MARINE TECHNOLOGY REPORTER

July/August 2026
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AUTONOMOUS VEHICLES

Trends and Innovations

Underwater Manipulators
Shifting Electric

Arctic Research
Aboard the Tara Polar Station

Hydrogen Fuel Cells
A Key to Subsea Endurance

Communications
Connecting Autonomous Operations

Volume 69 Number 5

Real-Time Data for Autonomous Vehicle Decision Making

React to hazards before they become obstacles

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Optimize movement in changing underwater conditions

- Ease of integration enhances control

Deploy, learn, and rapidly recover to maximize intelligence

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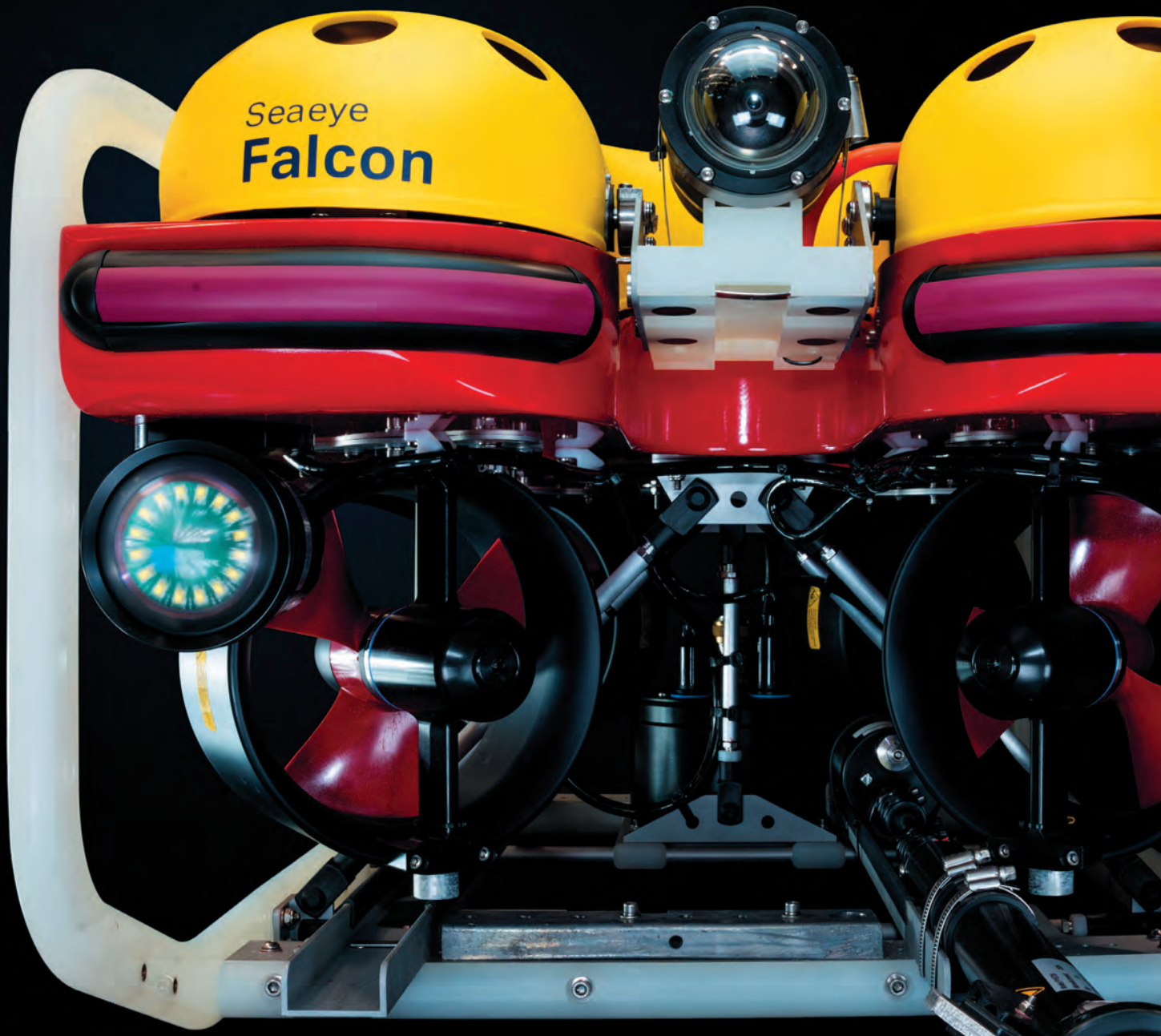

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SAAB TECHNOLOGIES

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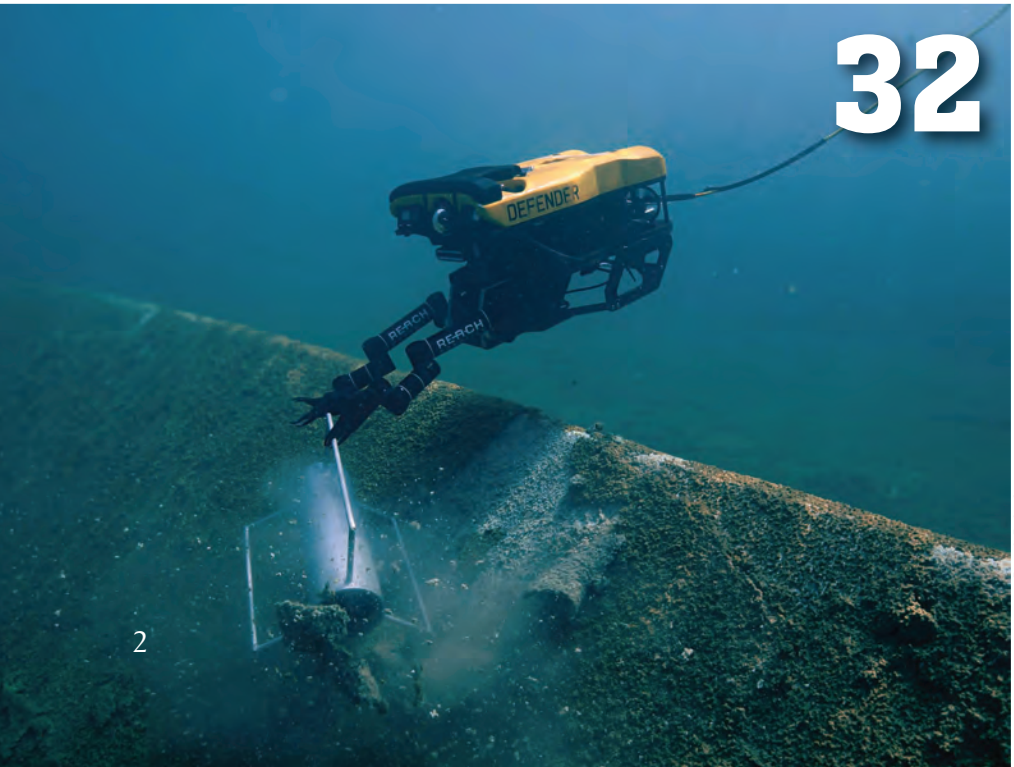
Volume 69 • Number 5

Celluda Robotics

Maéva Bardy - Fondation Tara Ocean



Reach Robotics

On the Cover

Image courtesy Maéva Bardy - Fondation Tara Ocean

U_TRACKER
FULL LINE

HIGH-PERFORMANCE AUV FOR BESPOKE MARINE EXPLORATION

U_TRACKER IV

Use cases:
Universities, research centers, underwater archaeology teams

Advantages:
Low cost, easy deployment, flexible payloads, user-friendly, man-portable system, user-friendly interface

U_TRACKER PRO

Use cases:
Commercial diving companies, port authorities, industrial inspection teams

Advantages:
Industrial-grade mapping, precise bathymetry, endurance, FOG INS, GNSS-denied operations, precise imaging, precise georeferencing, user-friendly interface man-portable system

U_TRACKER L

Use cases:
Offshore and subsea inspection, critical infrastructure monitoring, maritime surveys, autonomous navigation in complex environments, long-range missions, oceanographic monitoring

Advantages:
Mission-grade precision, high-resolution sonar and cameras, long endurance, FOG-based INS, GNSS-denied operations, edge computing, user-friendly interface, post-mission analysis, man-portable system

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DISCOVER MORE

Maéva Bardy - Fondation Tara Ocean

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Editorial

Scan the QR code to access the **Marine Technology TV** YouTube page:

This month, we focus on underwater vehicles across multiple industries and applications. We also dive into Arctic research, subsea communications, plus tools and manipulators.

Starting on page 8, David Strachan explores the role of hydrogen fuel cells in subsea vehicle endurance. On page 12, Wendy Laursen details the companies and unmanned vehicles poised to enter the defense market. Rob Helliar of Cambridge Pixel tackles radar processing for autonomous vessels on page 17. And, on page 22, SeaTrac Systems analyzes the role of modular USVs in autonomous operations.

On page 25, we explore the Tara Polar Station, a floating laboratory that recently set sail on an 18-month expedition to the North Pole. We learn about the construction, technology on board, and mission to expand Arctic research.

On page 28, Wendy dives into the evolution of subsea control and communication technology, and on page 32, we learn about some handy helpers—underwater manipulators and the trend towards greater electrification.

Finally, we share industry updates, including new products, company news and vessel highlights.

Our next print issue, September/October, is also our annual MTR100, where we highlight the leaders, technologies and companies that define the subsea industry. We encourage you to apply to be included in our pages, and have the opportunity to share your solutions with our readership. The application, which closes August 31, and additional details can be found on page 39 of this issue.

As always, we encourage you to reach out and connect, and we hope to see you in the pages of the MTR100 next month.

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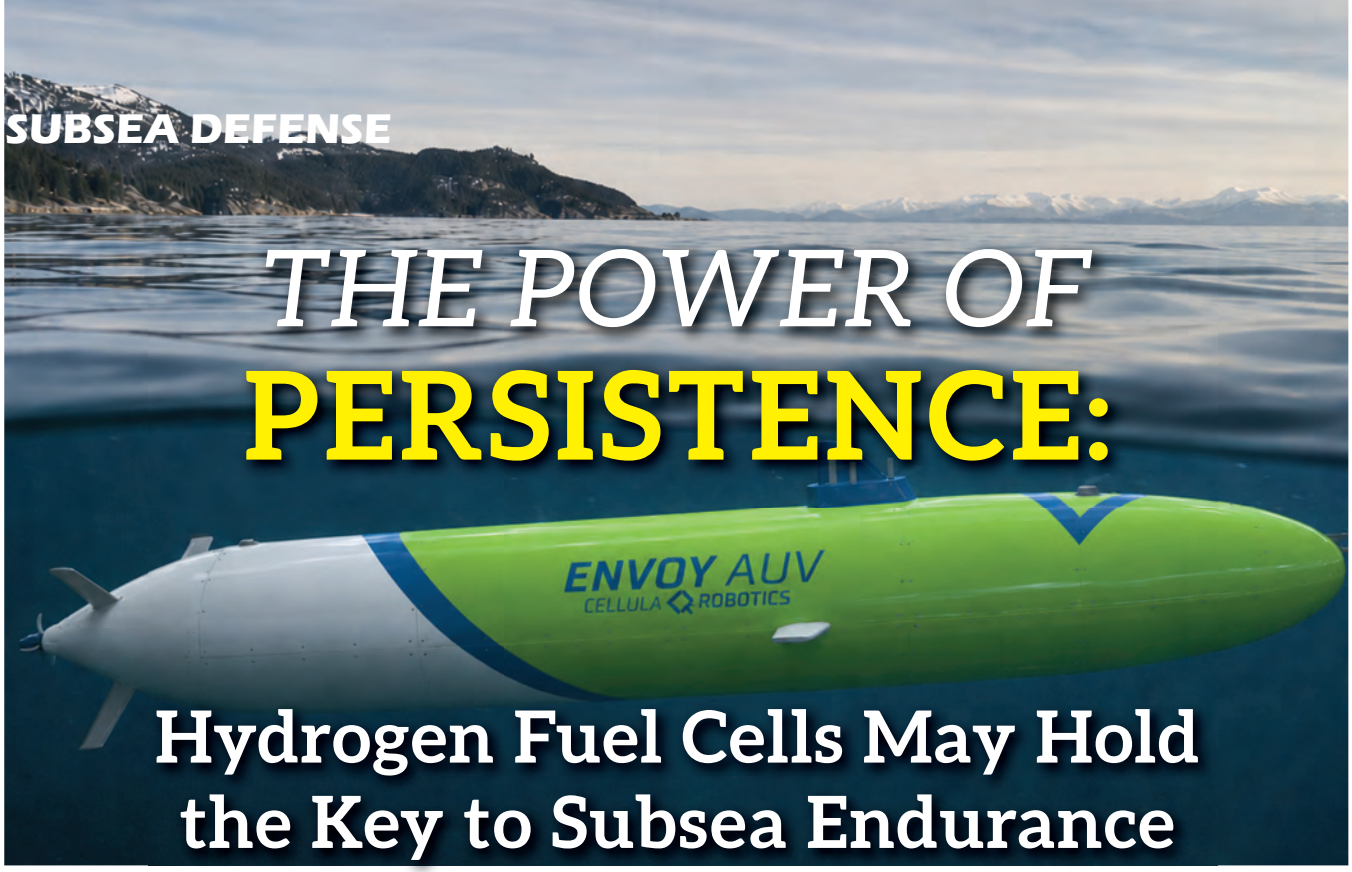


Credit: Cellula Robotics

THE POWER OF PERSISTENCE:

Hydrogen Fuel Cells May Hold the Key to Subsea Endurance

By David Strachan, Strikepod Systems

Credit: General Atomics

"Infantry wins battles. Logistics wins wars."

This quote, attributed to U.S. Army General John Pershing in the context of World War I expeditionary operations, is equally applicable today as we move further into the era of autonomous undersea systems. From the age of sail to the nuclear age, maritime power has been underpinned by how far and how long forces could operate forward, and while logistics has traditionally meant sustaining crews and platforms with fuel, food, and materiel, the logistics burden of autonomous underwater operations increasingly centers on one fundamental requirement: energy. It is energy that powers every onboard system – propulsion, navigation, communication, and autonomy – and ultimately enables the mission-critical endurance necessary to maintain a persistent subsea presence.

For years, the dominant underwater power paradigm has been stored energy. With their high energy density, scalability, and mature manufacturing base, lithium ion (Li-ion) batteries have been the standard for underwater systems for defense and commercial customers alike. But Li-ion's long-standing dominance could be giving way as onboard energy production, in the form of hydrogen fuel cells, is steadily gaining traction.

While a relatively new innovation for autonomous underwater operations, hydrogen fuel cells have been employed by crewed submarines for years to provide air-independent propulsion (AIP; also referred to as air-independent power). Conventional diesel-electric submarines must periodically snorkel to draw oxygen into their diesel engines, which in turn drive generators that recharge the batteries. But snorkeling makes a subma-

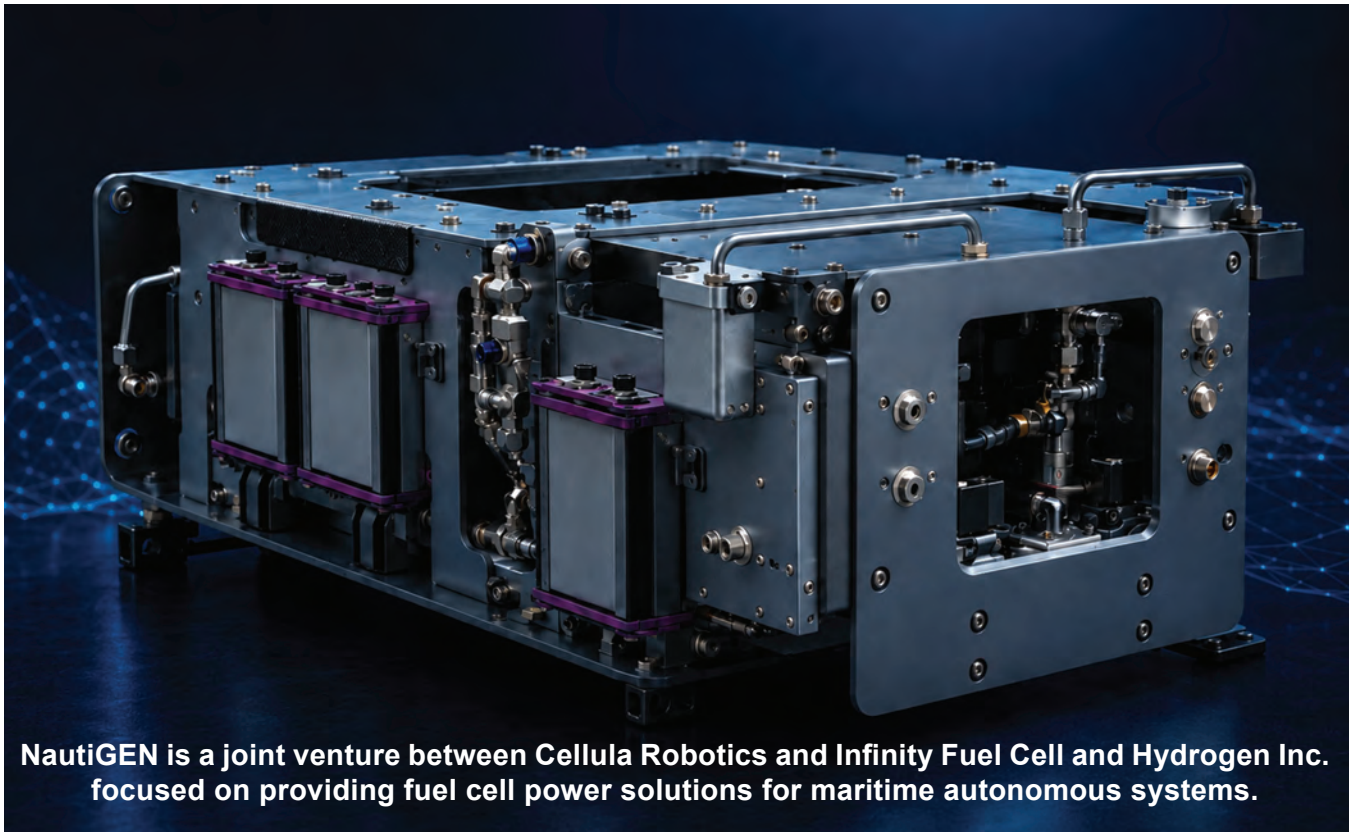
rine vulnerable to detection by surface or air platforms that could be prowling above. Fuel cells solve this problem by enabling a submarine to generate electricity without combustion and without atmospheric oxygen. Stored hydrogen and liquid oxygen feed proton exchange membrane (PEM) fuel cells, producing electricity silently, with water and heat as the byproducts. The result is stealthy, fully submerged power production, and an endurance measured in weeks rather than days. The same characteristics that make fuel cells attractive for conventional submarines- quiet operation, high efficiency, and extended submerged endurance - are now driving their adoption in autonomous underwater vehicles.

Unlike Li-ion batteries, which store a finite amount of electrical energy that is gradually depleted during a mission, fuel cells generate electricity for as long as reactants remain available. Although they are generally larger, more complex, and more expensive than battery-only solutions, fuel cells can provide several times the usable energy of a comparably sized and weighted battery system, and can extend underwater endurance from hours or days to weeks, or even months. In addition to higher energy density, fuel cells do not self-discharge during periods of inactivity, which could enable missions involving prepositioned systems in forward areas. And the higher endurance offered by such systems could reduce the total cost of sustaining an autonomous undersea presence. Maintaining that presence would require operating a fleet of platforms on a rotational basis - deploying, patrolling, recovering, replenishing onboard energy stores, and performing maintenance. If vehicles can remain on station for longer periods, and their energy systems can be replenished in minutes rather than hours, operators may require fewer platforms to sustain the same level of persistence and area coverage.

The endurance benefits of fuel cells for conventionally propelled AUVs are substantial, but combining them with an unconventional AUV whose unique design already provides extended range and endurance would be a significant achievement. General Atomics has done just that with the G-Ray, a blended-wing underwater glider that minimizes energy consumption through its high lift-to-drag ratio and buoyancy-driven propulsion. Recently unveiled at the Navy League's Sea-Air-Space conference in April of this year, the G-Ray incorporates a hybrid battery-hydrogen fuel cell system that enables extended endurance and range on the order of months, with potential for even longer durations. Rather than storing compressed hydro-

Credit: Teledyne Marine

Teledyne Marine's Subsea Supercharger.



Credit: Cellula Robotics

NautiGEN is a joint venture between Cellula Robotics and Infinity Fuel Cell and Hydrogen Inc. focused on providing fuel cell power solutions for maritime autonomous systems.

gen, the system reacts a lightweight aluminum alloy with water to generate hydrogen, resulting in an innovative on-demand energy system that shifts the endurance constraint away from stored energy to onboard reactant capacity.

Hydrogen fuel cells are no longer confined to underwater vehicles; they are becoming part of the subsea infrastructure that supports persistent autonomous operations. The Teledyne Marine Subsea Supercharger (SSC) is a fuel cell seabed energy depot enabling in-situ power production for sensors, effectors, or vehicle docking systems to allow AUVs to recharge and redeploy without surface recovery. Conceptually, an SSC functions much like a forward logistics node, providing the sustained energy that allows a regional autonomous undersea force to remain on station. The idea is not entirely new. Nearly a decade ago, the U.S. Navy proposed the Forward-Deployed Energy and Communication Outpost

(FDECO) concept to support persistent anti-submarine warfare (ASW) and intelligence, surveillance, and reconnaissance (ISR) operations.

For some companies, subsea hydrogen fuel cell power represents not only a game-changing product differentiator, but also an emerging market opportunity. In June of this year, Cellula Robotics and Infinity Fuel Cell and Hydrogen Inc. unveiled NautiGEN, a joint venture focusing exclusively on providing fuel cell power solutions for maritime autonomous systems. Windsor, Connecticut-based Infinity is a developer of fuel cell systems for aerospace, defense, and maritime applications, while British Columbia-based Cellula has been at the forefront of commercializing fuel cells through its family of long-endurance AUVs. Cellula and Infinity have previously partnered on fuel cell technology; in recent trials of Cellula's Envoy LD-AUV, the vehicle completed a submerged transit exceeding 2000 km over a mission duration of 385 hours, during which it executed over 4000 energy-consuming turns and maneuvers. The vehicle was powered by Infinity's Mystic 2000 AUV power system, which leverages fuel cell technology originally developed for aerospace applications before being adapted for maritime use. The creation of NautiGEN reflects growing confidence that fuel cell power has matured into a viable commercial market rather than remaining a specialized enabling technology.

Endurance is the lynchpin of autonomous subsea operations. It determines how long a platform can remain on station and the size of the area it can effectively monitor or influence. Whether trailing enemy submarines, conducting long-range seabed strike missions, or blockading a strategic chokepoint, AUVs will need access to high-density onboard energy to ensure mission success. Hydrogen fuel cells represent a shift from underwater platforms that store electrical energy to platforms capable of generating electrical power throughout a mission. While they may not come to replace Li-ion batteries in subsea operations, fuel cells could be integrated into hybrid power architectures like that of the G-Ray, with fuel cells providing high-energy, long-duration baseline power, and batteries supplying rapid bursts of electrical power for maneuvering, buoyancy control, communications, and payload operation. Whether fuel cells become the dominant energy solution for the broader autonomous maritime sector remains to be seen, but they appear poised to play an increasingly important role in establishing and sustaining a credible, persistent subsea force.

Source: Saildrone

HYBRID NAVY EXTRAVAGANZA

TECHNOLOGY COMPANIES AND SHIPYARDS ARE VYING FOR ATTENTION AS THE U.S. UNMANNED NAVY GROWS IN SIZE AND SOPHISTICATION.

By Wendy Laursen

Not too long ago, U.S. Navy Secretary John Phelan said: "If the last few years of conflict have taught us anything, it is that we will not win the wars of the future with the platforms of the past." The nation's ability to deter future conflict or to prevail, if necessary, will benefit from high quantities of low-cost air, surface and subsea unmanned systems. These will be used for close-range reconnaissance or one-way strike missions along with lower numbers of high-cost sophisticated systems with surveillance and/or mid- to long-range strike capability.

Kraken Technology Group is one of many companies ready with solutions. Anduril will build the small, mass-producible K5 KRAKEN and K7 SABRE unmanned surface vessels (USVs) and integrate payloads and its AI-powered Lattice autonomy software in the U.S., configuring each vessel for the full range of Navy missions.

Blue Water Autonomy is one of many companies forming partnerships to scale production of USVs. The company recently introduced its Liberty Class, a 190-foot autonomous ship designed for the U.S. Navy, currently under construction at Conrad Shipyard. It comes in support of the Navy's Medium Unmanned Surface Vessels program, the fleet's largest unmanned initiative with more than $6 billion of funding.

"Traditional shipbuilding doesn't scale, and pure software approaches don't deliver hardware," said Rylan Hamilton, CEO of Blue Water Autonomy. "We're doing both. Integrating proven marine systems with AI-driven manufacturing and operations to fundamentally rethink how ships are built. By distributing and parallelizing work across proven partners, we're creating a production system that can move at the pace

Image above: Saildrone has introduced Spectre, a 52-meter, 250 ton USV capable of up to 30 knots.

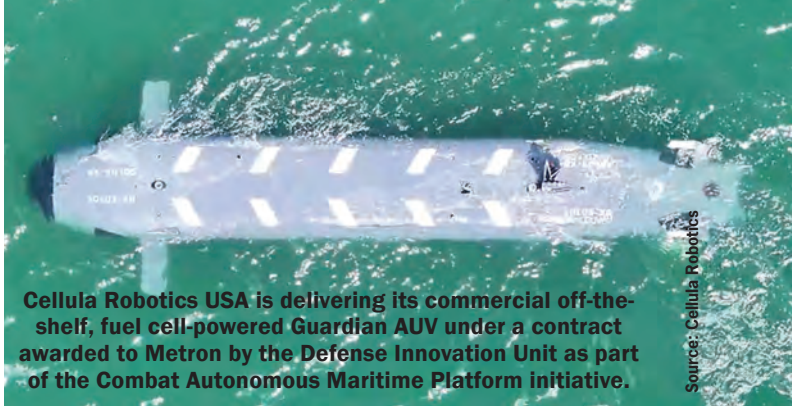
required for a modern maritime industrial base."

Philip Lewis, Director of Research at Intelatus, sees the power of this approach taking hold around the world, with the U.S. aiming to lead: "In the U.S., tech startups are raising billions of dollars, not millions, billions of dollars, and they are buying traditional shipyards. They are turning them into modern factories that are geared towards high production, low cost, rapid production." He points to Magnet Defense's acquisition of Metal Shark and Saronic Technologies' acquisition of Gulf Craft as examples.

The U.S. 2026 budgets included a long-term forecast for fleet building until 2056 with a clear focus on medium USVs, says Lewis, after earlier spending on small vessels suited to intelligence, surveillance and reconnaissance. "The medium USVs are going to have modularized or containerized payloads, so basically swap in, swap out, and this could include rocket launching capability, surface to air, surface to surface or anti-submarine torpedoes."

USVs are being built in large numbers and before the government places an order. "That means that there is probably going to be a few disappointed companies even though the U.S. government has said it will buy multiple platforms."

The risk is not deterring innovation. Among the new technologies emerging is Chaser and Comet USVs from BlackSea Technologies. Chaser is designed to expand payload capac-



Cellula Robotics USA is delivering its commercial off-the-shelf, fuel cell-powered Guardian AUV under a contract awarded to Metron by the Defense Innovation Unit as part of the Combat Autonomous Maritime Platform initiative. Source: Cellula Robotics

HII's ROMULUS is a modular family of AI-enabled USVs designed to support a wide range of missions and to scale across multiple vessel sizes. Source: HII

Anduril plans to build small, mass-producible K5 KRAKEN and K7 SABRE USVs.

Source: Kraken Technology

Saildrone has introduced **Spectre**, a 52-meter, 250 ton USV capable of up to 30 knots.

Source: Saildrone

ity, range and mission flexibility while maintaining rapid deployability and ease of use (meeting the Navy requirement to fit in a 20' shipping container). Comet is BlackSea's larger, high speed combat ready platform, designed to bridge the gap between small tactical USVs and larger unmanned combat craft. The 13.1-meter vessel can exceed 45 knots, carry a 10,000-pound payload including fuel, and support advanced payloads for missions including counter drone operations, mine countermeasures, surface warfare, antisubmarine warfare, electronic warfare, maritime domain awareness and high value unit escort.

The Chaser launch highlights BlackSea's work with key mission partners, including Lockheed Martin for the JAGM launcher, Echodyne radars for maritime domain awareness and high-fidelity threat targeting, Current for perception camera systems, and EOS Defense Systems USA for the gun system.

In April, HII announced plans for the production of four ROMULUS 151 vessels to be built by Breaux Brothers in Louisiana in addition to the ROMULUS 151 currently under construction. ROMULUS is a modular family of AI-enabled USVs designed to support a wide range of missions and to scale across multiple vessel sizes while maintaining a common manufacturing approach and autonomy baseline.

Earlier this year, Saronic released two new ASV models: the 40-foot Mirage and the 60-foot Cipher. The new vessels offer extended range and up to 10,000 pounds of carrying capacity. Mirage and Cipher join Saronic's Spyglass (6'), Cutlass (14'), and Corsair (24'), as well as the recently introduced medium unmanned surface vessel, Marauder.

Leonardo DRS has selected Sea Machines Robotics new 8-meter USV developed for the defense market to demonstrate their maritime mission equipment package for coun-

ter-unmanned aerial system missions. Purpose-built for autonomous maritime patrols and interdiction, STORMRUNNER has a 40+ knot top speed, 700+ nautical mile endurance, and modular payload bay.

Saildrone has introduced Spectre, a 52-meter, 250 ton USV capable of up to 30 knots. Spectre is designed to deliver multi-mission operation above and below the surface. Fincantieri Marinette Marine will build the aluminum hull form at its Wisconsin shipyards which have the capacity to build five Spectre vessels per year. The vessel's concealed payload deck provides room for dual 40-foot containers or up to five 20-foot containers. It allows easy deployment of payloads via the transom, while the bulwarks protect them from view and sea spray.

In the autonomous underwater vehicle (AUV) market, Cellula Robotics USA is delivering its commercial off-the-shelf, fuel cell-powered Guardian AUV under a contract awarded to Metron by the Defense Innovation Unit as part of the Combat Autonomous Maritime Platform initiative. The vehicle is designed for long endurance missions, with the ability to carry and deploy payloads at range. The company is collaborating with Schilling Robotics, Integer Technologies and General Dynamics Applied Physical Sciences to deliver the solution.

Innovation continues. Poseidon's Forge has launched its DarkWake AUV, a flexible, mission-configurable platform. Engineered with a flooded architecture to reduce mechanical complexity, the platform is the first AUV to offer the option of an integrated solid-state battery technology outside a pressure tolerant housing, delivering improved safety using a solid electrolyte and higher energy density while contributing to overall system simplification and performance.

"Investment in unmanned systems is the new arms race," says Lewis. "These systems are now being tested in combat, and this is drawing in a huge amount of capital from not just in the U.S., but Russia, China and in smaller navies around the world."

Saronic has released two new ASV models: the 40-foot **Mirage** and the 60-foot **Cipher**.

Source: Saronic

MTCOM:

Building the Connected Port of Tomorrow

Credit: EdgeLab S.p.A.

EdgeLab's USV_EL CAT, an autonomous surface vehicle designed to collect, process and transmit critical information.

Ports are evolving from traditional infrastructure into intelligent, interconnected ecosystems. The MTCOM initiative is driving this transformation by developing technologies that enable the port of the future.

Co-financed by the Regional Programme – European Regional Development Fund (ERDF) Liguria 2021–2027, MTCOM brings together EdgeLab, SMARTY, Sitep Italia, InfoCom, the University of Genoa and the Sant'Anna School of Advanced Studies (Pisa), combining expertise to develop innovative technologies for next-generation port environments.

At its core, MTCOM envisions the port as a cyber-physical ecosystem, where maritime assets, infrastructure and digital platforms continuously exchange information through a dedicated communication backbone. By integrating advanced monitoring systems, autonomous surface vehicles and a private 5G network, it delivers real-time situational awareness, improves the coordination of maritime traffic and infrastructure, enhances safety, and enables continuous environmental monitoring to support regulatory compliance and more sustainable port operations.

USV_EL CAT: A Mobile Intelligence Platform

Within the MTCOM ecosystem, EdgeLab's USV_EL CAT plays a central role as an autonomous surface vehicle designed to collect, process and transmit critical information.

Designed for both remote-controlled and autonomous operations, the platform performs continuous survey and monitoring missions in shallow-water and harbor environments. Equipped with a multiparametric probe capable of measuring conductivity, temperature, water level, pH, dissolved oxygen and redox potential, together with a stereo vision system for obstacle detection, it continuously monitors environmental conditions while navigating safely through complex port areas.

Its modular payload architecture allows the integration of a wide range of sensors, enabling the USV_EL CAT to operate as a mobile sensing and communication node. Combined with GPS/INS navigation, long-range Wi-Fi, LTE and satellite communications, and a user-friendly Ground Control Station providing real-time GPS tracking, video streaming and system monitoring, the platform delivers real-time data and ensures connectivity between autonomous platforms, port infrastructure and digital services. In doing so, it extends the reach of the MTCOM network while supporting safer, more efficient and data-driven port operations.

Shaping the Next Generation of Smart Ports

MTCOM demonstrates how connectivity, autonomy and environmental intelligence can converge to reshape modern ports. By transforming fragmented processes into a unified, data-driven ecosystem, the project lays the foundations for a new generation of ports that are more connected, resilient and sustainable.

As maritime operations continue to embrace digitalisation, initiatives such as MTCOM show how collaboration can turn today's technological vision into tomorrow's operational reality.

FROM RADAR RETURNS TO SAFE DECISIONS: Radar Processing for Maritime Autonomy

A SEA-KIT X class USV built for Fugro. SEA-KIT was an early adopter of Cambridge Pixel's radar processing.

Credit: SEA-KIT

By Rob Helliar, *Cambridge Pixel*

Without a human onboard with all-around situational awareness, the sensor systems of autonomous and remotely operated vessels are critical for navigational safety and mission effectiveness. Much attention goes to the onboard camera suite, but radars, and their associated processing, are also a part of the sensor system mix.

When developers specify radar for an autonomous vessel, attention often goes to factors such as range, resolution, antenna size, and technology. Those choices matter, but they do not determine what the autonomy system or remote operator ultimately receives. This is determined by the quality of the radar processing.

An autonomy control system needs machine-readable information; a remote operator needs the maritime picture presented as clearly as possible to aid decision-making and reduce cognitive load. In both cases, a suite of sensors, with data processed and fused into usable information, is ideal.

Why radar remains important

An autonomous vessel may carry cameras, an Automatic Identification System (AIS) receiver, Global Navigation Satellite System (GNSS) receivers, LiDAR, sonar, and other sensors. Cameras can help identify an object, while AIS can provide a transmitting vessel's declared identity, position, course, and speed. However, neither alone provides a complete picture.

Cameras can be affected by darkness, glare, fog, rain, and spray. Most can only provide contact bearing, or, at best, a rough estimate of range. Small and fixed contacts are unlikely to carry AIS transponders, and those that are fitted with AIS can have it switched off or incorrectly configured. However, radar can operate at long range in poor visibility and provide accurate position information for small and non-co-operative contacts.

Radar is not infallible. Performance is affected by the installation, sea state, weather, target size and reflectivity, and processor settings. Radar should complement other sensors rather than replace them, but it remains an important independent source of information that autonomous systems should not ignore.

From echoes to detections

A radar will output video, in either analogue or, increasingly, digital form. In radar terminology, "video" means the stream of return intensities from the radar, as opposed to image-like camera footage. It is a constantly changing field of reflections, in polar space.

The radar video picture may be cluttered and complex. A steel ship may produce a strong radar return, but so may a harbor wall or a bridge. A small inflatable boat may produce only a weak radar echo, which may be obscured by waves creating sea clutter. Rain creates unwanted returns, and land and port structures produce persistent reflections. Effective processing is therefore essential.

Radar processing software first acquires radar video data through a hardware interface or a digital network stream. It then applies filtering and detection techniques to find returns that stand out from the background.

This is more involved than simply setting a single threshold above which a radar video return is considered to be a contact. The background changes with range, platform motion, weather, and sea state. Settings suitable for calm water may produce many false detections in heavy rain; settings that suppress them may hide a genuine target.

Adaptive processing responds to local conditions. Dynamic thresholding adjusts to changing noise levels, while geographic masks reduce processing over known land or structures. Where software allows, different radar processing settings can be applied in different regions, allowing greater sensitivity in a channel or directly ahead of the vessel. The goal is useful detections without excessive false alarms.

Detection, tracking, and obstacle reporting

Once a significant return is identified, adjacent significant returns can be grouped together into a plot (detection). A plot is a single observation: something of interest appears to be present at a particular position during one radar scan.

Tracking adds history and trajectory. Tracking software compares plots between successive scans and decides which are likely to belong to the same object. From these linked observations, it estimates course, speed, and likely future position. Confidence tests help prevent unrelated detections from becoming a false track.

For small targets, tracking may become difficult as detection strength and reliability reduce. This is where tracking from video can help; a track that has already been acquired by traditional detection and tracking methods can be maintained for longer by tracking directly from the radar video.

For autonomous navigation, it is not always appropriate to wait for a fully established track. Short-range or intermittent detections of objects such as a floating container or a small mooring buoy may generate a hazard that needs to be reported before a track can be generated. Proximity detections from a radar processor report the closest returns meeting configured criteria within a defined area around the vessel.

Proximity detections are reported with very low latency, on each scan, as the radar turns. Safety areas can reflect speed, maneuverability, and environment. A forward zone might extend farther at higher speed, while a tighter zone may suit harbor maneuvers.

Cambridge Pixel has been providing technology components for USV and ASV developers for over a decade, including its SPx Server V2 software, which includes radar video processing, proximity detection and tracking for collision avoidance and autonomous navigation. Its Detection Server configuration provides plot extraction and proximity detection, while the Tracking Server adds multi-hypothesis target tracking. Obstacle and target data can be supplied to an external autonomy or vessel-control system using formats including ASTERIX, NMEA-0183, TAK, and SAPIENT.

Combining sensors

A radar track may show that an object is approaching or on a steady bearing without identifying it. AIS may provide identity data that can be correlated with the track, while a camera may offer visual confirmation. Sensor fusion combines these observations into a more complete picture.

Successful fusion depends on consistent timing and coordinate systems and an understanding of the accuracy of each source, particularly where position is concerned. Bounding boxes defining uncertainty margins are critical with the aim of maximizing the number of contact correlations while minimizing false matches. Robust fusion is what turns multiple sensors into a coherent navigational picture.

A correlated track report links the individual sensor observations that support it, allowing the receiving system to choose information from any of the inputs. For example, speed and course can be taken from the radar track, object classification and enhanced bearing measurement from a video track, and cargo information from the AIS.

Position integrity without GPS

Autonomous vessels commonly depend on GNSS/GPS. Loss of signal is a problem, whereas jamming can prevent reliable reception and spoofing can cause a receiver to report a plausible but false position.

In coastal areas, radar can provide an independent cross-check of GNSS-derived positions. Cambridge Pixel's GPS Assist compares live radar data with a predicted radar image generated from terrain and coastline information. By finding the alignment that best matches the two images, it estimates the vessel's position independently of incoming GNSS data.

If the positions differ significantly, GPS Assist can raise an alarm and also generate an alternative NMEA-0183 stream to provide backup positional information.

Safe and effective maritime autonomy will not come from one sensor or algorithm. It will come from systems that provide independent, timely, and understandable evidence. Radar is central to that picture, but raw echoes are not enough. Only through rigorous processing can radar deliver the detections, tracks and obstacle warnings that autonomy systems depend on.

Credit: Cambridge Pixel

Cambridge Pixel's SPx Fusion Server correlates track reports from multiple radar sources and AIS into single fused tracks.

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MASS MOMENTUM:
Making Maritime Autonomy Technology Fit for Purpose

With a regulatory framework crystallizing, understanding how autonomy fits with operational requirements and human factors are key to successful adoption.

By Michael Kei, *ABS Vice President, Technology*

The global momentum for maritime autonomous surface ships (MASS) is accelerating, and the International Maritime Organization (IMO) is moving decisively to support the evolution of autonomous shipping into a practical and commercial reality.

As the conversation has matured following an extended period of consultation, the focus is shifting from early ideas of fully unmanned ships to a more realistic spectrum of supervised, autonomous and remotely supported operations. This reflects a growing understanding that autonomy is not a single destination; rather it is a continuum that still relies on human involvement, whether onboard or ashore.

MASS' gradual evolution has prompted the industry to think carefully about the regulatory, technical and human element of autonomy. It also highlights the responsibility placed on regulatory bodies to offer strong oversight.

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The adoption in May this year by the IMO of the non-mandatory International Code of Safety for Maritime Autonomous Surface Ships (MASS Code) is designed to support the safe integration of autonomous and remotely operated commercial ships into global shipping.

The MASS Code sets out a comprehensive, goal-based framework to help ensure that remotely controlled or autonomous ships are designed and operated to a level of safety, security and environmental protection that is expected of a conventional ship—and with future compliance requirements in mind.

The development of the regulations saw the International Association of Classification Societies bring forward critical insights and technical guidance around this technological innovation's operational realities.

Fit for Purpose Autonomy

For vessel owners and operators, autonomy is not always the ultimate goal or single end-state, but rather a tool that can be applied at different levels depending on the operational needs. In that sense, the higher levels of autonomy are not always better. The 'right' level depends on the operational context, risk profile and human involvement required, and different operations may require different degrees of autonomy.

Autonomy is a journey, and its incremental steps should be developed through a gradual, safety focused progression that introduces new capabilities in controlled phases. Early steps may rely on advanced, non autonomous decision support

systems, such as automated monitoring, advisory functions, and other smart tools that enhance situational awareness across vessel systems.

As operational experience increases, higher levels of autonomy can be introduced incrementally, expanding from decision support functions to more autonomous capabilities across multiple shipboard domains.

Regulatory and technical requirements that apply a step-wise approach provide progressive assurance, testing and validation at each stage, which ultimately supports learning from real-world experience while also building trust among crew, operators, regulators and other stakeholders.

Bridging Human Factors Engineering and Training Gaps

Human Factors Engineering (HFE) remains one of the most significant challenges in the progression toward autonomous maritime operations. While many emerging technologies must consider how they influence human activity, autonomy is fundamentally built around human involvement. Every autonomous function interacts with human decision-making, oversight and intervention, which means the human element cannot be treated as an afterthought.

Current HFE gaps for autonomous operations include insufficient focus on how people will supervise, interact and intervene in autonomous systems. There is also a lack of clear definitions or a common benchmark for evaluating autonomous navigation solutions.

Additionally, the pace of technological development is now outstripping the ability of onboard personnel to adapt. Skills, competencies and training pathways have not evolved at the same rate as the systems being introduced. This creates a widening gap between what technology can do and what the workforce is prepared to manage. Without targeted investment in training and human-centric design, this gap will continue to grow.

Verification and validation remain at the heart of safety assurance for autonomous technologies. Traditional testing alone cannot capture the full range of scenarios that an autonomous system may encounter at sea.

As essential tools, virtual testing and both system-level and full-mission bridge simulation allow developers and assessors to explore edge cases, stress conditions and rare events that would be difficult or unsafe to reproduce in physical trials. When combined with real-world testing, this creates a more complete picture of system performance.

To improve transparency, consistency and trust, standardized virtual testing and evaluation frameworks could support more consistent assessment of system performance, while generating data to support regulatory decision-making for MASS.

ONE HULL, MANY MISSIONS:

Credit: SeaTrac Systems

How Modular USVs Are Changing Autonomous Marine Operations

The rapid expansion of autonomous marine operations has created a challenge for research institutions, government agencies, and commercial operators alike. As missions become increasingly diverse, from environmental monitoring and hydrographic surveying to defense exercises and subsea positioning, maintaining dedicated vessels for every application presents difficulties both financially and operationally.

Instead, many organizations are prioritizing modular uncrewed surface vehicles (USVs) capable of supporting multiple mission profiles through rapid payload reconfiguration. Rather than purchasing a new platform for every sensor or application, a single vehicle can adapt to changing operational requirements while minimizing logistics, training, and maintenance costs.

The University of Southern Mississippi (USM) is among the many institutions putting this concept into practice. Through its Marine Research Center, USM has employed SeaTrac Systems' SP-48 USV across an expanding range of scientific, defense, and industrial projects, demonstrating how a modular platform can serve as a force multiplier across different missions.

A Platform Designed for Adaptability

Unlike traditional, mission-specific vessels, the SP-48 is designed around a modular architecture. Payloads can be integrated using multiple mounting locations, including a moon pool, dry payload bay, mast, or keel, allowing operators to quickly configure the vehicle for different sensors without fundamentally changing the platform itself.

This flexibility eliminates the need to maintain separate vessels for every mission while allowing new technologies to be integrated as operational needs evolve.

The platform also incorporates over-the-horizon communications, multiple power options, and remote command-and-control capabilities that enable operators to supervise missions from shore. In many cases, a single operator can oversee multiple vehicles simultaneously, further increasing operational efficiency.

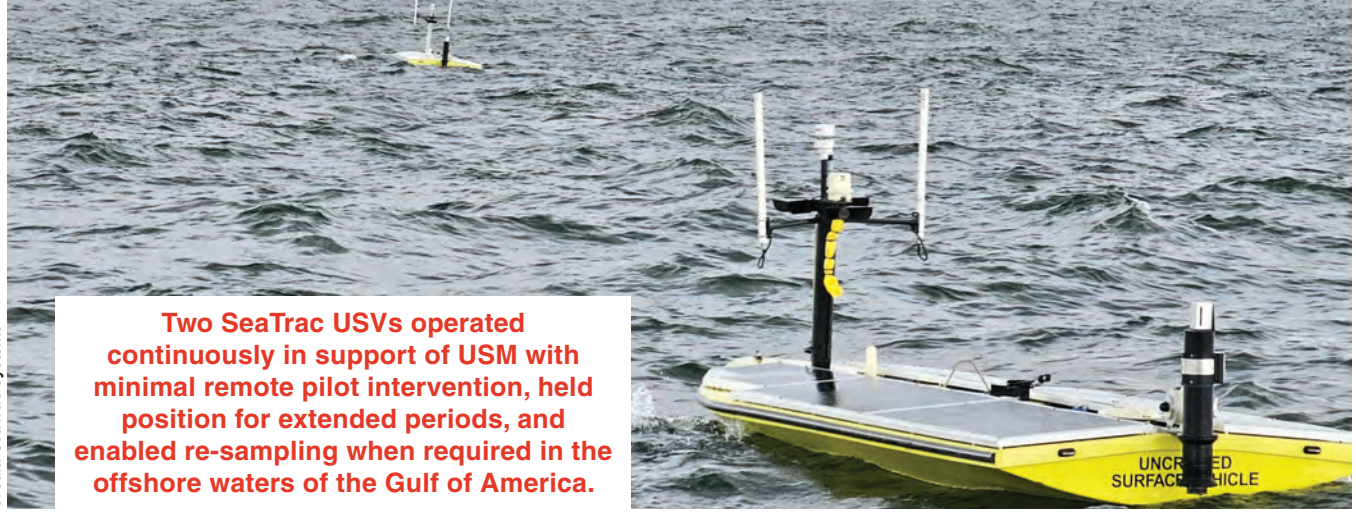
"USVs like ours offer researchers and project managers the opportunity to collect more marine data or surveil open waters with significantly reduced operational costs, risk to humans, and impact to the environment," said SeaTrac's Hobie Boeschenstein, director of business development. "Deploying USVs that are adaptable to nearly any marine environment, payload or sensor helps to ensure success across multiple mission profiles, further contributing to platform value. The use case opportunities in nearshore and offshore environments are endless."

Expanding Environmental Data Collection

One of the clearest demonstrations of this flexibility has been USM's ongoing hypoxia mapping program in the Gulf of America.

Building on previous deployments, researchers expanded operations by deploying two SP-48 USVs simultaneously, each equipped with acoustic Doppler current profilers (Teledyne Workhorse Monitor ADCPs) and AML Oceanographic Endura 6 sondes to collect water quality measurements.

Operating multiple autonomous vessels allowed researchers



Credit: SeaTrac Systems

Two SeaTrac USVs operated continuously in support of USM with minimal remote pilot intervention, held position for extended periods, and enabled re-sampling when required in the offshore waters of the Gulf of America.

Credit: SeaTrac Systems/USM

USM remotely commands two USVs in a nearshore waterway via laptop computer.

to increase both spatial coverage and data density while reducing the personnel traditionally required for coastal surveys.

"SeaTrac's SP-48 and transom winch successfully reduced the on-site personnel needed for coastal hypoxia mapping despite unfavorable sea states and congested coastal corridors," said James Thompson, USM's hydrographic instrumentation specialist. "Even more impressive was the boat's connectedness. We look forward to incorporating SeaTrac technology into future research."

Rather than replacing researchers, the USVs extend their operational reach, enabling more persistent sampling with fewer people at risk on the water.

Supporting Defense Training

The same platform has also been adapted for a vastly different mission: supporting U.S. Air Force pilot training.

Working alongside Parsons Corporation and the U.S. Air National Guard, USM configured the SP-48 to carry a TReX (Threat Representative Environment) emulator that simulated hostile air defense systems during flight training exercises.

Instead of collecting environmental data, the USV became a remotely positioned threat asset. Ultimately, the exercise targeted airborne systems and communicated with the command-and-control center via commercial and non-commercial communication mediums to develop skills in threat assessment and decision-making.

Because the USV was remotely deployed and repositioned as needed, it provided a flexible alternative to fixed infrastructure or manned support vessels.

"This innovative solution reduces logistical and personnel costs associated with manned missions while facilitating a high-fidelity simulation environment, ultimately elevating the U.S. Air Force's operational readiness," said Parsons' Mike Kushin, president of defense and intelligence.

SeaTrac Systems partnered with Parsons Corporation to support a threat environment demonstration for the U.S. Air Force.

In 2026, USM hosted a collaborative acoustic demonstration on the Gulf Coast with the University of Mississippi (Ole Miss), SeaTrac, Hyperion Technology Group and BLUEiQ.

Credit: SeaTrac Systems

Advancing Acoustic Operations

In the area of domestic security, SeaTrac's SP-48 also supports acoustic research and intelligence, surveillance, and reconnaissance (ISR)-related activities.

In collaboration with Hyperion Technology Group and Blue IQ, USM researchers integrated Blue IQ hydrophones onto the vehicle for acoustic monitoring missions.

During stationary operations, the USV recorded acoustic signatures from surrounding marine traffic and aircraft, collecting valuable datasets without requiring personnel aboard the vessel.

The platform was also used to track autonomous underwater vehicles (AUVs) equipped with acoustic pingers. Using real-time hydrophone data, operators could detect, localize, and close in on underwater assets throughout testing.

Mapping Above and Below the Surface

Another recent application involved collaborative magnetic mapping using QuSpin magnetometers.

For this mission, the sensor was mounted beneath the hull on the SP-48's keel, allowing it to remain submerged throughout operations and collect high-fidelity magnetic measurements.

The integration illustrates how physical mounting options are just as important as sensor compatibility. Different missions often require different sensor orientations or environmental exposure, and the ability to mount payloads on the mast, within the moon pool, inside the payload bay, or beneath the hull expands the platform's operational envelope.

Preparing for What's Next

USM continues to broaden the SP-48's capabilities through additional payload integrations.

Upcoming missions include incorporating Sonardyne's Gyro USBL 5000 system to support precise underwater positioning, as well as a Kongsberg EM2040P multibeam echo sounder for high-resolution harbor and seafloor surveys.

"This demonstration is essential for rapidly identifying solutions to meet the mission-critical needs of our warfighters and federal agencies," said USM's Dr. Brian Cuevas, associate vice president for research and innovation.

As remote-commanded marine operations continue to mature, versatility is becoming just as important as endurance or range.

Organizations increasingly require platforms that can move between environmental monitoring, defense, offshore energy, hydrography, and subsea operations without extensive reconfiguration or dedicated support vessels.

A single modular USV can support missions that once demanded multiple specialized platforms. And for operators facing expanding mission requirements and constrained budgets, that flexibility may prove to be one of autonomy's most valuable capabilities.

SNOW PROBLEM TOO BIG:

A floating polar laboratory tackles Arctic research

By Celia Konowe

On July 19, the Tara Polar Station, a drifting laboratory, departed from its homeport in Lorient, France to commence an 18-month Arctic expedition. As a year-round mission, the Tara Polaris I expedition was designed to explore the interconnectivity and seasonality of five components of the Arctic Ocean: atmosphere, snow, ice, biodiversity and the ocean itself. Tara Polaris I is just the first of multiple missions ongoing until 2046.

The Tara Ocean Foundation was launched in 2003 by Agnès Troublé and son Étienne Bourgois to support marine research, educate on its importance, and pledge for ocean protection. The Polar Station, built 18 years after the organization's first North Pole trip aboard the schooner Tara, was designed to fill a scientific gap in the Arctic Ocean, which lacks a long-term research station (compared to the five permanent sites in Antarctica) and remains vulnerable to climate change. Known as Arctic amplification, the ocean is warming three to four times faster than the rest of the planet. Arctic atlantification, the increased flow of warmer and saltier Atlantic waters, is also of concern and disrupts the natural stratification of the Central Arctic Ocean. Changes in sea ice, snow and water have consequences for the ecosystems and organisms that define the region.

"In the long term, the Tara Polaris (2026-2046) expeditions will help inform weather model forecasts in Europe by 2050 and shed light on the consequences of global changes (climate and pollution) on the functioning of our planet," explained Romain Troublé, CEO of the Tara Ocean Foundation. "The findings, which will be openly accessible, will support better governance of the Central Arctic Ocean, guiding regulations on industrial activities until we have a clear picture of the health of our planet's only polar ocean."

The floating base was built in 2023-2025 by Constructions Mecaniques in Cherbourg, France. Since delivery, the Tara Polar Station has undergone a full year of testing, followed by three months of drydock fine tuning.

The Tara Polar Station

Designed by Olivier Petit and the Tara Ocean Foundation, the station measures 26 meters in length and can withstand temperatures between -20° and -52°C. It can host a crew of 12 in winter and up to 18 in summer and has an autonomy of 500 days with up to 12 tons of food onboard. In addition to living spaces for the scientists, journalists and crew, the facility has five laboratories, offices, cold rooms and sample storage. Drinking water will be produced via a desalination system.

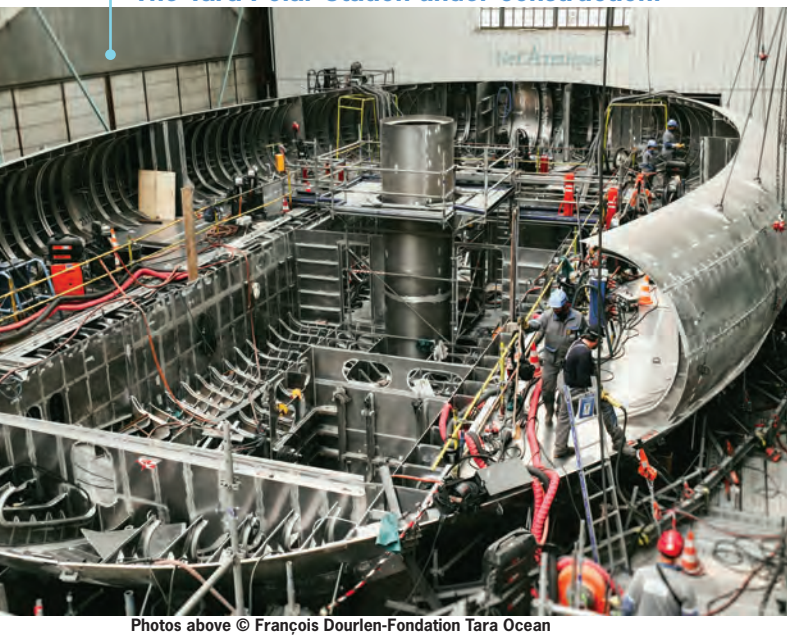
There is a six-foot-wide moon pool at the center of the drifting station, allowing for water samples down to depths of 2,500 meters. Atmospheric and underwater sensors line the outside of the vessel, and a CTD-rosette measures the physical, chemical and biological properties of the water column.

"For the sake of reliability, we have decided to avoid fancy and immature technologies but instead focus on efficiency and co-generation," said Troublé. "The efficiency of the power generator has been brought to 82% as the heat generated is captured to warm the vessel. The lab space for science represents 55% of the total area of the vessel, with direct access to the ocean through the moon pool. The station will also have a broadband connection through the OneWeb constellation by Eutelsat for crew communication with relatives, real-time data transfer and daily briefings with the consortium on land."

With such an ambitious mission, the Tara Polar Station faces its fair share of challenges. "The vessel will face enormous constraints from both operational and regulatory points of view," said Troublé. "The ice pressure expected has put a heavy load on the structure and shape of the hull, and the 500 days autonomy is demanding of storage and systems redundancy."

"The Polar Code has also brought a heavy burden on the footprint of the station and its efficiency. The exhaust of particles pushed us to use second-generation biofuel in the form of hydrotreated vegetable oil from Neste. Additionally, the eight tons

The Tara Polar Station under construction.



Photos above © François Dourlen-Fondation Tara Ocean

© Maéva Bardy - Fondation Tara Ocean

of jet fuel stored onboard for aircraft medical evacuation purposes has been a challenge for safety reasons." As such, collaboration between the architects, shipyard, Bureau Mauric and Bureau Veritas has been essential to tackle these challenges.

Collaboration is key

The Tara Polar Station, drifting in the Arctic Ocean for 18 months, also relies on collaboration at sea. "A true scientific hub, the laboratory-observatory will host researchers from all over the world: biologists, physicists, ecologists, glaciologists, atmospheric scientists, oceanographers, etc. The first 12 crew members are committing to a winter of around nine months," explained Clémentine Moulin, director of operations at the Tara Ocean Foundation and Coordinator of Tara Polaris I. "The selection and training process has been modeled on that used at remote research stations. Our aim: a close-knit group ready to face the challenges of an extraordinary expedition."

The collaborative science approach, as Troublé describes it, extends beyond the station. "We build ad hoc consortiums of laboratories that can host 30 to 40 laboratories internationally, made of 15 or more disciplines. The research goals and means are defined and funded collectively, and the six to nine scientists and engineers onboard will conduct the research. Then, the analysis and publications will be run collectively," he said. "The onboarding of new laboratories is evaluated by the consortium, based on the lessons learned before and the data gathered, raising new questions along the next 20 years of expeditions."

While research aboard the Tara Polar Station encompasses numerous scientists and disciplines, the overarching themes remain consistent. The key goals of Polaris I include exploring difficult-to-reach environments; discovering adaptations to extreme conditions; analyzing sea ice melt and pollution; identifying new molecules, species and processes; monitoring Arctic fish stocks; and providing new data to refine climate models.

While the Tara Polaris I expedition has just set sail, Tara Ocean Foundation is already looking ahead to Polaris II and III, developing the consortiums that will guide the laboratory's work from 2028 to 2031.

"It is unknown how organisms living in the heart of the Central Arctic Ocean cope with the extreme seasonality of light, temperature, sea ice and ocean dynamics, or how they survive during the long polar night. Over recent decades, this unique ecosystem has come under increasing threat. Its condition tells us how humanity is transforming the Earth," said Marcel Babin, polar oceanographer, CNRS/Laval University/Sorbonne (France/Canada), co-scientific director of the Tara Polaris program, and scientific director of Tara Polaris I.

"We urgently need observations to better understand the nature of the changes happening in the Arctic, particularly to capture the full annual cycle and track interannual variability," he added. "The Tara Polaris program will bear witness to the history of the Arctic."

An atmospheric balloon measures pressure, temperature, humidity, and wind speed.

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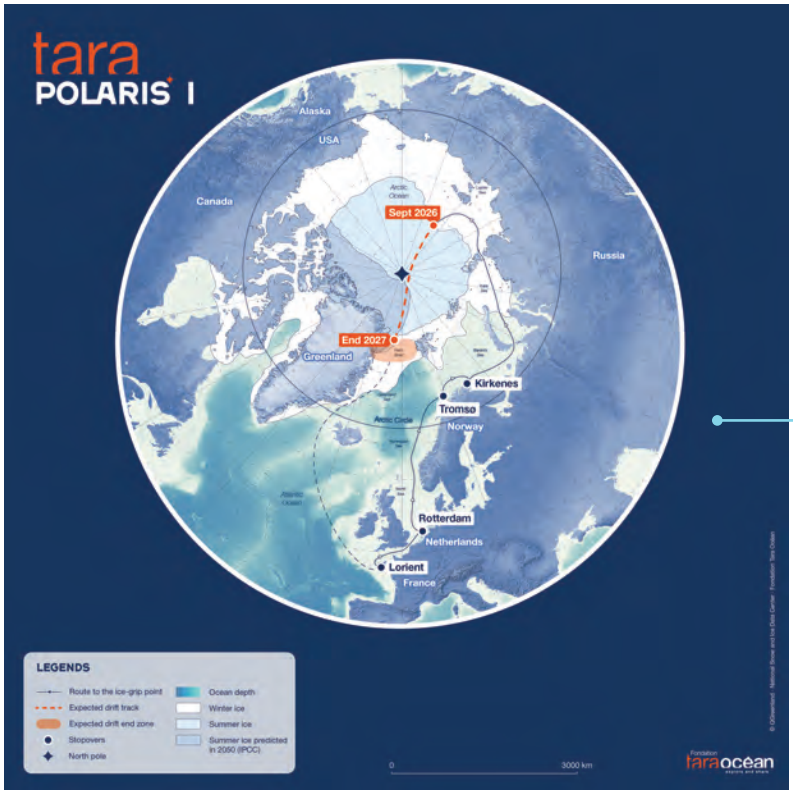

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A map of the Tara Polaris I expedition.

Cellula Robotics Envoy AUV with fuel cell power.

Credit: Cellula Robotics

COMMS AND CONTROL

Control and communication technology is evolving to support greater endurance in subsea operations.

By Wendy Laursen

In 2025, ecoSUB Robotics and Sonardyne delivered a breakthrough in autonomous underwater operations by demonstrating seabed mounted aided navigation and autonomous AUV launch — a capability that pushes the boundaries of what subsea systems can achieve.

The companies developed seabed nodes that combine Sonardyne's Compatt 6 acoustic communications with a passive ultra-short baseline (USBL) system to create fully autonomous subsea launch points capable of lying dormant for extended periods. Each node houses an ecoSUB AUV within a dedicated launch tube, remaining in hibernation until activated acoustically or by a defined trigger.

Once awakened, the ecoSUB AUV brings the node online, releases itself and flies from the launch tube. The AUV begins its mission without GNSS, instead receiving precise acoustic position updates from the node at ranges up to 600 meters. With a network of four nodes, this architecture scales to wide area coverage and coordinated multi-AUV response.

In June 2026, during the UK Smart Sound Connect Subsurface demonstration, ecoSUB and Sonardyne showed this concept in a real operational environment. "The demo showed how seabed mounted aided navigation can be used but also how ecoSUB platforms can exploit this infrastructure, showing the significant potential for this type of autonomous subsea operation," said Iain Vincent, Director and General Manager at ecoSUB Robotics.

The Smart Sound Connect Subsurface project, led by the University of Plymouth with Plymouth Marine Laboratory (PML), saw platforms from ACUA Ocean, ecoSUB Robotics, Seaber and Sonardyne working together above and below the surface.

During the demonstration, both the University of Plymouth's Seaber AUV and an ecoSUB AUV navigated simultaneously using only the seabed node array. At the surface, a PIONEER USV from ACUA Ocean tracked and controlled an ecoSUB AUV using a Sonardyne Ranger 2 Gyro USBL positioning system. The USV also wirelessly harvested data from a permanently deployed Sonardyne Origin 600 acoustic Doppler current profiler, and marine software engineering firm Marine AI demonstrated the ability to continue navigating, even when GNSS drops out, using Sonardyne's SPRINT-Nav.

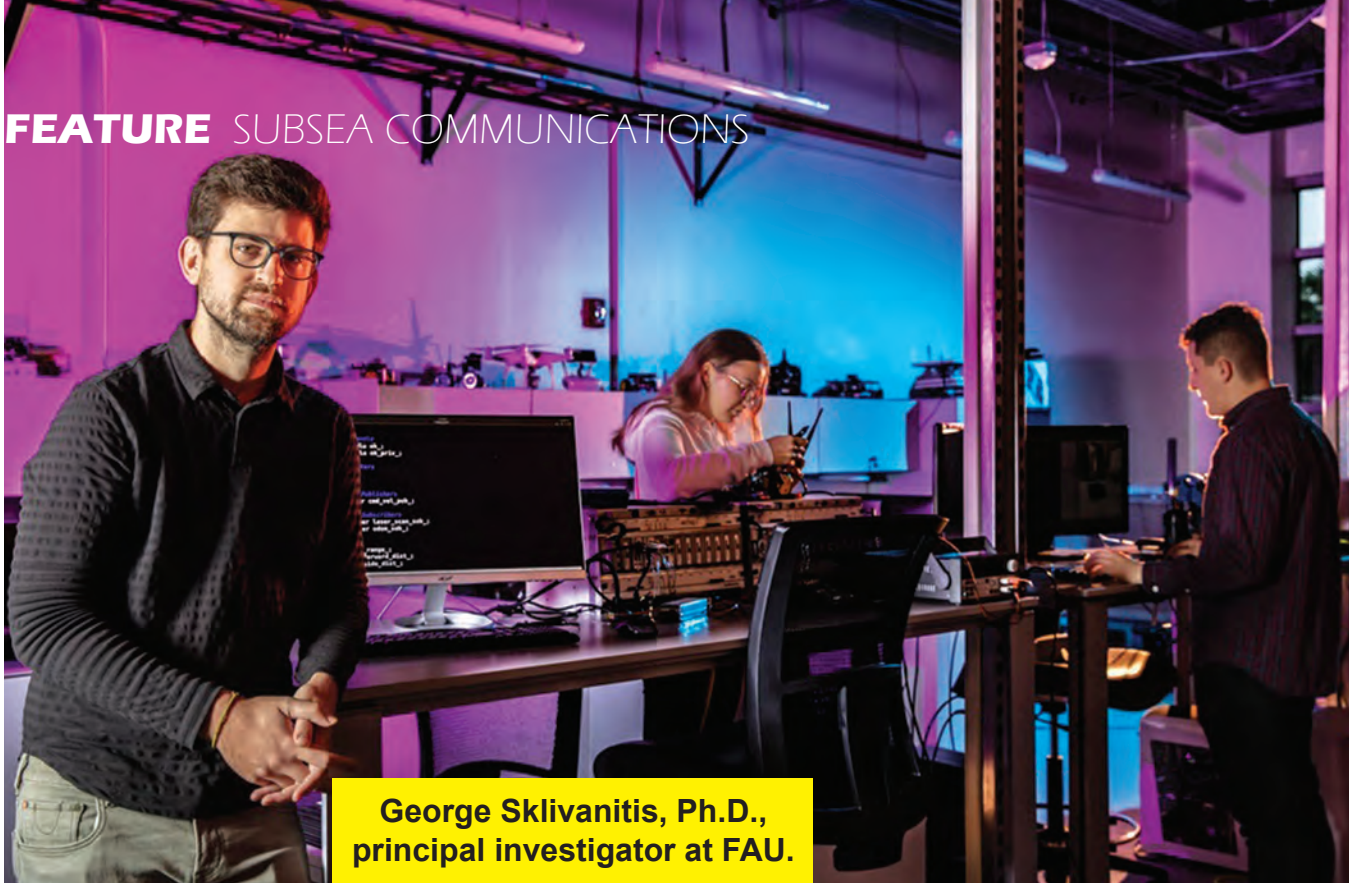
Two of the biggest challenges working with marine robotics are inter-operating multiple platforms, surface and subsea, in

Seaber Yuco and ecoSUB Robotics being deployed from Sonardyne's Echo Explorer at the Smart Sound Connect Subsurface demonstration.

Credit: Sonardyne

From PML's remote operations center, visitors were able to view live feeds, showing tracking and data telemetry from the AUVs and Sonardyne's Origin 600 ADCP to the PIONEER USV.

Credit: University of Plymouth/Plymouth Marine Laboratory



George Sklivanitis, Ph.D., principal investigator at FAU.

Credit: FAU

A PIONEER USV from ACUA Ocean at the Smart Sound Connect Subsurface demonstration.

Credit: ACUA Ocean

a multi-organization environment, said Aidan Thorn, Business Development Manager, at Sonardyne. “We showed how this can be done in a live environment – complete with an audience in PML’s remote control center.”

Seabed navigation nodes using passive USBL shifts the “intelligence” of the positioning system from the surface to the seabed, where it can support small fleets of AUVs that don’t need significant navigation and communication packages, he says.

As subsea vehicles, seabed systems and surface platforms are asked to operate farther from support vessels, remain deployed for longer and carry more capable payloads, energy availability is central to mission planning, system design and operating cost. NautiGEN, a maritime hydrogen power company formed by Cellula Robotics, has developed fuel cell systems to extend endurance beyond battery power. The architecture separates the fuel cell power plant from the stored hydrogen and oxygen that feed it, allowing mission energy to be increased through storage. For manufacturers and integrators, this offers a more flexible route to balancing endurance, payload energy, range and mission availability. Initial applications include subsea vehicles, static seabed power systems and surface uncrewed systems.

The technology base has already been demonstrated in a subsea environment. The fuel cell system powered a Cellula Robotics’ Envoy AUV through a more than 2,000 kilometers fully submerged mission over 385 hours of continuous operation, including over 4,000 non-linear maneuvers. The demonstration was achieved using the hydrogen fuel cell technology developed with Infinity Fuel Cell and Hydrogen, Inc.

On announcing a memorandum of understanding with Integer Technologies, Alex Johnson, Director of Products at Cellula Robotics, highlighted the need for system awareness

and mission confidence in long-range undersea operations. The agreement establishes a cooperative framework to layer Integer's DIGIT COMMAND operator software with Cellula's mission control software for its UUV platforms. DIGIT COMMAND is a multi-agent mission manager designed for shoreside operators that feeds existing command and control with a decision-support layer across all operations. Integer's DIGIT Mission Assurance Platform fuses high-fidelity digital twins with real-time environmental forecasting so that operators can assess, coordinate and adapt mission plans. By integrating real-time sensor data with physics-based models, platforms can adapt automatically to evolving threats.

"The next generation of defense technology will be defined by software that can anticipate, not just respond," said Duke Hartman, Integer CEO. "From platform-level introspection to global fleet orchestration, DIGIT provides the software architecture to win the fight. It represents a fundamental shift toward mission-aware technology, giving operators and autonomous systems the foresight to make confident decisions to deliver successful mission outcomes."

Florida Atlantic University (FAU) is advancing subsea communication technology with a one million dollar grant through the AUKUS Maritime Innovation Challenge, a defense innovation initiative supported by Australia's Advanced Strategic Capabilities Accelerator, the United Kingdom's Defense and Security Accelerator and the United States Defense Innovation Unit.

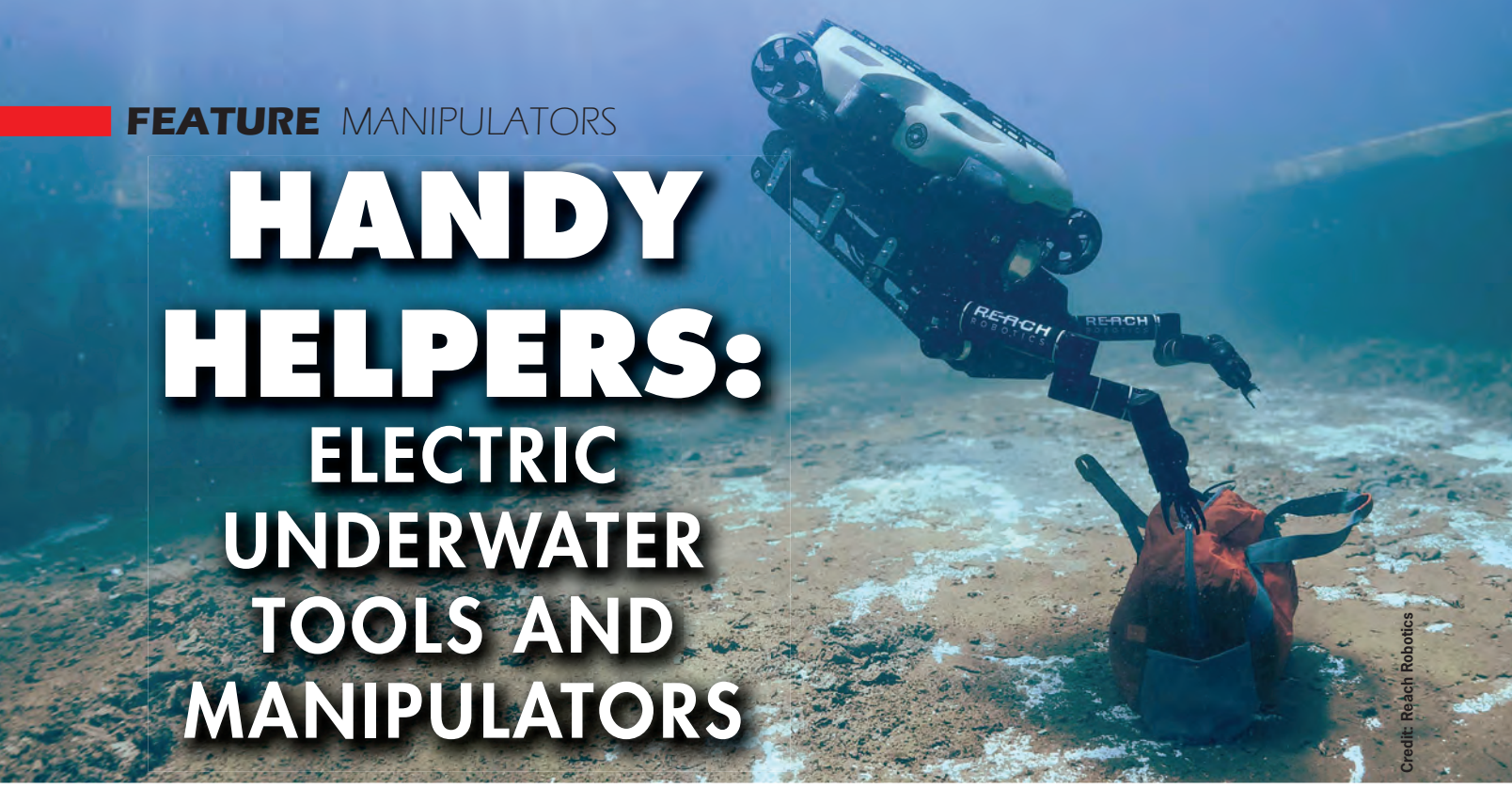
The project, led by FAU's Center for Connected Autonomy and Artificial Intelligence (CA-AI) in collaboration with Hydromea, aims to develop a next-generation underwater communication and networking system designed to help autonomous underwater vehicles, seabed sensors and maritime operators share information more quickly, reliably and securely.

"Today's underwater communication systems typically force operators to choose between range and speed," said George Sklivanitis, Ph.D., principal investigator at FAU. "Acoustic communication signals can travel long distances but offer limited bandwidth, while optical communications can transmit data quickly but only over short distances."

The FAU-Hydromea solution will combine both technologies into a single programmable platform. Long-range acoustic links will provide resilient command-and-control communications, while high-speed visible-light links will enable rapid data sharing among nearby autonomous vehicles and sensors. The system will be capable of adapting to changing underwater conditions and maintaining connectivity even in congested or contested environments.

The researchers anticipate the technology will provide a pathway toward future operational deployment for allied maritime forces while supporting broader applications in scientific research, environmental monitoring and offshore industries.

HANDY HELPERS: ELECTRIC UNDERWATER TOOLS AND MANIPULATORS



Credit: Reach Robotics

By Celia Konowe

Underwater vehicles fill a crucial place in maritime operations, providing support across multiple industries, reaching remote locations despite extreme conditions and reducing risk to workers. They function as surrogate eyes and ears where we cannot be, and for periods of time longer than many humans could manage. However, underwater systems reach beyond observational abilities—literally. Tools and manipulators broaden the capabilities of vehicles, allowing them to perform a variety of subsea tasks.

Reaching new depths

"One of the most significant trends we are seeing is the growing expectation that inspection-class vehicles should also be capable of intervention," explained Nigel Steven, head of commercial at Reach Robotics. "Operators are no longer satisfied with simply observing a problem. They want to recover objects, manipulate equipment, collect samples and complete tasks without deploying larger, more expensive systems."

As such, there is growing demand across multiple sectors—ranging from defense and offshore energy to commercial inspection, research and environmental monitoring—for manipulators that are lightweight, straightforward to integrate and specific to a project's needs.

Reach Robotics develops electric manipulators for remotely operated vehicles (ROVs), enabling operators to perform precise underwater intervention tasks. The company's product range spans compact systems for smaller inspection-class ROVs through to seven-function manipulators for more demanding subsea projects.

Steven recalled that during a recent inspection, maintenance and repair campaign, operators used a pair of Reach X five-function manipulators on an inspection-class ROV to move beyond visual inspection and conduct direct asset interaction. "The manipulators were used to place corrosion monitoring probes, clean marine growth to provide inspection access, and handle small subsea components, allowing condition assessment work to be completed without mobilizing a larger intervention system.

"For us, this project reflects a broader shift in the industry," he added. "Operators are increasingly looking to perform practical intervention tasks from compact ROV platforms, reducing mobilization requirements while maintaining operational efficiency. It demonstrated how electric manipulation can expand the capability of inspection-class vehicles without the complexity traditionally associated with larger intervention systems."

"I think we're at a real turning point for subsea manipulation," added Rob Dewell, electric manipulator product manager at Saab UK, also recognizing the industry shift towards this capability.

"For a long time, people viewed electric systems as a compromise compared with hydraulics, but that's no longer the case," he explained. "Advances in power density, control systems and system integration mean electric manipulators can now deliver the strength, precision and reliability needed for demanding intervention tasks, while also supporting the wider move towards all-electric and more autonomous subsea operations."

Saab boasts the Seaeye eM1-7 Electric Manipulator (eM1-7), an electric manipulator arm designed for demanding underwater intervention tasks. It combines high lifting capability with precise control, offering up to 122kg lift capacity at a 2-meter reach and 454kg when retracted, while its six degrees of freedom provide the dexterity needed for complex operations. The system is also engineered for deepwater environ-

Credit: Reach Robotics

ments, with a depth rating of 4,000 meters.

Nauticus Robotics, Inc. also has an electric work-class subsea manipulator designed for ROV applications: the Olympic Arm. More recently, however, the company is integrating electric manipulators and autonomous operations with their first prototype built for autonomous underwater vehicles (AUVs) and robotic systems.

The initial prototype, described in a press release, features a modular three-joint configuration that serves as the foundation for planned five-joint and seven-joint variants capable of supporting increasingly complex subsea operations. Integrated with Nauticus Robotics' ToolKITT software, the manipulator will autonomously recognize work sites, identify intervention points, compensate for changing underwater conditions, and execute tasks with reduced operator input.

Development teams have started functional and load testing, with Nauticus Robotics' Aquanaut AUV serving as the initial integration vehicle for future field demonstrations.

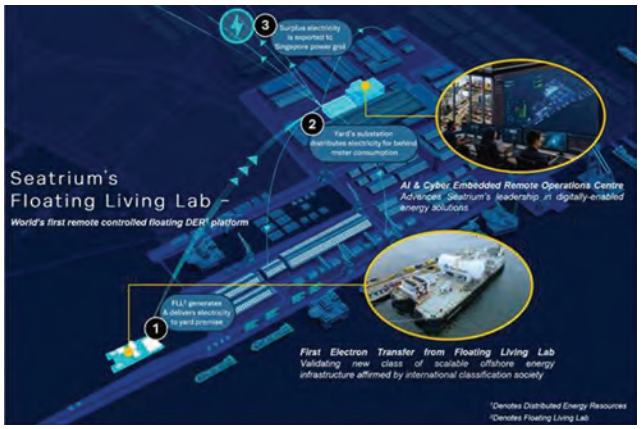
An electric future

"What's particularly exciting is the role these technologies will play in reducing human intervention in hazardous environments," Dewell enthused. "By combining advanced manipulation with greater automation and, ultimately, AI-enabled capabilities, we can improve safety, make operations more efficient and unlock new ways of working underwater that simply weren't possible before."

Steven concurred, adding, "The subsea industry continues to evolve towards smaller, more agile robotic systems. As these platforms become increasingly capable, the role of electric, high-performance manipulation becomes even more important."

Credit: Saab

■ Seatrium



■ Kongsberg Maritime

■ Seatrium Powers First Electricity Export to Singapore Grid from Floating Platform

Seatrium Limited has announced that it has achieved the first export of electricity to the Singapore national grid from its Floating Living Lab (FLL), marking a step forward in next-generation floating energy infrastructure.

The FLL is a world-first, Remote-CON notated floating DER platform, classed by the American Bureau of Shipping (ABS) and supported by a Remote Operations Centre (ROC), built on DNV's assurance frameworks for remote operations. It integrates distributed energy resources into floating power assets serving both grid and marine consumers across Singapore and Southeast Asia.

Combining a stacked battery energy storage system and gas bunkering infrastructure, the facility supports emerging business models such as PaaS and new energy infrastructure ownership, positioning the Group at the forefront of offshore energy as power demand in heavy consumer markets grows.

The FLL received its first operational parcel of Liquefied Natural Gas (LNG) in March this year via ship-to-ship bunkering. The LNG is converted into electricity using onboard gas engines to support Seatrium's operational energy requirements, with surplus power exported to the Singapore electricity grid. This dual capability enables the FLL to reliably meet peak on-site demand while generating sufficient excess electricity that can meet the monthly energy needs of approximately 1,500 four-room HDB households, underscoring its role as an integrated and scalable energy solution.

In addition, the FLL has achieved the Remote-CON notation from ABS, validating its remote-control capabilities for power generation and controls from an onshore command center. The notation recognizes the integration of advanced automation, secure communications and control system architecture, enabling key onboard systems to be operated remotely while meeting stringent safety and redundancy standards.

To further scale these capabilities, Seatrium has operationalized a ROC built on DNV's assurance frameworks, integrating secure communications, data pipelines, and human-in-the-loop decision support for centralized monitoring across the FLL and broader connected offshore assets.

Seatrium's ROC capabilities are strengthened with the application of AI and AI-Ops to automate data processing, optimize energy use and accelerates decision making with analytics. Cybersecurity, including post-quantum encryption, protects systems interactions with ROC. Together, these capabilities enable Seatrium to meet global standards for safety and reliability, while scaling remote operations, improving asset performance, and delivering advanced digital infrastructure solutions to customers worldwide.

In collaboration with partners, Seatrium is advancing its design and operational capabilities, leveraging data-driven optimization, AI-enabled tools, and digital twin technologies. These efforts expand its engineering, procurement and construction (EPC) opportunities in decarbonization projects, while growing its software and service offerings and advancing floating energy storage as a new infrastructure asset class.

Looking ahead, Seatrium intends to scale the proven FLL capabilities for nearshore electrification solutions in Singapore and beyond, drawing on its integrated capabilities in engineering, digitalization and energy systems.

■ Kongsberg Maritime, BCIT Invest in Future Marine Innovation Simulation Centre of Excellence

KONGSBERG, Kongsberg Maritime, and British Columbia Institute of Technology (BCIT) announced an investment that will establish the Marine Innovation Simulation Centre of Excellence (MISE) in British Columbia. The initiative is designed to strengthen maritime innovation and skills development, support ongoing research and development, while building on key objectives outlined in Canada's Defence Industrial Strategy.

The partnership and subsequent investment are enabled through the Industrial Technological Benefits (ITB) policy, and in support of KONGSBERG programs in Canada. This investment will directly support improved facility infrastructure, onboarding of applied

■ **Fincantieri**

■ **Cellula Robotics**

■ **NORBIT**

research and faculty expertise, and ongoing research and long-term capability development.

Through the partnership, BCIT's new Simulation Center will be built around the Kongsberg Maritime simulation technology, providing a synthetic environment, development tools, and APIs to support collaborative applied research with Canadian industry, academia, defense, and public-sector stakeholders. It will serve as a platform for prototyping, human factor studies, testing, and accident and incident analysis, including de-risking new concepts in areas such as maritime safety, autonomy, cyber resilience, critical infrastructure, port development, and low- and zero-emission operations. The hub will also help accelerate commercialization opportunities and support the development of sovereign Canadian capability in a strategically important sector.

The partners will implement a strategic long-term capability to support sustainable and future-oriented maritime development. The technology partners will deliver the core systems, simulation environment, and technical expertise required to enable high realism, scalability, and innovation across the project's solutions.

To expand access and increase training capacity, the partnership will provide licenses for cloud-based simulation systems, enabling BCIT to extend learning beyond the campus ties.

■ **Fincantieri Strikes Four Deals in $687M Underwater Expansion**

Italian shipbuilder Fincantieri has agreed to acquire majority stakes in four companies for an initial expenditure of about $687 million (€600 million), expanding its capabilities in marine drones, subsea services and underwater communications across commercial and defense markets.

The agreements cover acquisitions of majority stakes in Next Geosolutions, WSense, Graal Tech, and Defcomm, which will be integrated into Fincantieri's Underwater technological hub.

Next Geosolutions, listed on Euronext Growth Milan, provides marine survey and geoscience services as well as offshore construction support services.

WSense specializes in underwater communications and the Internet of Underwater Things, while Graal Tech and Defcomm specialize in autonomous underwater vehicles and autonomous surface vehicles, respectively.

The transactions follow Fincantieri's acquisition and integration of WASS in 2025 and Remazel in 2024. The expanded underwater platform will comprise eight companies and about 1,500 professionals across Italy, the UK, the Netherlands, Norway and the UAE.

Fincantieri said the platform will combine capabilities spanning hardware, software and telecommunications, underwater platforms and services, with applications across conventional and unconventional underwater activities.

The expanded capabilities are intended to serve both defense and commercial markets, including critical subsea infrastructure protection, maritime security and offshore services.

■ **Cellula Robotics, Metron to Advance Undersea Capability for the US Defense Market**

Cellula Robotics US Inc. and Metron, Inc. have signed a 10-year agreement to deliver a combined solution for the United States defense market, bringing together Cellula's commercial off-the-shelf (COTS) long-endurance autonomous underwater vehicle (AUV) platforms with Metron's adaptive mission autonomy and undersea warfare and maritime domain expertise.

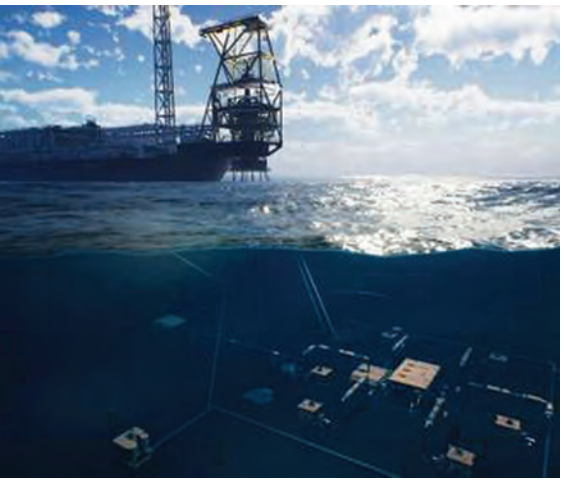
The agreement reflects growing demand in the US defense market for solutions that can move rapidly from program need to operational deployment, quickly scale, and deliver the autonomy, endurance, reliability, and payload modularity necessary to be operationally relevant.

The collaboration is designed around a modular, open-architecture approach that supports continued integration of third-party sensors, payloads, and mission systems, helping ensure the solution remains adaptable as technologies evolve and customer requirements change.

■ **NORBIT Acquires Water Linked**

NORBIT has acquired Trondheim-based Water Linked, a provider of underwater navigation and imaging

■ Sonardyne



■ Eni/Fincantieri

■ SubSea Craft

technologies for ROVs, AUVs and uncrewed surface vessels.

Founded in 2013, Water Linked has developed a position in the subsea technology market with products including Doppler Velocity Logs (DVLs), 3D imaging sonars, acoustic positioning systems and underwater communication solutions. These technologies enable navigation, perception and autonomy in GPS-denied environments and are widely used in subsea inspection, offshore energy, marine research, defense and underwater infrastructure applications.

The addition of Water Linked strengthens and complements NORBIT Oceans' existing underwater acoustics portfolio. Together, the combined technologies create new opportunities to deliver integrated solutions for underwater vehicles and expand capabilities in navigation, positioning, imaging and autonomy.

Water Linked will continue operating as Water Linked, a NORBIT Company, maintaining support for its existing customers while benefiting from NORBIT's global reach and broader technology platform.

■ Sonardyne, AMOG Join Forces on Subsea Asset Integrity Services

Sonardyne and engineering consultancy AMOG have signed a memorandum of understanding to jointly offer subsea asset monitoring services for offshore energy infrastructure.

The partnership will combine Sonardyne's underwater monitoring, positioning and communication technologies with AMOG's engineering assessment capabilities to support the monitoring and integrity management of offshore assets, including moorings, pipelines and risers in the oil and gas and floating offshore wind sectors.

The collaboration will incorporate Sonardyne's Observer wireless subsea asset integrity monitoring system, which provides motion monitoring, third-party sensor integration and onboard data analytics.

The combined offering is intended to help operators improve asset visibility, reduce downtime and support life-extension strategies through enhanced monitoring and engineering analysis.

The partners are already working together on a near real-time mooring monitoring system for a floating offshore wind project in Europe.

■ Eni, Fincantieri to Advance Underwater Monitoring Technologies

Eni S.p.A and Fincantieri, through its subsidiary IDS – Ingegneria dei Sistemi, announced the signing of a strategic agreement granting IDS an exclusive license for the worldwide commercialization and industrial development of Eni's Clean Sea technology.

The technology will be deployed for underwater inspection activities and initiatives related to the offshore market's energy transition objectives, with particular focus on Carbon Capture and Storage (CCS) projects in marine environments. This license will enable IDS to use Clean Sea to support Eni's operational requirements and those of third-party customers.

Clean Sea is based on hybrid ROV/AUV (Remotely Operated Vehicle/Autonomous Underwater Vehicle) architecture, that allows it to be used in remote-controlled form, from a support vessel or in fully autonomous mode. The technology incorporates interchangeable modular payloads, known as e-pods, which combine instruments and sensors tailored to specific monitoring and inspection tasks, including water sampling, detailed visual analysis, and 3D acoustic reconstructions. The technology will be integrated with various autonomous platforms and unmanned systems developed by the Fincantieri Group, enabling scalable applications both in terms of operational volumes and new use cases.

■ **MARTAC**

■ **MacArtney**

■ **SubSea Craft Expands Operations to Virginia Beach**

British maritime technology company SubSea Craft has announced plans to expand its operations to Virginia Beach. The company's expansion into Virginia Beach represents a step in growing its U.S. footprint, while strengthening collaboration opportunities within one of the world's most concentrated maritime and defense ecosystems.

As part of its expansion, the company anticipates hiring for a range of positions spanning leadership, operations, field engineering, and technicians.

Founded in the United Kingdom, SubSea Craft develops maritime platforms and technologies designed to support modern naval and defense operations in complex maritime environments.

Virginia Beach will serve as a strategic location for the company as it continues expanding engagement with U.S. defense stakeholders, maritime industry partners, and technology collaborators, including local company Global Technical Systems. The city's proximity to military installations, maritime infrastructure, advanced manufacturing capabilities, and a highly specialized workforce make the region an attractive fit for the company's continued growth.

The project was led by Virginia Beach Economic Development and the Hampton Roads Alliance, and received an Economic Development Investment Program grant from the Virginia Beach Development Authority. The company was recruited with support from Virginia Economic Development Partnership.

■ **MARTAC Expands Across Western US With Opening of San Diego Innovation Center**

Maritime Tactical Systems, Inc. (MARTAC), a provider of fully autonomous unmanned surface vessels (USVs), announced the opening of the MARTAC Innovation Center West in San Diego, California

The MARTAC Innovation Center West will serve as a hub for research, development, testing and customer engagement, complementing MARTAC's headquarters in Melbourne, Florida. San Diego's ties to the U.S. Navy, its defense technology ecosystem and its access to open-water testing environments make it the ideal location for MARTAC's next phase of growth.

The new center will support a range of activities, including advanced engineering and systems integration, live-water demonstrations of MARTAC's autonomous vessels, customer training and mission planning and collaborative development with defense and industry partners. The facility is expected to create new jobs in the San Diego.

MARTAC's facility expansion comes at a time of accelerating demand for autonomous maritime capabilities. The U.S. Navy has outlined plans to grow its fleet to include a number of uncrewed vessels, and MARTAC's platforms, including the MANTAS T-series and Devil Ray, are already in operational deployment supporting fleet operations worldwide.

■ **MacArtney Strengthens Swedish Presence with New Gothenburg Office**

MacArtney has taken the next step in its Sweden operations, moving into an office at Nya Varvet near central Gothenburg on Sweden's west coast.

Located along the Göta Älv, connecting Gothenburg to the North Sea and the Baltic region via the Kattegat, the setting brings MacArtney closer to customers operating in marine and offshore, ocean science, and naval industries. Since relocating, the Swedish operation has begun welcoming visitors, using the space for dialogue, demonstration, and ongoing collaboration.

■ Vatn Systems

■ KONGSBERG

■ RS Aqua

■ **Vatn Systems Launches Autonomous Mine Countermeasure System**

Vatn Systems announced the launch of SIGURD, a fully modular mine countermeasure system capable of both detecting and neutralizing naval mines. Built on Vatn's Skelmir S6 AUV platform, SIGURD is the first all-in-one autonomous mine countermeasure system capable of tracking, detection, and terminal engagement at an unmatched price point that makes wide-scale deployment achievable.

The launch of SIGURD comes as global demand for scalable, affordable mine countermeasures capability accelerates, particularly across the Indo-Pacific and in maritime chokepoints where undersea threats have increased. In testing against inert mines, SIGURD has successfully detected and intercepted targets, and the system is expected to be deployable this year.

The system has the same platform, software stack, and command and control architecture that powers the company's broader AUV product line, now available with two payloads for mine countermeasures and upgraded software to support mine countermeasures. The system's two modular components can be deployed independently or together as a complete end-to-end solution. The detection variant equips the S6 with a side scan sonar payload capable of detecting undersea mines at operational depths of up to 100 meters, with a roughly 6-hour run time and 30 nautical mile operational range.

The neutralization variant uses a forward-looking sensor system to execute terminal guidance on confirmed targets, with operators choosing between a fully autonomous engagement mode or a human-in-the-loop approach. Both variants integrate with Vatn's TAK-based command and control interface.

■ **KONGSBERG Delivers Vessel Traffic Services Solution to Great Belt VTS**

KONGSBERG has successfully delivered a new Vessel Traffic Services solution for Great Belt VTS, supporting traffic management through one of Europe's busiest straits and providing information services to vessels passing the Great Belt Bridge in Denmark.

The contract was awarded by DALO, the Danish Ministry of Defence Acquisition and Logistics Organisation, which is responsible for the procurement, supply, maintenance, development and decommissioning of materiel capabilities, IT and services for the Danish Armed Forces and the Danish Emergency Management Agency.

KONGSBERG has delivered Foresight, their in-house developed family of software systems for maritime domain awareness, including special adaptations and development tailored to Great Belt VTS' needs. The solution is integrated with existing radar and CCTV infrastructure, with KONGSBERG holding full responsibility for the integration and interfaces.

In addition to the delivery, KONGSBERG will support Great Belt VTS through a long-term Managed Services agreement, ensuring continuity, reliability and lifecycle support for years to come.

■ **RS Aqua Launches Enhanced Marlin Underwater Acoustic Monitoring System**

RS Aqua has introduced an enhancement to its Marlin underwater acoustic monitoring system, designed specifically for offshore wind developers, subsea construction contractors, and marine environmental teams. The latest Marlin update combines Harbor Porpoise Detection, Acoustic Anomaly Detection, and Impulsive Noise Metrics Monitoring.

Harbor porpoises are a protected species and remain one of the most sensitive and closely monitored marine species within offshore development zones. During activities such as seabed piling and construction, underwater noise can disrupt migration routes, feeding behaviors and breeding patterns.

Marlin's enhanced harbor porpoise de-

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■ **PMI Industries, Inc.**

■ **Silicon Sensing**

tection capability monitors for the high-frequency clicks produced by these marine mammals, providing operators with near real-time awareness of their presence within the project area.

In addition to marine mammal monitoring, Marlin can now continuously profile the underwater environment to establish a baseline sound signature. The system automatically identifies and flags unexpected acoustic events. These could include illegal vessel activity for example, or security-related disturbances.

The Marlin system consists of three integrated components:

- Marlin Link: The self-contained telemetry hardware deployed in the field. It connects to acoustic recorders, captures data and transmits it securely for processing.
- Marlin Cloud: The secure processing layer. It receives and stores incoming acoustic data, runs AI-enabled analytics and generates real-time alerts, turning raw sound and data into tangible, structured information.
- Marlin Connect: The desktop application where users interact with the system. It provides live and historical data visualization, detection results, analysis tools and export functionality.

Marlin also automatically measures and logs the metrics required for environmental assessments, as impulsive noise generated during offshore construction remains a key regulatory concern.

Marlin is calibrated and connected across the entire monitoring chain, including hydrophones, data acquisition hardware and processing software. Operators can access live and historical monitoring data remotely through the Marlin Connect desktop application, enabling project teams to review acoustic information from anywhere in real time.

With Marlin Link installed directly onto a buoy or fixed platform, the system operates autonomously without the need for dedicated vessels or onboard crews, helping reduce monitoring costs while maintaining continuous environmental oversight.

■ PMI Industries Launches New Split Bending Strain Relief

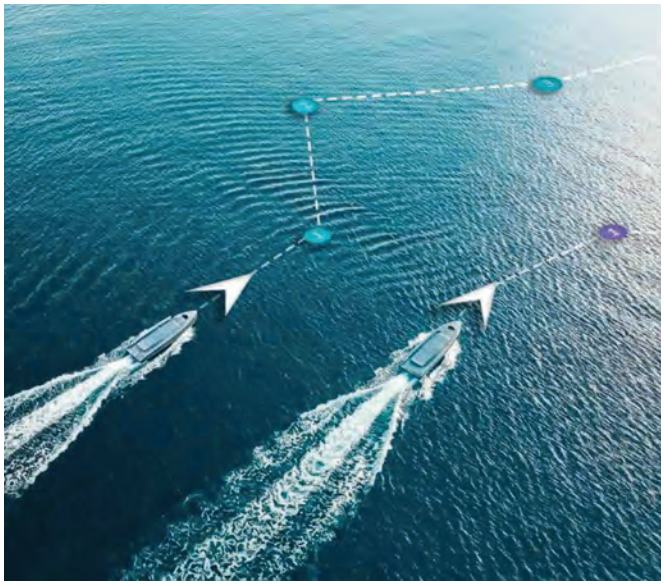
PMI Industries, Inc., a provider of engineered solutions for underwater marine cable connectors and subsea cable terminations, introduced its new Split Bending Strain Relief (BSR), a cable protection solution designed to provide graduated stiffness, limit bend radius, and protect systems in demanding marine environments.

Constructed from a corrosion-resistant adaptor, polyurethane, and stainless steel bands, the Split BSR features a symmetrical design with omnidirectional performance. Unlike traditional bending strain relief products that must be installed at the cable end, PMI's split design allows the unit to be installed mid-span without disconnecting equipment or performing cable preparation, making it ideal for retrofit applications, maintenance, and field replacement.

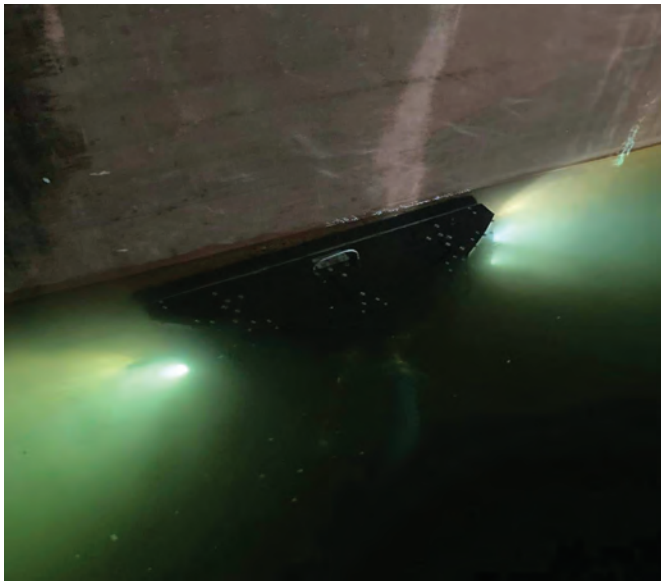
The Split BSR can be designed for a wide range of cable sizes, from 0.2 inches to 5 inches, and tailored to specific cable system requirements by adjusting stiffness characteristics, length, and connection requirements. Its split construction also allows the unit to slide along the cable during or after installation. The custom-designed strength capabilities help distribute bending forces along the length of the cable as load conditions vary.

The Split BSR is well-suited for gov-

■ UAV Navigation-Grupo Oesía



■ Subsea Global Solutions



ernment, defense, research, and marine applications where existing cable systems require additional protection or replacement of aging strain relief components without major system disruption.

■ Silicon Sensing Launches New Gyroscope

Silicon Sensing has launched its latest gyro, the CRG21.

The CRG21 is Silicon Sensing's latest compact micro electro-mechanical systems (MEMS) gyroscope. This closed-loop, single-axis rate sensor is a direct replacement for the company's CRG20 gyro. Engineered to operate in harsh conditions, this single chip, fully integrated digital solution also minimizes space and weight requirements.

Available in multiple rate ranges and bandwidths to meet a wide range of requirements, CRG21 has an identical footprint to CRG20 for a 'plug and play' retrofit. At 9.5 x 9 x 3.4mm, it can operate in temperatures from -40°C to +105°C.

■ UAV Navigation-Grupo Oesía Releases New Version of VECTOR Autopilot Software

UAV Navigation-Grupo Oesía, a Spanish company that provides guidance, navigation, and control solutions for unmanned vehicles, announced the release of software version 9.2, introducing enhanced interoperability, modularity, and multi-domain operational capabilities.

Version 9.2 further strengthens coordinated multi-domain UxV operations, enabling interaction between aerial and maritime platforms. The navigation and control system supports heterogeneous UAV-USV swarms, including shared situational awareness and cooperative behaviors across air and sea domains.

In the maritime domain, version 9.2 incorporates advanced navigation, safety, and mission capabilities, combining detect-and-avoid functions adapted from UAV operations with AIS-based situational awareness. This enables safe navigation in complex maritime environments, including during critical phases such as approach, launch, and recovery.

VECTOR autopilots v9.2 include:

- Coordinated multi-domain operations
- Interoperability-driven autonomy
- Mission autonomy
- Precision guidance capabilities
- Maritime navigation and safety
- Heading estimation and fault-tolerant architecture
- Flexible mission execution

■ Subsea Global Solutions Launches New C-ROV Services

Subsea Global Solutions announced the official launch of their C-ROV hull cleaning services in Belgium, effective July 2026, with operations based out of Antwerp.

This expansion further strengthens Subsea Global Solutions' environmental service capabilities in Europe and provides vessel operators with advanced underwater hull cleaning solutions designed to support fuel efficiency, vessel performance, and proactive biofouling management.

Services now available from the Antwerp office include:

- C-ROV underwater hull cleaning
- Biofouling management support
- Propeller polishing
- Underwater inspections and maintenance services
- Technical underwater repairs, including propeller repairs, underwater wet welding, stern seal support, and class-approved in-water repair solutions

■ ACUA Ocean

■ Hyliion Holdings

■ ACUA Ocean USV Collects 100 Hours of Continuous Multi-Domain Data

ACUA Ocean's Mk1 USV PIONEER has successfully completed a five-day remotely operated offshore demonstration, validating multi-domain maritime operations using an uncrewed surface vessel.

On Monday, June 22, 2026, PIONEER departed Turnchapel Wharf, Plymouth, and operated continuously 16–20 nautical miles offshore until Friday, June 26, completing more than 100 hours at sea without physical intervention. The demonstration combined two independent mission systems operating simultaneously:

• A CommsAudit SPECTRA Super Resolution Direction Finding (SRDF) surveillance system, with antenna and receivers installed aboard PIONEER.

• An advanced Multi-Beam Echo Sounder (MBES) undertaking hydrographic survey operations.

To demonstrate land/sea operations, the RF surveillance capability was supplemented by a second land-based Electronic Warfare system, Guardian Vantage, provided by Leonardo and deployed on England's south coast.

Throughout the mission, PIONEER was monitored and controlled from ACUA Ocean's Remote Operating Centre in Plymouth, while hydrographic data was streamed in real time and the CommsAudit payload was independently controlled and analyzed from its operations center near Cheltenham. The demonstration tested the simultaneous operation of multiple payloads from different OEMs, managed by separate organizations, from geographically dispersed locations.

Despite ambient temperatures exceeding 35°C, wave heights above two meters, electrical storms and five days of continuous exposure to the marine environment (including the inevitable attention of hundreds of seabirds), PIONEER completed the mission without interruption.

Key outcomes included:

• More than 100 hours of continuous remote-controlled offshore operation without physical intervention.

• Production of Admiralty chart-standard multibeam bathymetric data across tens of square nautical miles of the English Channel.

• Continuous passive RF surveillance with direction finding and simultaneous tracking of multiple maritime and airborne emitters.

• Geolocation of a low-power satellite Personal Locator Beacon (PLB) from approximately 22 km from PIONEER's position at sea, with the beacon located to within approximately 20 meters of its true position inside Devonport Dockyard before its location was passed to HM Coastguard.

The demonstration also validated the operational concept of a persistent, low-cost USV acting as a common host platform for multiple independently developed payloads. Sensors from different manufacturers were integrated and operated concurrently without affecting one another.

The trial also demonstrated the potential for long-endurance USVs to provide persistent ISR, maritime security and hydrographic capability for the protection of ports, national infrastructure, offshore energy assets and strategic waterways.

ACUA Ocean's Mk2 PIONEER, scheduled to enter the water in Q2 2027, will extend endurance to several weeks while offering greater payload capacity of seven tons, increased sprint speeds and mission capability.

■ Hyliion USX-1 Defiant USV Chosen as Launch Platform for KARNO Core Sea Trials

Hyliion Holdings Corp. announced that the U.S. Navy's Office of Naval Research (ONR), in partnership with the Defense Advanced Research Projects Agency (DARPA), has selected the USX-1 Defiant as a candidate test vessel for Hyliion's KARNO technology. Initial sea trials are funded under a development program from the Office of Naval Research (ONR) to advance the use of KARNO Cores for onboard power generation in U.S. Navy vessels.

For the USX-1 Defiant sea trials, Hyliion will deliver a drop-in 800 KW power system consisting of four 200 KW KARNO Cores in a keel cooled configuration. The modular architecture is designed to demonstrate reliable, low-maintenance power generation for an unmanned vessel, where onboard servicing is not available. Trials are aimed at highlighting KARNO technology's inherent scalability and redundancy, with power units that can be distributed across the ship to support mission reliability.

The USX-1 Defiant was developed under DARPA's No Manning Required Ship (NOMARS) program, which challenged

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■ Cellula Robotics

■ KONGSBERG

RV Anna Weber-van Bosse at the sea trials on 6 February at Vigo.

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the traditional naval architecture model by designing a seaframe (the ship without mission systems) from the ground up with no provision, allowance, or expectation for humans on board.

Measuring about 180 feet in length with a displacement of about 240 metric tons, USX-1 Defiant is designed for long duration autonomous operation in the open ocean, independently, or alongside other naval assets. The vessel is designed and developed by Serco-North America as a full-scale technology demonstrator and is currently undergoing sea trials.

Hyliion's KARNO Core is a heat powered linear generator designed for high modularity, efficiency, and low maintenance operation, making it well suited for unmanned maritime platforms. For the U.S. Navy deployment, the KARNO Cores will operate on F-76 marine diesel and to demonstrate its ability to supply onboard power for extended durations with a low thermal and acoustic footprint. The KARNO Core generates direct current (DC) power output at 800Vdc enabling direct integration into modern ship electrical architectures. The KARNO technology is currently undergoing land-based testing and development using simulated U.S. Navy load profiles.

■ Cellula Robotics, DRDC Collaboration on Long-Endurance AUV Development

Cellula Robotics Ltd. and Defence Research and Development Canada/Recherche et Développement pour la Défense Canada (DRDC/RDDC) are marking continued progress in the development of long-endurance autonomous underwater vehicle capability.

Progress was recently reflected in a fully submerged endurance demonstration by Cellula's Envoy AUV, powered by a hydrogen fuel cell. In a representative underwater mission profile, the vehicle remained on mission for 385 hours and covered 2,023 km submerged, exceeding the platform's published performance specification. The mission included more than 4,000 turns and maneuvers, each of which increased energy demand compared with steady, linear travel.

The demonstration was achieved using hydrogen fuel cell technology developed with Infinity Fuel Cell and Hydrogen, Inc., and reflects part of a broader effort to mature autonomous subsea systems capable of delivering greater persistence, stronger mission continuity, and more practical offshore performance.

■ KONGSBERG Supplies Technology Suite for NIOZ RV Anna Weber-van Bosse

KONGSBERG has supplied a package of ocean science and navigation technologies for RV Anna Weber-van Bosse, the new ocean research vessel owned and operated by Royal Netherlands Institute for Sea Research (NIOZ).

Christened on the island of Texel in early March, the 80-meter newbuild has been outfitted with a range of innovations including HiPAP acoustic positioning systems, EM304 and EM2040 multibeam echosounders, TOPAS sub-bottom profiling technology, advanced echosounders for water column observation, and Seapath inertial navigation systems.

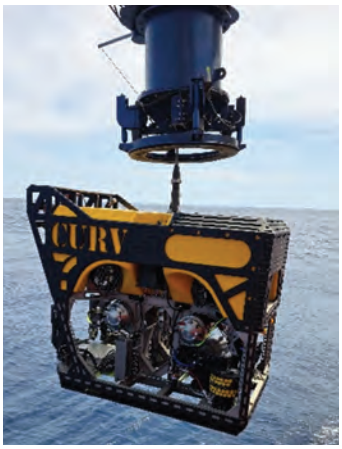
The solutions will deliver a vast range of high-resolution data, and operational stability, helping scientists conduct vital research into climate change, ocean circulation, marine biodiversity, and more.

The RV Anna Weber-van Bosse has been designed to house up to 30 scientists in 'a floating lab' capable of operating everywhere from tropical seas to the edges of Arctic ice. Equipped with sensors, underwater robotics capability and real-time data connections, the vessel allows scientists to observe and analyze ocean processes with unprecedented accuracy.

KONGSBERGs technology will enable the team to build a picture of the ocean environment, combining bathymetric mapping, geological imaging and acoustic sensing in single mission workflows. Meanwhile, inertial navigation systems will ensure that data can be collected with precision, confidence and safety.

RV Anna Weber-van Bosse, which is named after pioneering marine biologist Anna Weber-van Bosse (1852–1942), has been built to replace previous Dutch research ship RV Pelagia. NIOZ is celebrating its 150th year of operations this year.

■ Phoenix International



■ **Cellula Robotics, Integer Technologies to Advance Adaptive Mission Assurance for Multi-Vehicle Undersea Operations**

Cellula Robotics signed a memorandum of understanding (MOU) with Integer Technologies, a provider of mission assurance and reliability software for maritime operations. The agreement establishes a cooperative framework to layer Integer's DIGIT COMMAND operator software with Cellula's mission control software for its advanced unmanned underwater vehicle (UUV) platforms.

Integer's DIGIT Mission Assurance Platform fuses high-fidelity digital twins with real-time environmental forecasting, empowering uniformed operators to assess, coordinate and adapt mission plans at the tactical edge. DIGIT COMMAND is the company's multiagent mission manager designed for the shoreside operator. It feeds existing command and control (C2) with a decision-support layer across all operations.

The collaboration will focus on interface opportunities between DIGIT COMMAND, Cellula's Nexus mission control software and Cellula's long-range AUV platforms. The intended architecture would allow DIGIT COMMAND to act as an adaptive decision-support and mission assurance layer, while Nexus continues to provide the core mission control environment for Cellula vehicle operations. This approach is designed to support multi-vehicle monitoring, task prioritization and operator decision-making across complex undersea missions where communications may be limited, delayed or intermittent.

Future collaboration between Integer and Cellula will focus on accelerating the flow of crucial mission data between unmanned operating centers and deployed unmanned vehicles.

■ **Phoenix International CURV 7 ROV Completes First Operation Mission**

Phoenix International has announced that the new CURV 7 Remotely Operated Vehicle (ROV), developed for the Naval Sea Systems Command Supervisor of Salvage and Diving (SUPSALV), has successfully completed its first operational mission. CURV 7 is the latest evolution in the CURV family of

■ **Greensea Systems, Inc.**

ROV systems that Phoenix has designed, built, and supported for SUPSALV.

The CURV 7 system consists of the ROV, electro-optic umbilical cable, umbilical traction winch and storage reel, deck hydraulic power unit, operations van, maintenance van, and spares storage van. Powered by six electric thrusters, CURV can maneuver in all six degrees of motion. For specialized missions, the vehicle can be outfitted with customized tool packages, including dredgers, jetters, specialized salvage tools, instrument packages, and other mission-oriented equipment.

Additional testing is planned later this year to further validate the system's capabilities and continue expanding its operational readiness.

■ Greensea IQ to Provide Four Bayonet 250 AUGVs for the Marine Corps

Greensea Systems, Inc., (Greensea IQ), has received a $3.7 million dollar task order from the United States Marine Corps for the procurement of four additional Bayonet 250 Autonomous Underwater Ground Vehicles (AUGVs) to further support the Littoral Explosive Ordnance Neutralization (LEON) Family of Systems, which is a capability for mine countermeasures and subsea threat mitigation in the littoral battle space. This task order for the delivery of additional systems is issued under the existing multi-year Indefinite Delivery/ Indefinite Quantity (IDIQ) contract.

The Bayonet 250 is the adaptable workhorse of the AUGV lineup. Bayonet AUGVs can navigate from deep ocean through the surf zone and onto land, a capability that allows operation across seabed, littoral, and coastal environments. Powered by Greensea IQ Core open-architecture autonomy software with Bayonet Workspace, the Bayonet 250 AUGV is purpose-built for high-risk unmanned subsea reacquisition and threat neutralization missions.

■ **OMS Group**

■ OMS Confirms Ongoing Sea Acceptance Tests for USV Elite

OMS Group provided an update on the ongoing Sea Acceptance Tests (SAT) for USV Elite, its long range DriX O-16 Uncrewed Surface Vessel (USV), currently being conducted off the South of France. The SAT program is demonstrating seakeeping characteristics and strong early results on deepwater multibeam echosounder performance, supporting OMS's strategy to scale long-range uncrewed survey capabilities globally.

The SAT campaign is focused on validating vessel handling, stability, systems integration, operational controls and survey performance under representative offshore conditions. Early observations confirm that USV Elite delivers stable line keeping and platform behavior suitable for continuous offshore survey operations over extended missions.

A key component of the program is the verification of the Kongsberg EM124 deepwater multibeam echosounder suite. Initial results demonstrate robust full-swath bathymetric acquisition capability aligned with the requirements of full ocean-depth cable route survey operations. The program also continues to validate end-to-end integration between vessel systems and survey payloads, supporting OMS's operating model for reliable deepwater data acquisition.

OMS confirmed that SAT results will support final operational procedures and deployment planning ahead of regional mobilization in early Q4 2026.

■ **MARTAC**

■ MARTAC, Mystic Powerboats to Expand ASV Production Capacity

Maritime Tactical Systems, Inc. (MARTAC) and Mystic Power Boats announced a co-production partnership to increase MARTAC's domestic production capacity to meet growing requirements from U.S. and allied customers.

MARTAC's partnership with Mystic is the first of several pending domestic co-production partnerships the company is finalizing that will support an expansion of its co-production framework. The distributed production model strengthens MARTAC's ability to meet operational demand by increasing surge capacity, diversifying the supply chain, and accelerating delivery timelines.

Demand for autonomous maritime systems is accelerating as defense and national security organizations expand their use of autonomous capabilities in distributed maritime operations, maritime domain awareness, logistics support and force protection. MARTAC's family of USVs, including the Devil Ray and MANTAS platforms, has been operationally proven for over ten years in multiple government programs and exercises.

Mystic Powerboats brings three decades of expertise in carbon-fiber and composite manufacturing. Mystic's capabilities in epoxy resin infusion, carbon-fiber lamination and foam-core construction align with the materials and methods used in MARTAC's Devil Ray and MANTAS platforms.

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INSIGHTS FROM THE EXPERT

Navigating the Future of Maritime Operations with Greater Confidence

SBG Systems' Product Manager discusses how advanced navigation technologies are helping maritime professionals improve positioning reliability, collect higher-quality data, and operate with confidence in increasingly challenging environments.

The future of maritime navigation lies in combining real-time reliability with intelligent data processing to deliver accurate and reliable results in every mission.

Mathieu Peyrega
Product Manager
SBG Systems

Qinertia

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Navsight

High-Performance Navigation & Surveying Solutions

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Q1 Why is maintaining positioning accuracy still a challenge in modern marine operations?

Achieving high accuracy when GNSS is available isn't the challenge; modern receivers do that very well. The real challenge is maintaining that accuracy when GNSS signals become unreliable due to obstructions, multipath reflections, jamming, spoofing, or harsh operating conditions. A standalone GNSS receiver can quickly lose its positioning capability when satellite signals deteriorate.

Q2 How do modern navigation systems maintain reliable navigation when satellite signals degrade?

This is where an Inertial Navigation System (INS) comes in. It bridges the gaps between GNSS updates by providing continuous, high-frequency navigation data, even during temporary GNSS outages. Modern GNSS/INS systems also detect and mitigate jamming and spoofing by validating GNSS measurements against inertial data rejecting unreliable or inconsistent GNSS signals.

Q3 Is the biggest navigation challenge today achieving accuracy or maintaining it?

Maintaining accuracy. Delivering consistent positioning throughout an entire mission, despite changing conditions, is what truly defines a high-performance navigation system.

Q4 What trends will shape maritime navigation in the coming years?

Autonomy, digitalization, and resilient positioning will continue to transform the maritime operations. We are seeing greater use of sensor fusion where GNSS, INS, LiDAR, radar, vision systems, and emerging LEO PNT technologies work together to provide continuous and reliable positioning. As GNSS interference becomes more common, robust GNSS/INS integration will be increasingly important for safe and autonomous navigation.

Q5 How are technologies evolving to support applications like hydrographic surveying & autonomous vessels?

The industry is moving toward smarter, more integrated solutions. High-performance inertial navigation and advanced processing capabilities allow operators to collect better-quality data and make faster decisions about their application, without the need to come back to the position and attitude question, because it is already solved.

Q6 What role does post-processing play in improving marine survey results?

Post-processing adds another layer of accuracy and reliability by optimizing recorded data. It allows survey teams to maximize the value of their missions and deliver higher-quality results. It's also a valuable tool in development phases as it helps provide unmatched accuracy data post-mission that can be used as a ground truth for benchmarks.

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