that the parameters of the eROV in respect of the size and weight of the system were quite strict, but needed to be complied with to fit the USV's footprint and endurance. This led to some hard design decisions regarding, for example, sensor placement and correct payload, but our engineers at Fugro used their experience and ingenuity to come up with a suitable design that fitted all of these pre-existing constraints.


Courtesy of Fugro

FLEXIBILITY

Offshore operations are highly changeable and at times unpredictable, so it's important to have a solution which is flexible and can adapt to changing work scopes in real time. Being able to complete a wide range of inspection tasks from the same platform is also vital; the Blue Volta™ achieves this by having one of the highest specification sensor payloads for a vehicle of its class. The wide beam MBES is one of the standout sensors on the vehicle, providing users with accurate seabed topology data acquired at the lowest operational carbon footprint currently seen in the industry. The vehicle also comprises a fully electric seven-function manipulator, which allows the Blue Volta™ to complete light dexterous intervention tasks such as CP, valve operations, and potentially light cleaning and flooded member detection (FMD) operations.

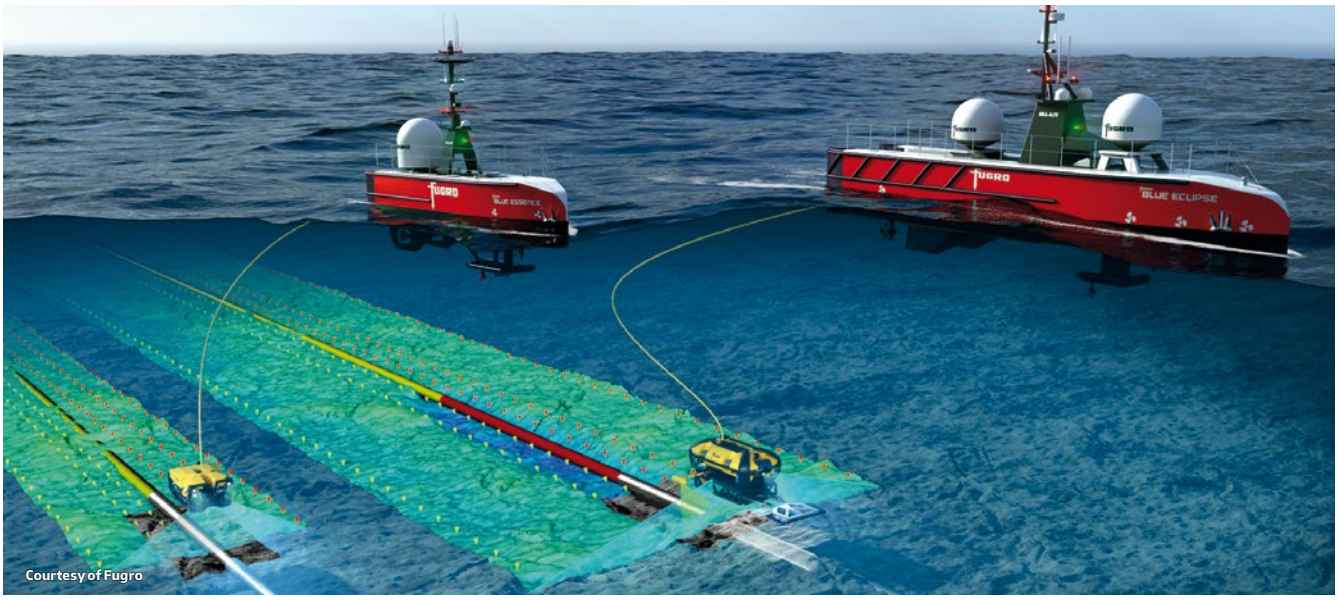
RELIABILITY

One of our aims when designing the USV and eROV to work together was to achieve an endurance of up to 14 operational days from an offshore distance of 75 nautical miles. This minimises the number of returns to port needed for refuelling, which increases productivity, as the schedule is less interrupted, and more tasks can be completed within the same transit, which is ultimately more cost-effective. Therefore, reliability of the Blue Volta™ was at the top of the design team's mind when they developed the vehicle: every design decision was driven by the need to provide a stable and solid platform as, with no crew onboard, any problems, repairs or reconfigurations to the vessel would result in a costly return to port. We also sought to minimise parts and design complexity to provide the widest possible base for a variable work scope, which was one of the main requirements requested by our clients. To help achieve this, the sides of the eROV's base frame can be removed and replaced with various sensor or tooling set-ups, depending on each project's unique requirements. For example, we integrated the pipe tracker system to provide flexibility on mounting options for the communication and power bottle. Also, in the not-too-distant future, it could also provide flexibility to mount side scan sonar systems and boom arms, without overhaul because of the modular design.

LAUNCH AND RECOVERY

It's well known that the launch and recovery of remote and autonomous craft is a critical part of any remote offshore operation. Weather conditions, swell, current and wind all affect launch and recovery; furthermore, with no crew onboard, minimising the effect of these environmental factors and designing a repeatable, simple process is essential for an eROV's and USV's safe and successful launch-and-recovery.

Fugro's Blue Volta™ is deployed from the USV by a dedicated launch sled and umbilical management system (UMS). This has evolved from vast experience on the vessel builder's involvement with AUV's. The UMS is a lightweight, all-electric



Courtesy of Fugro

design which ensures the efficient use of the USVs powertrain and maintains the efficiency and sustainability credentials of the Blue Volta™. The sled consists of a simple lowering mechanism, which lowers the Blue Volta™ thrusters beneath the waterline, while the vessel is ballasted at the aft end to allow for smooth launching of the vehicle within its targeted weather conditions. Being able to reliably return the Blue Volta™ to the vessel, especially with no crew to assist, meant the self-alignment design and shape of the rear of the USV complimented the safe recovery of the vehicle in a wide range of conditions, ensuring a simple, robust, and efficient setup.

ROBUSTNESS

To be able to launch and recover the eROV from the USV in sea conditions of up to 2 metres significant wave height, the vehicle must be robust and recoverable directly into the stern of the USV. The Blue Volta™ will perform thousands of launch and recovery sequences at sea, so our mechanical team built the frame to a resilient specification that can withstand its offshore operational environment. However, the robust design had to accommodate certain constraints; for example, as the USV is only 12 metres long, its size, simply doesn't allow for the Blue Volta™ to have a subsea tether management system. Therefore, the system has no main lift umbilical, making it a "free swimming" launch system. Ensuring every scenario was covered both from a standard operational recovery to an emergency recovery, the key goal is to ensure the safe retrieval of the asset. This design requirement is a key driver both with the eROV and the launch and recovery system.

DIFFERENTIATORS

The eROV's in house designed control system sits on a software platform specifically chosen for it's flexibility for remote and autonomous operations. The need for a stable and highly efficient software platform was key to being able to transfer high speed Geo-data to and from the parent vessel back to shore, ensuring the lowest possible latency. This efficient platform allows clients early insights into their assets to support fast and effective decision-making. The design is also future proofed to fit with Fugro's roadmap towards increased autonomy, including less "in the loop" control and moving towards "out of the loop" pilot control, reducing the need for constant operator input, yet ensuring the safety of the asset. Finally, being able to combine the Blue Essence™ with the Blue Volta™ gives us the advantage of being able to deliver all the tasks expected of a USV, while also conducting operations that can only be carried by a ROV, such as close visual inspections of pipelines.

FUTURE OUTLOOK

The second half of 2022 promises to be an exciting time. Fugro expects to have four Blue Essence™ USVs and respective Blue Volta™/eROVs working on commercial projects across the world, including Europe, the Middle East and Australia. These will all be remote inspection campaigns controlled from Fugro's global network of remote operations centres (ROCs), which deliver industry-leading solutions and real-time insights so our clients can safely manage their offshore projects. Further ahead, in 2023 we'll be adding a new addition to our next generation eROV fleet, the Blue Amp™, which will be integrated into our forthcoming 18 metre USV, the Blue Eclipse™. The ability of the Blue Amp™ to operate in harsh subsea conditions is designed to complement the higher speed, endurance, and high-powered thruster capacity of the Blue Eclipse™. The addition of a new launch and recovery system will also mean it can operate in waves of up to 3 metres, so it can support operations all year round. As the Blue Amp™ has a larger payload capacity and potential to fit skid systems, this should provide a wider range of inspection capabilities, such as dual head MBES to capture larger swath and full circumferential pipeline surveys, further closing the gap between conventional crewed vessels and our eROV/USV solution. With increased autonomy between the two robotic systems, and almost double the endurance of our original 12 metre solution, the Blue Eclipse™ and Blue Amp™ will be yet another game-changer from Fugro. As the expansion and influence of marine robotics stretches ever further across the offshore industry, we are committed to leading the industry's remote and autonomous revolution.

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TEN TYPES OF USVS FOR US TO EXPLORE IN 2022

By Capt. Marc Deglinnocenti, U.S. Merchant Marine (Ret.), oldarmada@gmail.com

Where's the captain?! No, it's not a mistake that some boats at sea have no one on board. They were once overwhelmingly named Unmanned Surface Vehicles (USVs) which are now more commonly known by their more all-encompassing term as Uncrewed Surface Vehicles whilst still using the same acronym. These USVs started out small but grew quickly. They were originally built just big enough to carry a small sonar, a battery to power a small propulsion motor, a laptop computer to collect the sonar readings, and a remote control (RC) receiver. They were piloted with a simple hobby controller from the nearby shore or a small boat. Simply put, they were slightly larger than their small hobby RC boat cousins. Maybe they were a metre in length, but that's about it. They grew up fast into larger, smarter, and more versatile vehicles. They can now collect seabed topography data, water quality data, weather information, and even current data. They can do all this cheaper than a crewed research vessel can in some cases and in most cases cheaper and more efficiently for shallow water surveys. In the beginning that shallow water niche was the driving market force for their sales. Now they can ply deep ocean waters well over the horizon and far out of the range of those original RC hobby controllers. Since they have branched out so quickly and into many different functions, it's only right that there should be a list of USVs for us to explore as those same USVs explore our waters. Not every USV could possibly be listed here, but this list will give you a good look into some of the many different types of USVs available. Let's end our list with the larger USVs and start it off with the smaller ones.

Teledyne Marine Z-Boat 1250 with pontoons extended for maximum stability. (Courtesy of Teledyne Marine)

10.

Small USVs have the advantage of being easy to transport by a single person. Teledyne Marine of San Diego, California, USA offers up a very popular small transportable USV called the Z-Boat 1250. The trimaran hull is made of ABS (Acrylonitrile Butadiene Styrene) and is just 127 centimeters in length. What's nice about this small trimaran is that the outside pontoons slide inward for ease of transportation and then slide back out for maximum stability on the water. The two brushless 9-40 VDC motors can power the Z-Boat 1250 to a top speed of 2.3 metres (7.5 ft.) per second. If you slow down the USV to one metre per second, which is still pretty fast, then you can run it for 4 hours per charge. These speeds equate to relatively great performance numbers especially for working in areas of fast currents. Go even slower to conserve your three batteries and you can stretch out the Z-Boat 1250's operational time to 10-12 hours. It still uses an RC controller, but that range is an impressive 750 m. I operated the Z-Boat 1250 on Mission Bay in San Diego, and it was extremely responsive to the controls as advertised. Teledyne Marine also makes a myriad of different marine data collection instruments for this USV. So, they can recommend and supply the instruments that you might need for you specific missions or even sell you one of their other USVs altogether. It's a one stop shop for most of your marine surveying needs.

Hybrid Robotics' ambitious all-in-one flying USV Catalina with its tethered ROV. (Courtesy of Hybrid Robotics)

09.

Multiple marine surveying needs is an understatement when it comes to a drone that is being developed by Hybrid Robotics of Travis City, Michigan, USA. They are developing an ambitious and innovative USV called the Catalina, but what is it? Is it a flying drone, a USV, or an ROV (Remotely Controlled Vehicle) with a tether? It's all three in one package! Just think of the multiple missions that this drone can accomplish. You can fly it directly over any land or water obstacles all while surveying any discrepancies in the ocean environment from the air. It can then survey a dam or seawall from the air via its real time video transmission to your home base via its two-tiered communications system. The controls are on a 900 MHz frequency whilst all the other sensor data is transmitted in real time via a 2.4 GHz stream. You then set it down in the water to take a closer look all along the waterline of that dam in the self-propelled USV mode. After you do that up close survey, you can then launch its small ROV to complete the survey on the underwater portion of the dam. How can all those functions be practical or even possible? Catalina uses four ducted fans to fly up to 30 miles per hour (48 km per hour). That's faster than any of the USVs listed here can move. The range is of course shorter than most, but it can still fly two miles out and then fly two miles back to base. But that's not all that Hybrid Robotics has up their sleeves. They just introduced a new USV control system and a new USV tether management system that can be retro fitted onto your existing USV. Now you can accomplish towing operations and instrument mooring deployments from your existing USV without having to invest in a whole new one.

The Uncrewed Surface Vehicle CETUS from the University of Plymouth, United Kingdom. (Courtesy of University of Plymouth)

08.

You cannot invest in this USV, because it's not for sale. The USV CETUS was built by the University of Plymouth, United Kingdom and is not just another ordinary student project. This USV puts some commercial USVs to shame. Let's look at what the young brain power of the UK came up with. This USV isn't propelled by an electric motor like so many others. It's propelled by a 35 horsepower Yanmar marine diesel engine powering a waterjet. That design can scoot the CETUS along at 7 knots for 48 hours. This impressive power drivetrain along with its 4.17-metre-long aluminum monohull can carry a heavy payload within a waterproof .5 cubic metre space. That diesel engine's alternator can generate 400 Watts of continuous power for all the instruments and additional equipment needed on board. The engine and waterjet drive can also tow equipment behind easier than many other battery operated USVs. It deploys its standard on board equipment in a smart way too. Why cause a lot of drag cruising to and from data collection positions with permanently mounted under the hull transducers and sensors when you can just lower them through its built-in moon pool when needed? CETUS has a radar and multiple cameras including infrared for a 360-degree operator's view. It can also be piloted semi-autonomously or fully autonomously. CETUS is in constant communication with its operators for real time data transfer and collision avoidance. Navigation lights and the Automatic Identification System (AIS) are smart additions too. It is also uniquely equipped with air conditioning to keep everything cool in hot climates. It may not be for sale, but it's certainly a well-conceived and well-built USV.

TEXTRON Systems "CUSV" is named the Common Unmanned Surface Vehicle and will soon be armed. (Courtesy of TEXTRON Systems)

07.

Not all USVs are conceived and built for marine survey work. TEXTRON Systems of Providence, Rhode Island, USA is a global corporation that delivers a dizzying array of military products and services to its customers. They make what they call the Common Unmanned Surface Vehicle (CUSV) for the United States Navy. This 4.26 m (14 ft.) long CUSV has a 6 foot (1.8 m) wide payload bay and can tow 4000 pounds (1814 kg) at 20 knots. The hull is designed to cut through relatively high seas with improved stability. They claim that it can handle up to a Sea State 5 (13 ft. or 4 m) high waves. The CUSV has a satellite communications system for over the horizon missions. They use the same control system in the CUSV that they use in their flying drones. That Common Command and Control System has been proven to be reliable for over one million flight hours. It's rumored that this well proven CUSV will soon become an armed CUSV with a 20-hour endurance.

Seafloor Systems' Hydrocat-180 with independently articulating pontoons and a gimbaled bridge deck. (Courtesy of Seafloor Systems)

06.

Well proven USVs don't only come from military contractors. I know because I've toured the Seafloor Systems factory headquarters in Shingle Springs, California, USA. I saw a wide range of small yet proven extremely capable USVs there such as their 2.4 m (7.87 ft.) monohull EchoBoat-240 and their 1.3 m (51.2 in.) trimaran Trident. I also observed their now successful 5.5 m (18 ft.) USV prototype called the HydroCat-180 being built. It's worth taking note of. Yes, it has a catamaran hull, but it's a very unusual one. If you saw it underway, you might think that someone forgot to tighten all the bolts. One pontoon might be pitching up while the other one pitches down. The bridgedeck or crosspiece connecting the two pontoons also looks like it has a mind of its own. All this independent movement is intentionally planned into the USV's design to keep your top mounted instruments as stable as possible. All these gimbaled and articulating parts really come in handy if you need to use a LiDAR or Laser Ranging device. Unlike a radar that uses radio waves on a somewhat broader scanning swath, LiDAR uses a pinpoint laser beam that's subject to data loss if tipped up or down too far. LiDAR is a great device for scanning dams, seawalls, pilings, and over the water bridge spans. LiDAR can detect minute cracks and flaws in those structures. The HydroCat-180 is a great stable platform for those types of marine surveys as well as many others. This USV can also be preprogramed to conduct fully autonomous marine surveys. If you need the instruments to go along with it, Seafloor Systems is also a Teledyne Marine instrument dealer.

USV DriX from iXblue of France. (Photo by Capt. Marc Deglinnocenti)

05.

Also, a dealer of multiple types of marine scientific instruments and software is iXblue of France. This company sells the unmistakably bright red USV DriX. I first saw and learned about this USV in London at the Oceanology International (Oi) convention in 2019. There have been many improvements made to Drix since then. DriX has a 7.7 m long composite narrow hull that's great for cutting though rough sea states. It even has survived a recorded 4.5 m high wave! It has excellent stability with a strong righting arm for minimum rolling. It has a self-righting capability due to its weighted keel that extends 2 m below the hull. The multibeam sonar housing (gondola) pod at the bottom of the keel provides for a far less noisy environment due to its shape, material used, and deep distance from the noisy surface waves. Needless to say, all of this quiet and stable sonar scanning can really help reduce data errors well beyond other USVs. The endurance and speed statistics for DriX are equally as impressive. Its top speed is 14 knots, but it can cruise for 7 days at an optimal speed of 7 knots. Lower that speed even more to 4 knots, and it can handle a 10-day mission. DriX can communicate during those missions via satellite for real time data collection, manual piloting, semi-autonomous piloting, or for fully autonomous operations. iXblue offers two comprehensive training courses for DriX operators. DriX can help itself avoid collisions at sea without any operators though. With the addition of Artificial Intelligence Maneuvering (AIM), which is a collision avoidance system, it can collect information from several on board sources such as LiDAR, radar, cameras, AIS, etc. It interprets all this information and then takes action to avoid a collision whilst complying with the navigation regulations. It's no wonder why the United States National Oceanographic and Atmospheric Administration (NOAA) took delivery of a USV DriX in July of 2021. USVs equipped with various AIM devices are now all the rage.

Kongsberg of Norway offers up their multipurpose USV Sounder. (Courtesy of Kongsberg)

04.

Kongsberg Marine of Norway has become a giant in the world of all things autonomous and AIM related in the marine and maritime marketplace. So, of course they offer a USV of their own, and it's aptly named the Sounder. The Sounder has an 8 m long monohull made of glass reinforced polyester with a positive floatation foam core. The hull has a wrap-around fender for protection too. It's powered by a 125 horsepower Steyer marine diesel engine. The engine also supplies the electrical power via a mounted generator. This USV's endurance is listed at a maximum of 20 days at 4 knots. Sounder's top speed is 12 knots. The USV Sounder has satellite communications and is equipped with their famous AIM controller known as K-MATE. They claim that K-MATE is an "autonomous decision making and artificial Intelligence and machine learning system" for plotting and executing courses and for collision avoidance. Sounder is equipped with a forward-looking infrared camera as well as other cameras. It has a Simrad radar, Automatic Identification System (AIS), GNSS (Global Navigation Satellite System), an acoustic positioning system, multiple sonars, and much more. This USV also has a moon pool for more sensor access to the waters bellow. The USV Sounder has three rudders and a single four-bladed propeller. Kongsberg Marine supplies other USV builders worldwide including Fugro of Brazil.

Fugro's USV Blue Shadow is suitable for hydrographic surveying as a force multiplier. (Courtesy of Fugro)

03.

Fugro a global Geo-data company, acquires, analyses and provides advice on the data acquired for its customers worldwide, and they are also a Kongsberg Marine customer. One of the services Fugro provides is hydrographic surveying. So, in partnership with L3 Harris they built two of their very own wave piercing 8.85 m USVs called the Blue Shadow. It has been designed to operate as a force-multiplier and 'shadow' parent vessel operations to improve both acquisition efficiency and schedule. Its 80-horsepower diesel engine gives it a cruising speed of 8 knots with an endurance of approximately 7-days and has multiple modes of operation, including up to IMO autonomy level 4 where the vessel's operating system can make decisions and determine actions by itself. The Blue Shadow is deployed with state-of-the-art hydrographic surveying and supporting equipment, including a fully integrated obstacle and collision avoidance solution using 360 camera, radar and AIS. With its survey equipment, it is capable of acquiring very high precision and high resolution datasets in support of hydrography, seabed mapping and coastal resilience. Depending on your survey requirement Fugro also has two additional 12 m (11.75 m actual) USVs that they designed and built with SEA-KIT International for inspection surveys, capable of deploying electric remotely operated vehicles (eROVs)

The SEA-KIT 12 m Fugro Blue Essence equipped with satellite communications. (Courtesy of Fugro)

02.

SEA-KIT International is a United Kingdom based company with its production facility in Tollesbury, England. SEA-KIT X is a very popular 11.75 m in length USV with up to a 14-day endurance depending upon the mission profile. It has a long narrow well deck specifically designed to carry untethered Autonomous Underwater Vehicles (AUVs) or tethered Remotely Operated Vehicles (ROVs) up to 2 tons in weight. Established in 2017 and winning the Shell Ocean Discovery XPRIZE competition in 2019, SEA-KIT International have sold five of their 12 m SEA-KIT X units to Fugro, but they are offering even more choices for you. They are now offering a SEA-KIT XL at 17.625 m in length which can cruise at sea for 28 days at 5 knots. That's an impressive 3360 nautical mile endurance. Their SEA-KIT Ω is 23.7 m in length and has a 102-day endurance using a hybrid propulsion system. Their most ambitiously designed USV is the SEA-KIT Σ at 36 m (118 ft.) in length! It also has a 102-day endurance. Propulsions options include a hybrid hydrogen engine or a diesel electric drive. All SEA-KIT USVs are self-righting, which is impressive, but that 102-day endurance is quite impressive for an engine powered USV.

Saildrone's USV Surveyor from Alameda, California literally takes the prize for the best USV endurance. (Courtesy of Saildrone)

01.

The so-called impressive endurance limits of other USVs has now been turned upside down by Saildrone headquartered in Alameda, California, USA. Their ultimate USV is called the Surveyor, and it has a ridged sail and several solar panels. It uses both the free wind to propel itself at 5 knots and the free sunshine for electrical power. It also has a diesel electric drive for more specific maneuvering and for higher speeds up to 10 knots. Not even the usual communications restrictions can hold it back either. It communicates in real time to its operator via satellite for over the horizon global missions. It will keep going and going until its human operator needs to be relieved rather than itself. Saildrone boasts a greater than a 180 day endurance for their USV Surveyor! Maybe that's why Saildrone Founder and CEO Richard Jenkins was recognized with the 2022 Albert A. Michelson Award for Innovation by the Navy League of the United States. (This author is a life member of the Navy League of the United States). The Saildrone Surveyor is 72 ft (22 m) in length and was the first USV to cross the Pacific Ocean from San Francisco to Hawaii. It also crossed the Atlantic Ocean and circled the Antarctic continent. It can perform benthic surveys down to 7000 m (23000 ft). The Kongsberg Marine sonar along with other instruments are situated in the gondola at the bottom of its approximate 3 m (11 ft) deep keel. Those are some pretty innovative statistics right there.

It's true that the above USVs all have their own unique innovations and varied capabilities, but there's so much more to see out there. Describing ten USVs is only just scratching the surface of all surface vehicles being developed worldwide. They may not be able to do everything that a fully crewed research vessel can do, but these ten USVs along with other USVs on the market might be able to perform the type and scope of marine research that you're looking for. Visit the above USV company websites or search for other USV websites on your own. You might be pleasantly surprised at what you find. After all, USVs are getting larger and more capable every day.

National Oceanography Centre

MARINE AUTONOMY & TECHNOLOGY SHOWCASE 2022

The Marine Autonomy Technology Showcase, hosted by the National Oceanography Centre in Southampton, is returning this November!

Join us for a packed three days of insightful presentations and networking opportunities, focusing on new developments and innovations.

Learn more about our exhibitor packages and register to attend today
NOC-EVENTS.CO.UK/MATS-2022

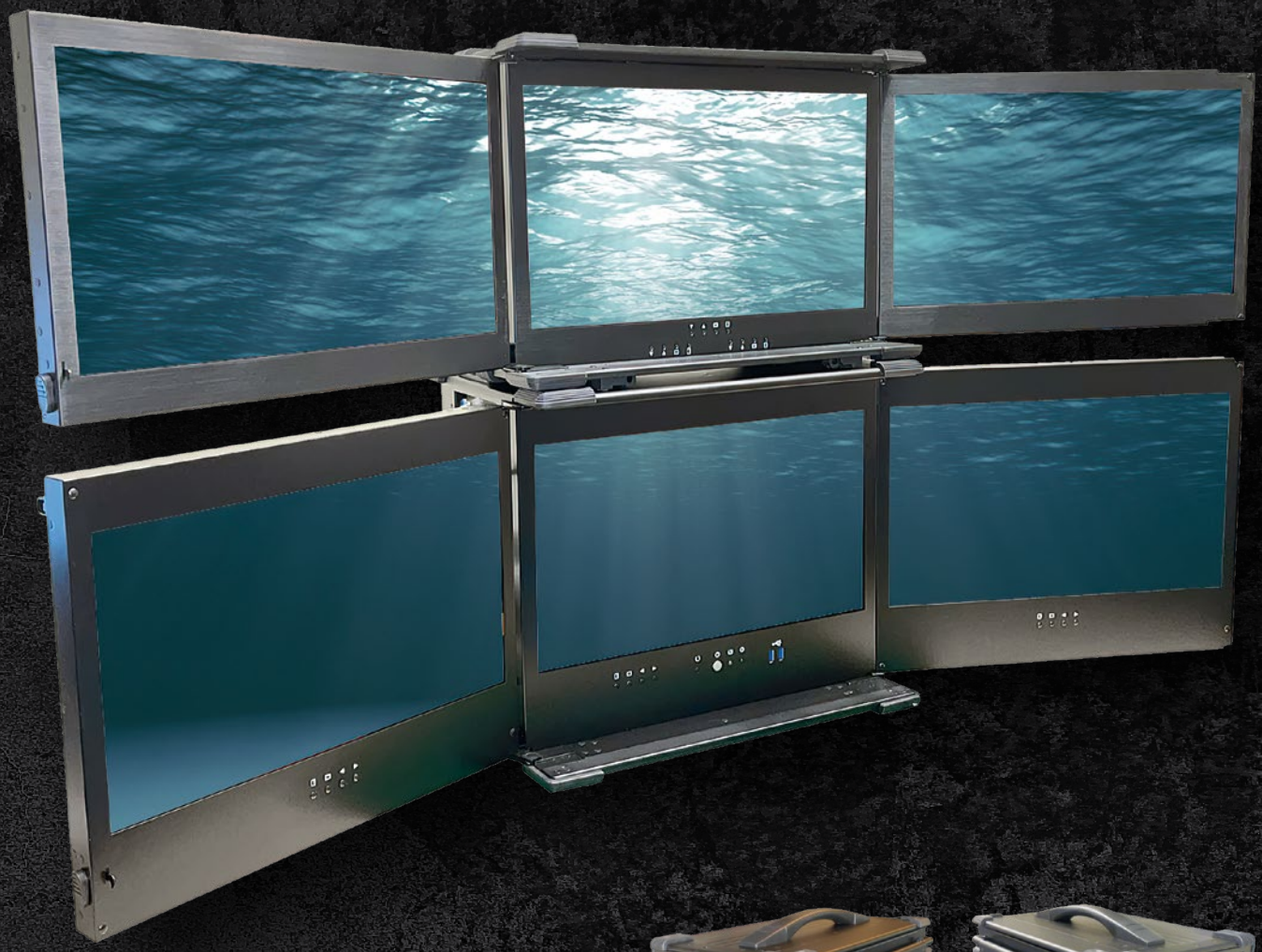
DIGITAL EDGE'S NEW MOBILE DVR WORKSTATION

In late 2021, Digital Edge Subsea announced that they would soon add another new industry-first product to their growing range of digital video inspection systems. As a world leader in offshore digital video recording and inspection systems, they continue to innovate, develop, and manufacture products for use throughout the offshore oil and gas industry.

If you need portability or have projects short on space, Digital Edge Subsea now offer the Mobile Edge DVR Workstation. This portable workstation features 17" integrated triple-monitor display units in a small form factor for field deployment. The three screens fold out from the main unit to create a compact system capable of displaying sonar, ROV topside, and DVR displays.

The Mobile Edge DVR workstation has all of the capability of a 4U rack mounted unit and a total storage capacity of 30TB. It is available in SD, HD, and 4K configurations, with composite SD, HD-SDI, HDMI, and IP camera inputs. You can also create a command-and-control field computing solution by adding a further mobile display unit of another three 17" screens.

Furthermore, the system has three removable hard drives which store the survey video and photos. The Windows 10 Pro OS is stored on a solid-state hard drive for increased speed and reliability, with a second solid state hard drive for redundancy. The system is supplied in a custom Pelicase and is only available to rent.



As with all their hardware, three levels of software are available:

1. **EdgeLite:** an entry level unit, suitable for surveys and inspections, where there is no requirement for eventing;

2. **EdgeDVR:** able to record four channels of HD simultaneously. It still offers the option to create Workpacks and offline editing;

3. **EdgePro:** has an extended database that allows tasks to be assigned to components currently under inspection. This allows customers to either create their own Workpacks, or commission them in-house at Digital Edge. It also provides an automatically generated report to capture inspection results.

Whatever you choose, you can be assured of a reliable system. Digital Edge also supply excellent technical support where all systems can be remotely accessed. All units have been designed to be simple to use by personnel of any skill level, and further training is also offered for increased peace of mind.

EdgeArchive is a data storage and back-up solution that uses an integral app within the Edge architecture to avoid the need for an additional third -party app. Edge Archive handles the transfer of data from the internal DVR drives to client storage, either on a NAS or a Raid, or via phased delivery to multiple external hard drives. Being a native app, the data transfer ensures that the quality of live recordings is not impacted by a third-party program trying to access the same file as the DVR app while in use. An EdgeArchive licence is available at extra cost when requested by the client.

Digital Edge Subsea work with clients of any size to provide the system that suits them best.

WWW.DIGITALEDGESUBSEA.COM

RENTAL TECHNOLOGY & SERVICES (RTS) CELEBRATES 20 YEARS IN BUSINESS

The island of Karmøy lies off the west coast of Norway and has a rich history dating back over 3,500 years. It's here that the Viking "sea king" Harald Fairhair established his seat of power centuries ago. The name Karmøy originates from the Old Norse word Kormt which means shelter. This long and narrow island protects the mainland from the North Sea and forms the fairway Karmsundet. It was against this imposing backdrop that RTS was established, back in September 2002.

The founders of Rental Technology & Services (RTS) are Freddy Knutsen and Odd Kåre Øygarden. Both have similar backgrounds in survey and systems engineering, and initially worked together at Stolt Offshore.

When Stolt Offshore decided to relocate from Haugesund to Stavanger, Freddy and Odd Kåre both saw an opportunity in the market to help with mobilisations, and the organisation of infrastructure on survey and construction vessels. Of course, the importance of having a local supplier was especially pronounced in the rental market at the time. Back then, there was a lack competent and qualified support and technical equipment that actually worked, so having local support was of great importance.

L-R: Freddy Knutsen, Alistair Coutts (Seatronics), and Odd Kåre Øygarden (Courtesy of Odd Kåre Øygarden)

The first RTS product to hit the market was a self-developed videolink. It was designed to assist Stolt Comex Seaway with ROV operations on the drilling rigs of several Norwegian oil companies. In 2002, RTS delivered a computer system that could live stream video footage via the Internet from ROVs to their onshore support offices. This provided the opportunity for ROV superintendents and onshore support teams to assist several offshore operational teams at the same time, without having to fly out to each drilling rig to address minor issues.


L-R: Freddy Knutsen, David Currie (Seatronics), and Odd Kåre Øygarden (Courtesy of Odd Kåre Øygarden)

When this method was initially suggested, representatives from the oil companies couldn't believe it was possible. After it was tested on rigs with good internet connections, the

The RTS headquarter in Norway (Courtesy of Gunnlaug Broshaug)


L-R: Odd Kåre Øygarden, David Currie, and Freddy Knutsen (Courtesy of Gunnlaug Broshaug)


Tore Hafte Staalesen (Courtesy of Gunnlaug Broshaug)

system was then implemented onboard many of the Stolt Comex Seaway group vessels.

Freddy and Odd Kåre wanted to expand their offering and range of equipment so contacted several international rental companies and suppliers who could potentially work with RTS and benefit from a local representative in Norway. However, only David Currie, the Managing Director of Seatronics, responded positively. Subsequently, the Operations Manager of Seatronics, Alistair Coutts, came to Norway, and the collaboration between the two companies became official in 2003.

Over the years RTS has greatly benefitted from access to the international network that Seatronics had to offer. Meanwhile Seatronics was able to expand its portfolio of products into the Norwegian market. Initially, it was mainly Seatronics equipment that was rented out, and this helped RTS to establish a good name and reputation within the industry. At the same time RTS started a separate organisation within the company was built to provide equipment support, with the addition of an electronic workshop and tooling facilities.

In 2004, RTS started their own engineering business covering electronics, hydraulics, and mechanics. This was intended to serve the communications and data market with niche solutions. Since then, they have built up a product portfolio that has proven itself internationally, and RTS has become a well-recognised global supplier. Although the company initially focused on catering to the subsea industry, their products can easily be adapted into new energy markets such as the offshore wind, wave and tidal power and aqua culture.

One of the key milestones for RTS included the world first subsea deflection monitoring system (SDM) that was designed for large structural subsea installations. The SDM was also used in the installation of the Åsgard Subsea Compression System, weighing 1800 tonnes with the height 15 meters and the size of a football field.

RTS is also internationally known for its Gen 5 MUX, which has become one of the leading ROV survey multiplexers in the market. The new Gen 6 MUX will be launched later this year. It will offer more channels, more bandwidth, more DC power and all in the same compact size.

There are more exciting new products currently being developed for the RTS portfolio. One is the NEMO subsea navigator: an inertial navigation system used for remote operations. And the NAUTILUS sequel to the NEMO but with higher accuracy, greater DVL range and deeper rated will also be launching soon.

With a local presence, top end products, and an extremely focused 24/7 service and delivery capability, RTS now stands firm as they mark their 20th anniversary. But they are not resting on their laurels.

This spring the first engineer was hired in Spain, and the team will embark on the adventure of having a new, fully equipped office in Aberdeen this autumn. Not only that, but the Managing Director of the newly established RTS UK is the same David Currie who believed in the concept and the company almost 20 years ago. Perhaps this says something about the RTS excellent cooperation on an interpersonal level.

WE WISH THE BEST OF LUCK TO RTS. HERE'S TO ANOTHER SUCCESSFUL 20 YEARS!

Fun fact:
Freddy was Norway's youngest ROV-Pilot at just the age of 17!

Jupiter FLOT

FLYING LEAD ORIENTATION TOOL

The Jupiter Heavy Duty Flying Lead Orientation Tool (HD FLOT) interfaces to Jupiter Class 1-4 Hydraulic & Electric Torque Tools.

Seamlessly integrates with the Zetechtics range of Jupiter Subsea Control Systems, and also operates with other systems with suitable hydraulic interfaces.

Specification

- Pitch: +60° / -90° (from horizontal)
- Roll: ±15° (available roll torque 2,400N·m)
- Load Capacity: 318kg (700 lb)
  (nominally acting on the nose of the Torque Tool)
- Size: 753 x 420 x 493mm
- Weight: 104kg (air) / 82kg (water)
- Depth Rating: 3,000 msw

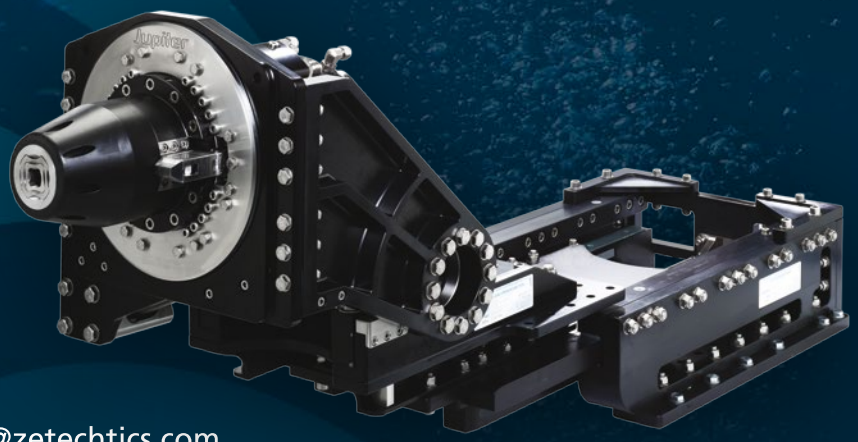


Image right shows FLOT mounted to optional Jupiter FLOT Extender, which can provide up to 300mm of forward advance.

For further information, contact sales@zetechtics.com

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Powering autonomy at sea.

Able to conduct both remote-controlled and supervised autonomous operations the DriX USV offers outstanding seakeeping and speed capabilities. It is a versatile and efficient USV that can host a wide range of payloads and that offers optimum conditions for high quality data acquisition in both shallow and deep waters.