

# MARINE TECHNOLOGY

REPORTER

September/October 2022  
[www.marinetechologynews.com](http://www.marinetechologynews.com)

The 17<sup>th</sup> Annual

# MTR100



- A **Hydrogen** Future
- **Subsea Mining**
- Underwater **Releases**



# MISSION SUCCESS

When your mission must succeed the first time...and failure is not an option.



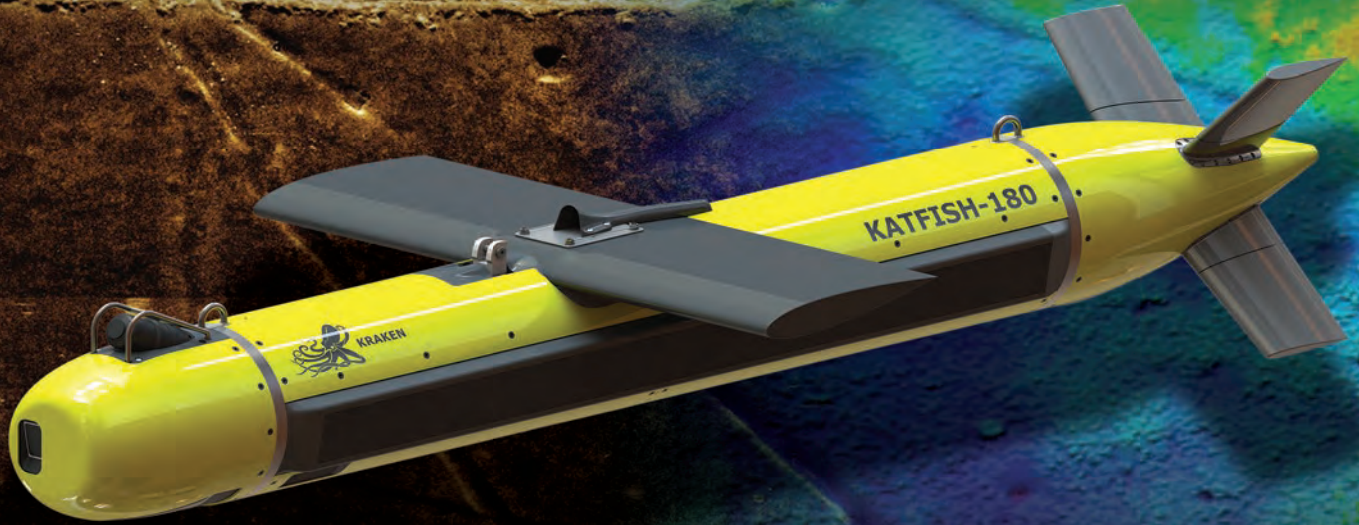
## Depend on VideoRay Mission Specialist Technology.

VideoRay ROVs are one-made portable and made in the USA to deliver maximum performance and reliability when it matters most during challenging operations. And if things go sideways, we've got your back with exceptional, worldwide service and support to get you up and running fast.

Want to know more? Visit [www.videoray.com](http://www.videoray.com)



# KATFISH™ - SURVEY SMARTER



KATFISH™ enables high speed, ultra-high resolution surveys with area coverage rates of over 3 km<sup>2</sup> per hour. For the ultimate in image quality, KATFISH™ acquires over 3 billion pixels for every hour of survey. That's 30 times more detail than conventional side scan sonar.

Advanced SAS algorithms perform thousands of adjustments per second to ensure every pixel displays data with incredible focus and clarity. Real-time signal processing minimizes data conversion times and enables 3D seabed mapping while on-the-fly.

KATFISH™ is engineered using Kraken's innovative and proven Miniature Interferometric Synthetic Aperture Sonar (MINSAS) technology – now deployed in over 10 countries by leading military and commercial operators. And it's non-ITAR.

KATFISH™ provides the industry's highest resolution seabed pixels at the lowest cost. Period.


## KATFISH™ 180 - Performance Characteristics

Ground Speed	4 - 10 kn
Operational Depth	10 m - 300 m
Dual Sided Max Swath	>270 m at 8 kn (>440 m at 4 kn)
Typical Survey Altitude	5 m - 30 m (>30 m Height Alt Mode Available)
SAS Image Resolution (Range Independent)	3 cm x 3 cm (2 cm x 2 cm UHD Available)
SAS Bathy Resolution - Real-Time	25 cm x 25 cm
SAS Bathy Resolution - Post Proc.	6 cm x 6 cm
SAS Bathy Vertical Accuracy	10 cm @ 200 m Swath
Nadir gap Coverage	Acoustic and Laser
Pulse Center Frequency	337 kHz
SAS Robustness Against Yaw	±10° over 50 m track length
SAS Robustness Against Sway	±0.2 m/s

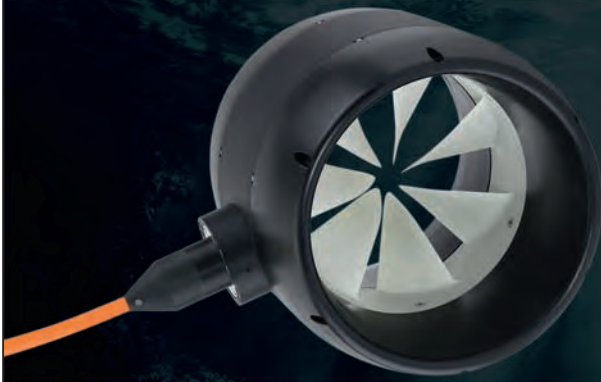


# THE MTR100 2022

Company	Page	Company	Page
ACUA Ocean .....	45	Massa Products Corporation .....	36
Advanced Navigation .....	17	McLane Research .....	14
Airmar Technology .....	7	MIT's Environmental Dynamics Lab .....	29
AML Oceanographic .....	12	Moana Minerals .....	27
applied acoustics .....	19, 67	National Oceanography Center .....	27
Arctic Canadian Diamond Company .....	11	Naval Research Laboratory .....	60
Arctic Rays .....	13	Norbit Subsea .....	75
Armach Robotics .....	21	Novacavi .....	12
Balmoral Group .....	20	Ocean Aero .....	58
Bayonet Ocean Vehicles .....	8	OceanAlpha .....	12
BIRNS .....	18	Ocean Infinity .....	40
Blueprint Subsea .....	37	Ohmsett .....	54
Blue Robotics .....	16	Oshen .....	8
Boxfish Research .....	38	Plymouth Marine Laboratory .....	76
Bramble Energy .....	44	RBR .....	54
Caladan Oceanic .....	65	Reefy .....	9
Cellula Robotics .....	34, 47	Remote Ocean Systems .....	59
Chelsea Technologies .....	13	RTSys .....	55
Copenhagen Subsea .....	56	Saab Seaeye .....	55
CorPower Ocean .....	51	Seaber .....	56
D-2 Incorporated .....	13	Seafloor Systems .....	56
Deep Ocean Engineering .....	61	SEA-KIT (USV) .....	44
Desert Star Systems US .....	67	Sea Machines .....	57
develogic GmbH DE .....	67	SeaTrac Systems .....	14
Edgetech .....	50, 67	Seatronics .....	15
ENDURUNS .....	46	Sensor Technology .....	57
EvoLogics .....	24	Silicon Sensing .....	58
Falmouth Scientific .....	41	Sonardyne .....	52, 67
Fugro .....	34	StillStrom .....	23
General Dynamics Mission System .....	60	Subsea Europe Services .....	59
GeoAcoustics .....	18	SubSeaSonics .....	67
GEOMAR .....	20	SubCtech .....	53
Geoquip Marine .....	37	Sunfish .....	76
German Research Center for AI .....	25	TDI Brooks .....	76
Global Sea Mineral Resources .....	27	Teledyne Gavia .....	60
Greensea Systems .....	6	Teledyne Benthos .....	67
HII Hydroid .....	38	Teledyne Marine .....	64
Hydrocomp .....	14	Teledyne Energy Systems .....	48
IHC Mining .....	11	Tidewise .....	10
Impact Subsea .....	14	Tritech International .....	39
Impossible Mining .....	31	Triton Submarines (combined) .....	65
Inmarsat .....	41	UKHO .....	62
Iridium .....	33	University of Alaska Fairbanks Geophysical Institute .....	76
iXblue .....	59, 67	UTEC (an Acteon Company) .....	62
Jaia Robotics .....	35	uWare Robotics .....	10
JW Fishers .....	50	Valeport .....	63
Kraken Robotics .....	22	VideoRay .....	63
Kongsberg .....	53	Wittenstein cyber motor GmbH .....	25
Linden Photonics .....	12	XOcean .....	64
Lhyfe .....	49	XSens Technologies .....	76

 **On the Cover:** ACUA Ocean's H-USV. Image courtesy ACUA Ocean

# NEW class of ROV Propulsion



Powerful and silent subsea thrusters from Copenhagen Subsea A/S have been developed with reliability as the highest design priority.

The ROV thrusters are responsive, powerful and easy to integrate – and will provide vehicles with a unique combination of silent power and high maneuverability.

**COPENHAGEN SUBSEA A/S**

sales@copenhagensubsea.com • www.copenhagensubsea.com



Learn more [www.copenhagensubsea.com](http://www.copenhagensubsea.com)

## GORILLA ROV THE MOST RELIABLE ROV?

The thrusters are verified against our world leading test standard:



**Endurance  
Test**

1000 hours at full power.



**Dynamic  
Stress Test**

Full Power Direction shifts every second in 24 hours.

Don't settle for less - challenge your ROV provider to fulfill the highest standard.

**COPENHAGEN  
SUBSEA**

## Editorial



Image courtesy ACUA Ocean

www.marinetechologynews.com

### NEW YORK

118 E. 25th St., New York, NY 10010  
Tel: (212) 477-6700; Fax: (212) 254-6271

### CEO

John C. O'Malley  
jomalley@marinelink.com

### Publisher & Editor

Gregory R. Trauthwein  
trauthwein@marinelink.com

### Contributing Writers

Edward Lundquist, U.S.  
Elaine Maslin, Aberdeen  
Tom Mulligan, Ireland

### Production Manager

Irina Vasilets  
vasilets@marinelink.com

### Production & Graphic Design

Nicole Ventimiglia  
nicole@marinelink.com

### Corporate Staff

#### Manager, Marketing

Mark O'Malley  
momalley@marinelink.com

#### Accounting

Esther Rothenberger  
rothenberger@marinelink.com

#### Manager, IT Services

Vladimir Bibik

### Circulation

Kathleen Hickey  
mtrcirc@marinelink.com

### Advertising

Vice President, Sales and Marketing

Terry Breese  
breese@marinelink.com  
Tel: (561) 732-1185

#### Advertising Sales Manager

Mike Kozlowski  
kozlowski@marinelink.com  
Tel: (561) 733-2477

#### Advertising Sales Manager

John Cagni  
cagni@marinelink.com  
Tel: +1 (631) 472-2715



The 17<sup>th</sup> Annual MTR100 is brought to you again with the requisite amount of work that never seems to lighten in the least, keeping on top of the people, companies and technologies that serve a fuel for this industry's future.

In fact "fuel" is the perfect bridge to this edition, as future or alternative fuels is a topic that dominates our discussions in *Marine Technology Reporter*, as well as in our maritime and offshore energy titles, *Maritime Reporter & Engineering News* and *Offshore Engineer*, respectively. Geopolitical unrest and energy security concerns for the European continent aside, there is a growing and tangible push to diversify the fuels that power our systems on and under the water, but as of today there is no single fuel that will get the job done. However, many favorites are emerging, and hydrogen in particular has been making big headlines in the energy world. Various uncrewed surface vessel (USV) developers, autonomous underwater vehicle (AUV) builders and even subsea power delivery system providers are taking a serious look at – and even trailing – hydrogen as an option, **Elaine Maslin** reports starting on page 42.

In evaluating 'hot' markets that have driven business in 2022 and promise to continue in 2023 and beyond, military markets, premised on Russia's war with Ukraine and all that it potentially entails; and offshore wind and its meteoric rise in the U.S. and abroad are the two that come first to mind. But a not-so-distant third is the subsea mining market, a sector that has been on the fringe for many years longer than the 17 that I have served this industry. The decarbonization push has led to a rapid uptake of battery solutions, and those batteries create an obvious need for mineral resource. The ocean potentially holds a wind-fall of resource riches, but as anyone reading these pages know all too well, it's a double edge sword: balancing the acquisition of mineral resources with the potential environmental damage to the ocean. **Celia Konowe** takes a look at both sides, including some exciting new technology under development, starting on page 26.



**Gregory R. Trauthwein**  
Associate Publisher & Editor

**MARINE TECHNOLOGY**  
REPORTER

www.marinetechologynews.com

Vol. 65 No. 7  
ISSN 1559-276

118 East 25th Street,  
New York, NY 10010  
tel: (212) 477-6700  
fax: (212) 254-6271

Marine Technology Reporter (ISSN 1559-7415) is published monthly except for February, August, and December by New Wave Media, 118 E. 25th St., New York, NY 10010-1062. Periodicals Postage Paid at New York, NY and additional mailing offices.

**POSTMASTER:** Send all UAA to CFS. NON-POSTAL AND MILITARY FACILITIES send address corrections to Marine Technology Reporter, 850 Montauk Hwy., #867,

Bayport, NY 11705.

The publisher assumes no responsibility for any misprints or claims or actions taken by advertisers. The publisher reserves the right to refuse any advertising. Contents of the publication either in whole or part may not be produced without the express permission of the publisher.

Copyright © 2022 New Wave Media.

Member



All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means mechanical, photocopying, recording or otherwise without the prior written permission of the publishers.

**Subscription:**  
To subscribe please visit  
www.marinetechologynews.com



IGP

# INTELATUS

GLOBAL PARTNERS

## OFFSHORE WIND MARKET INTELLIGENCE PACKAGE

### 2022 U.S. Offshore Wind Outlook and Market Forecast

The monthly report and database contains all of the latest developments and information on the projects that will lead the U.S. to deploy 30 GW of offshore wind by 2030 and 110 GW by 2050. The report contains insights to support component manufacturers, shipyards, vessel owners and operators, service providers, ports and terminal operators, public agencies and financial institutions amongst others to better understand the opportunities and challenges presented by this growing segment.

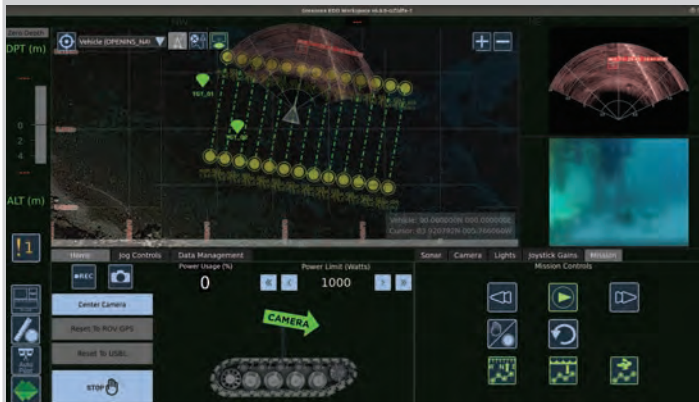
Get all the information you need to access this growing multi-billion dollar market today!

VISIT US

[WWW.INTELATUS.COM](http://WWW.INTELATUS.COM)

## Greensea Systems, Inc.

<https://greensea.com>



Marine robotics technology specialist Greensea Systems Inc. (Greensea) is a provider of a software suite that enables true autonomy, and advances underwater robotic systems and vehicles. Greensea's team of engineers, following CEO and President Ben Kinnaman's vision for advancement through technology, developed OPENSEA, an open architecture software platform with a modular framework. OPENSEA enables quick and easy integration of robotic systems, providing the client with a smart solution to deliver precision and accuracy to ROVs, AUVs and marine robotics. The modular framework offers the end-user a significant assurance of futureproofing, with the core operating software maintenance resting with the experts at Greensea.

Greensea was founded in 2006 with the aim to help deliver robust and precise integrated navigation and control systems for offshore vehicles, through a commercially available open architecture software platform. This, together with the vision of improving the relationship between operator and machine, has been achieved through the open architecture software platform OPENSEA, which provides a robust technology framework for a range of robotic applications that is regularly updated to ensure it can meet the requirements for autonomous robotic navigation now and in the future.

OPENSEA is an open architecture software platform with a modular framework that is flexible and scalable. It facilitates quick and easy integration of any brand of sensors, devices and equipment into a single underwater robotic system, and, together with its operator interface, Workspace, delivers a cutting-edge solution in marine ro-

botics. OPENSEA provides the capability to make robotic hardware ready to deploy through its extensive library and array of applications to provide sensor fusion, navigation, data management, communication, and payload and vehicle control. Its open architecture platform underpins integrated systems for navigation and localization, as well as control and autonomy, and provides operators with a straightforward and intuitive human-machine interface for supervising robotic vehicles. It also provides the foundation for industry-leading OEMs' innovative and emerging technologies, and expedites their route to market. OPENSEA, as an open architecture platform, opens up a vast realm of opportunities and possibilities for customers and collaborators, with vehicle autonomy, long range command & control and vehicle agnostic driving continuous advancement in marine robotics. Since its launch, OPENSEA has been used in over 2500 marine robotic systems.

Greensea has launched two new companies, Armach Robotics and Bayonet Ocean Vehicles, that take OPENSEA into new directions. Armach Robotics is using the on-hull navigation technology pioneered by Greensea, and will provide proactive, in-water hull cleaning. Bayonet Ocean Vehicles is using OPENSEA to provide amphibious subsea vehicles for autonomous use in deep sea, surf zone, and land travel. Federal contracts were awarded to develop a fully Autonomous EOD Vehicle capable of Automatic Target Recognition, long range command and control, and tetherless operation, and to prototype an Autonomous Amphibious Response Vehicle capable of detecting, identifying, localizing, and neutralizing hazards from Very Shallow Water through the Surf Zone.



# AIRMAR Technology Corporation

[www.airmar.com](http://www.airmar.com)

This year, Airmar celebrates its 40th anniversary as a leader in the advancement of ultrasonic sensor technology. Since 1982, Airmar has been committed to developing cutting-edge ultrasonic technologies and products. Airmar and its subsidiary, Marport, have recently joined forces on a major project—the Trident Pro—Marport's new multi-echo beam headline sounder for pelagic fishing trawls. Expected to be released later this year, Airmar and Marport capitalized on both companies' experience to build the Trident Pro: Marport developed the electrical system and software, while Airmar handled the mechanical design. Once on the market, Airmar will also be manufacturing the Trident Pro on site at their headquarters in Milford, New Hampshire. Mounted remotely on the trawl gear headline, the Trident Pro relays detailed echogram images from four individual sonars to the vessel via acoustic link: one image from directly below, two from each side of the first, and one from directly above. The ranges of each echogram are configurable from 20 meters to 160 meters, so the Trident Pro can detect the fish passing above and below it, the fish inside the trawl, and the footrope. The fully remote Trident Pro has a



depth range of 1700 m and is powered by a lithium-ion battery rather than a power cord tethered to a vessel. The wide range of unique echogram data provided by the Trident Pro enables it to serve as an important complimentary or backup tool for the conventional third-wire headline sonar used by most pelagic vessels.

## — Making Hydrographers' Tasks Easier



### Navsight Marine Solution

State-of-the-art Motion & Navigation Solution



### Qinertia

The Next Generation INS/GNSS Post-processing Software

[www.sbg-systems.com](http://www.sbg-systems.com)



# EYE ON THE NEW NAMES & START UPS

*Innovation is the life-blood of any industry, particularly the subsea business where ideas, products and organizations regularly emerge from academia and as spin-offs from existing companies. Here are five worth a watch in 2023 and beyond.*

## **BAYONET OCEAN VEHICLES**

Technically, Bayonet Ocean Vehicles is not a “start up,” created in 2022 through the acquisition of IP and inventory of C-2 Innovations Inc. along with its crawling robots product line by marine robotics technology specialist, Greensea Systems Inc (Greensea). But it is a new name with the heft of Greensea behind it now. Bayonet Ocean Vehicles was created to help bridge the gap between open water and the beach with a series of “AUGVs” or Autonomous Underwater Ground Vehicles that can transition from the ocean in through the surf zone and onto the beach. The vehicles are at home in estuaries, marshes, and amongst the dunes and can be used in a variety of military (EOD and reconnaissance) and commercial applications (cable surveys, erosion inspection, wind energy inspection). Built to be very adaptable autonomous platforms with extensive payload support, capable of performing numerous missions and tasks where a ROV, AUV or USV cannot. The company was created to further develop, manufacture and distribute a line of amphibious crawling robots based on the original concept of C-2 Innovations Inc. Bayonet Ocean Vehicles now designs and manu-

factures a product line of amphibious crawlers to operate in areas difficult for other vehicles to operate in, specifically on the beach and in the surf zone environment. They cover commercial and military applications, including hydrographic, environmental and other surveys, coastal dredging support, and littoral warfare such as mine detection and clearance. The Bayonet Ocean Vehicles team is led by Greensea’s CEO and Founder, Ben Kinnaman and the executive team, and includes highly experienced industry veterans with years’ of experience in manufacturing and ocean robotics.

The product line of amphibious crawling robots includes three Bayonet vehicles; the Bayonet 150, Bayonet 250 and Bayonet 350. These are built on OPENSEA, Greensea’s open architecture platform designed to provide precision navigation, payload integration, autonomy and over-the-horizon command and control. Combined with robust hardware, they cover a wide range of payloads and applications.

## **OSHEN**

Oshen is a young enterprise created by a team of Imperial College London graduates, and supported by a number of

## **BAYONET OCEAN VEHICLES**



## **OSHEN**



professional advisors. It is aiming for a world-first by creating the first fully autonomous sailboat to cross the Atlantic and complete the Microtransat challenge. The challenge states that boats must be under 2.4m and that no communication can be sent to the boat during transit. No contestant has succeeded since the challenge launched 16 years ago, including the US Naval Academy. The Oshen boats will set off in October 2022 from Portugal with the objective of landing in the Caribbean by January 2023. Unique Group is sponsoring the attempt, and it will include partnerships with Inmarsat and CLS. The aeronautical engineers in Oshen's team have identified an approach to the Microtransat challenge that takes a different angle. Rather than focusing purely on boat design, it has developed a path-planning algorithm that is unique. The algorithm is designed to allow the boat to travel along an optimal path using wind and current models, ostensibly avoiding conditions that could threaten the boat's journey.

## REEFY

In collaboration with the Municipality of Rotterdam, Rijkswaterstaat and Boskalis, the start-up Reefy from Delft will test a modular artificial reef system that protects the riverbank against large ship waves and stimulates the development of nature. Reefy combines biology and hydraulic engineering to

develop nature-inclusive solutions for water safety. Reefy's innovation consists of massive "Lego-like" blocks, which have been hydrodynamically designed and tested in the Deltares wave flume. By assembling these blocks underwater, a stable structure is formed

that breaks waves but also creates an underwater labyrinth where fish and other species can shelter and breed. The blocks are made of sustainable concrete with a special texture on the surface. Reefy was founded by Jaime Ascencio and Leon Haines.



### Teledyne Geospatial Imaging Solutions for Land and Water

## COLLECT WITH CONFIDENCE

# CARIS COLLECT

THE EVOLUTION OF CARIS ONBOARD HAS ARRIVED

**FEATURING**

- CARIS Collect module for sonar and lidar acquisition
- Seamless integration into survey operations
- Complete Ping-to-Chart workflow solution

Available as a perpetual or SaaS annual license  
 CARIS Collect provides a cost-effective acquisition software package to the market.

**FOR MORE INFORMATION:**  
[www.teledynegeospatial.com/cariscollect](http://www.teledynegeospatial.com/cariscollect)

# TELEDYNE

## TIDEWISE

Brazilian startup Tidewise has been making in-roads into USV-based operations. Co-founded in 2019, by a naval architect and a robotics specialist, it launched its first USV, the 4.95 m Tupan, the same year. It initially developed a UAV-hosting capability, primarily for oil spill detection, for Repsol Sinopec. But this year, for Belgium's Elia, it demonstrated visual inspection capability for offshore wind substations, alongside multibeam data collection, to assess the subsea cables, and lidar, to create a point cloud of the structure.

In Tidewise's sights is foundation and turbine base inspection, says co-founder and director Rafael Coelho. In deeper water, moorings and floating structure inspection, similar to FPSO uWILD (underwater inspection in lieu of drydocking), Tidewise is targeting in Brazil. For this it's working on integrating a DeepTrekker Evolution inspection ROV into its USV for up to ~75m deep.

This is due to be demonstrated in February 2023, with visual and CP measurements. But it's also targeting thermal inspection and close visual inspection of the blades and turbines using a UAV and high optical zoom camera.

For the UAV, it's been using a DGI M600, but Coelho says smaller sys-

tems can be used and they want one with more open architecture for development work to increase capability and remote operations. But AI will also play a role, says Rafael, for things like spotting blade defects.

For using a larger ROV and being able to integrate more sensor payloads, Tidewise is developing a larger USV.

## UWARE ROBOTICS

uWare Robotics is a European deep tech startup that was founded on the premise of optimizing the way in which underwater data can be gathered, processed and accessed. It designed its Autonomous Underwater Vehicle, the uOne, for maximum mobility, stability, cost-effectiveness, and autonomy. It works in conjunction with state-of-the-art software system to plan, monitor, visualize and analyze the missions. You do not need to be an engineer, diver, marine biologist or data scientist to gather intelligible and frequent data on your blue economy application with uWare's systems, and in effect, the company is setting out to democratize access to underwater data.

The uOne Autonomous Underwater Vehicle (AUV), hardware comprised of eight vectored thrusters allowing for six degrees of freedom in movement. The proprietary acoustic communication system allows for wireless interaction underwater at up to 500m range

at 1kbps, while the BT/WIFI connection (when at the surface) allows for the accurate transfer of data. The uOne is also equipped with five cameras for stereoscopic SLAM-based navigation and photo & video capture for real-time CV and data analysis thanks to the GPU-powered internal computing unit. In addition, the modular design allows for additional sensors such as depth (CTD), temperature, acidity, pH, redox, turbidity, etc., providing the user with a complete overview of the area being inspected or monitored.

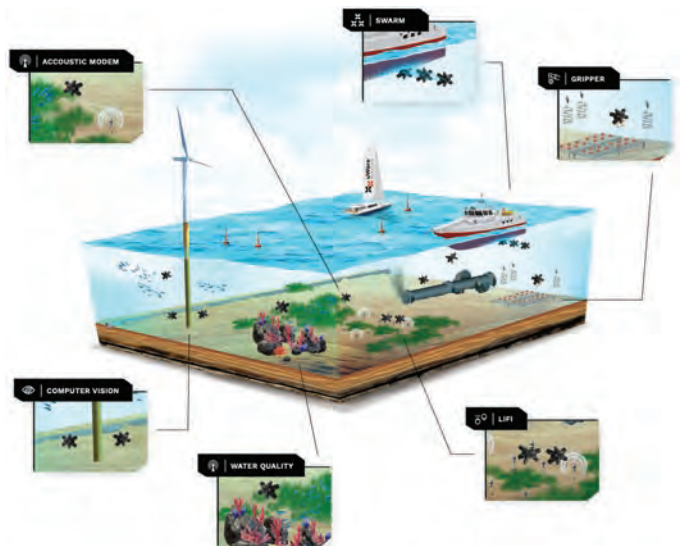
Its software suite includes a mission planner with drag and drop GPS based interface, a mission monitoring system that allows users to send new commands to the uOne and receive live status updates, and a proprietary data platform that employs ML and CV to provide automated 2D and 3D map generation, intelligent visual inspection (e.g. pollution spotting, infrastructure anomaly detection, etc.), and environmental and biodiversity data analysis. Communication during missions is established via our uBuoy, utilizing our proprietary acoustic communication system, the uCom.

Within one year it aims to be ready for full commercialization for the uOne, its first light AUV model. The first market batch to be sold will be between 50 and 100 units at a price point of \$18,000 to \$30,000 depending on the exact model.

## TIDEWISE



## UWARE ROBOTICS





Marc/AdobeStock

# Tech Talk: Crawlers for Mining

Arctic Canadian Diamond Company and IHC Mining reached the next important milestone in the development of the underwater remote mining (URM) system for the extraction of diamond-bearing kimberlite ore from deep open pits at the Ekati Diamond Mine in the Northwest Territories of Canada. Arctic Canadian and IHC Mining started their cooperation in 2018, to jointly develop a mining solution. From the start, an important focus is to develop a mining solution that would have a much lower environmental impact than conventional mining methods. As the URM crawler is only mining the kimberlite ore and minimal waste, it significantly reduces the mine's footprint. The URM solution could allow the Ekati Diamond Mine to extend its lifetime by at least 10 years.

The underwater mining crawler is a remote operated continuous mining machine. The ore is excavated with a drum cutter in small layers and eliminates the need for blasting. From the crawler the ore is pumped to the surface of the flooded pit via a vertical pipeline system to the Launch and Recovery Platform. The crawler system is capable of operating at a water depth of up to 400m.



## TRANSFORM YOUR CAPABILITY

### USBL POSITION TRACKING FOR ALL ENVIRONMENTS

#### SeaTrac Acoustic Positioning Beacons

Accurate, reliable USBL positioning even in the most challenging underwater environments. Real-time ROV, AUV and diver tracking over a 1000m range. Depth rated to 300m or 2000m.



[www.blueprintsubsea.com](http://www.blueprintsubsea.com)  
[enquiries@blueprintsubsea.com](mailto:enquiries@blueprintsubsea.com)

## NOVACAVI



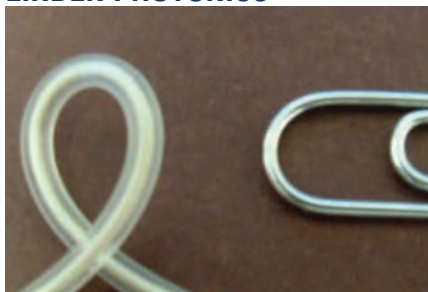
## NOVACAVI

Specializing in custom cables design and manufacturing since 1975, NOVACAVI provides dynamic and maneuverable underwater cable solutions ensuring smooth and reliable operations to any robotic vehicles used in aquatic exploration, environmental monitoring, hazardous environments inspection and maintenance, protection and surveillance activities, and search and rescue operations. NOVACAVI has recently specially designed and manufactured an umbilical ROV cable used on board the underwater instrumental research unit of the Garda Volunteer Group (Gruppo Volontari del Garda). It is a neutrally buoyant cable with application-specific watertightness and maneuverability as needed by the rescue team for any type of emergency and underwater rescue in lakes, rivers, seas and artificial basins.

## AML OCEANOGRAPHIC



## LINDEN PHOTONICS



## AML OCEANOGRAPHIC

AML Oceanographic has been a designer, manufacturer and seller of high-performance hydrographic and oceanographic equipment in Canada since 1974. In 1995, AML pioneered time-of-flight sound velocity and is still a vendor for sound velocity measurement for a wide range of marine survey organizations. The latest generation of profilers and sensors was recently released in 2020—the X2•Series Instrumentation and X2change sensors. These configurable multiparameter sondes are designed to suit a wide range of applications. As well as minimizing downtime, the field-swappable sensors also help companies reduce logistic costs. AML's UV biofouling solution, which uses ultraviolet light to provide a non-toxic, non-contact solution to prevent marine growth, is also available with the X2•Series Instrumentation.

AML also manufactures and sells the underway profiling system, the Moving Vessel Profiler. The MVP allows for frequent, high-density profiles continuously and in real-time. AML's UV biofouling control technology.

## LINDEN PHOTONICS

Linden Photonics was founded in 2002, and since its inception, Linden's design specialists have developed a range of miniature, high strength optical fiber, hybrid and specialty copper cables for environments where high performance and compact size are critical. Linden has since expanded into a worldwide cable supplier offering high strength optical/hybrid/electrical cables. Specializing in thin & strong cables, buoyant cables, Linden's fiber optic & hybrid cables are optimized for underwater use as well as use in larger umbilicals.

Linden continues to expand its product portfolio and design expertise through ongoing internal research as well as collaboration with technology companies. Its core technology, employed in its ST-FOC products exploits the properties of Liquid Crystal Polymers (LCPs). These unique materials are sometimes referred to as self-reinforcing polymers and can exhibit a specific tensile strength ten times that of steel cable.

## OCEANALPHA GROUP LTD



## OCEANALPHA GROUP LTD

In April 2022, OceanAlpha's Unmanned Surface Vessels (USVs) and passive acoustic monitoring technologies were used in China for the first time to monitor and investigate the population of Chinese White Dolphins that inhabit the National Nature Reserve in Pearl River Estuary of Guangdong. The Chinese White Dolphin, or *Sousa chinensis*, is renowned as the "panda of the ocean." It was classed as "vulnerable" on the IUCN Red List of Threatened Species. An OceanAlpha M40P autonomous survey vessel equipped with sonar devices sailed on the designed route within the natural reserve. The acoustic equipment towed at the stern quietly recorded the sounds of the white dolphins, which provided essential data support for the population and distribution feature research of Chinese White Dolphin. The case of USV applied to protect Chinese White Dolphins demonstrates how unmanned systems technologies can em-

## ARCTIC RAYS



power wildlife protection and contribute to the earth's biodiversity. OceanAlpha has grown from a single small office in 2010 to a workforce of over 626 today, with more than 214 R&D engineers and 395 pieces of USV related patents.

## ARCTIC RAYS

Arctic Rays was created in 2015 and specializes in deep-sea lighting and imaging systems and other subsea technologies specifically for use on AUVs, ROVs, manned submersibles and other offshore and underwater structures. Arctic Ray's team of seven comes with a breadth of experience, including robotics and controls, sensors, marine science, manned submersible and AUV design, terrestrial lighting, life-critical electrical system design and more. The team has worked with some of the best underwater film makers in the industry—for example, the EagleRay 4K cinema-quality camera was used by the BBC to film during "Blue Planet 2."

The company's strobe products use a patented, proprietary strobe-driving technique, which uses LEDs in a unique way. This patented technology results in a small form factor with the lowest power draw and the highest output.

## CHELSEA TECHNOLOGIES

Chelsea Technologies, as a fully integrated technology company and part of the Covelya Group, carry out in-house research, testing, development, design, prototyping and manufacture. For more than 50 years, its fluorometers, sensors & systems have been used around the world to help customers understand the natural environment, improve water treatment processes, comply with ballast water and exhaust gas wash water monitoring regulations, monitor for pollution and contaminants in rivers and lakes, and support oceanographic research. In addition, it is fully equipped to provide factory servicing and re-calibration, dedicated product support, and opportunities to work with our research and development team on bespoke projects.

## D-2 INCORPORATED

D-2 introduced its Hybrid CTD technology, developed with support from NRL, WHOI and the NOPP. D-2 is a sensor manufacturing company, with a focus is the physical property measure-


ment of fluids, including electrical conductivity, pressure, temperature, composition. The company is active in two general areas: oil & gas and the oceanographic market. The Hybrid CTD key technology is its newly patented con-

Visit us at  
**INTERGEO**  
BOOTH  
F3.023

# MOTION SENSING AT ANY DEPTH

TOUGH, LOW DRIFT INERTIAL SENSORS & SYSTEMS - SUSTAINED, PRECISE PERFORMANCE FOR EXTREME DOWNHOLE DRILLING OPERATIONS

- Precision MEMS technology
- Ultra-compact, easily integrated
- Inertial sensors for all performance requirements

 [siliconsensing.com](http://siliconsensing.com) **SILICON SENSING**

## IMPACT SUBSEA



## MCLANE RESEARCH LABS



## SEATRAC SYSTEMS INC.



## SEATRONICS



ductivity sensor which offers the user a full internal volume measurement that eliminates the influence of mounting structures on calibration. It's well suited for traditional shipboard wire lowered operations, while at the same time being an ideal sensor for the new wide variety of AUV, UUV, ROV and Unmanned Vehicles. In addition, the sensor is significantly shorter in length with a large internal diameter allowing it to free flush (no pump required) even when used on slower moving AUV's and drifters. When moored and biologic fouling is an issue, the Hybrid sensor can be pumped using traditional chemical anti fouling cylinders. A new ultra-low power version released in 2022 breaks the 50 mW barrier for full 2 Hertz frame CTD data, which is ideal for battery supplied measurement platforms such as wire crawlers, drifters, floats, etc.

## IMPACT SUBSEA

Impact Subsea specializes in a range of high-performance sensor solutions for underwater vehicles and associated applications used in the oil and gas, renewables, underwater research and defense sectors. seaView V3 is a new software development, providing a platform for existing Impact Subsea sensors and future sensor developments. This release also saw both software and firmware redevelopments from the ground-up, providing capabilities to new and existing sensors and ensuring they remain at the forefront of innovation. The newest generation of Flooded Member Detection system, the ISFMD V3, provides users with an intuitive underwater flooded member detection system for deployment by divers or ROVs.

## MCLANE RESEARCH LABS

McLane Research Laboratories, Inc. was founded in 1983 to manufacture and develop advanced time-series instrumentation for the international oceanographic community. McLane instruments are central to many long-term global projects and cruises including

such initiatives as OOI, GEOTRACES, and the RAPID array.

The company produces three main product lines: Profilers, Samplers, and Flotation. The Profiler line collects high density data in the vertical water column from the near surface to the deep ocean. Products include the Prowler, the Ice Tethered Profiler (ITP) and the McLane Moored Profiler (MMP). Samplers include Sediment Traps, the Remote Access Sampler (RAS), Particle and Phytoplankton Sampler (PPS), and Large Volume Pumps. Recently, McLane launched the new Signal Activated Bottom Lander (SABL) Sediment Trap. This addition to its flagship Sediment Trap product line is a low-profile sediment sampler ideal for studies in stormwater discharge, dredging, sediment disturbance and HAB events. SABL was developed jointly with The Naval Information Warfare Systems Command.

## SEATRAC SYSTEMS INC.

SeaTrac Systems, Inc. manufactures, sells, and rents multi-purpose long endurance solar-powered Uncrewed Surface Vehicles for commercial, scientific, and military applications. SeaTrac's 4.8m solar powered SP-48 can carry a wide variety of sensors and custom payload modules that make it applicable for research, monitoring or surveillance tasks where autonomy, cost and ease of deployment are important. It is well suited for a myriad of sensors and applications such as hydrographic survey, data relay, mammal monitoring, metocean and eelgrass monitoring, real time data collection, subsea positioning, seafloor geodesy.

## HYDROCOMP INC.

HydroComp provides engineering tools to develop ships, boats, and other marine vehicles—and their propellers—with more than 35 years in applied hydrodynamics and propeller design. Its development in hydrodynamic body and thruster design tools offers benefit for



any UV product developers interested in improving their Vehicle, Propulsor or Drive Design. Most notable is its work for electric motors and hydroacoustic metrics for noise sensitive applications.

The AUV/ROV/UUV industry uses HydroComp's tools and consulting services to design and analyze the propulsion package for their vehicles and submersibles. Better hydrodynamic performance for UVs leads to greater speed and reduced power requirements for propulsion, allowing more power to be applied to sensors and more efficient data collection. Recent engineering projects highlight HydroComp's expertise in vehicle hydrodynamics and thruster design, including the new award-winning JaiaBot "micro-sized" autonomous robotic vehicle. New updates to HydroComp's commercial design tools for

this space include a new electric motor drive module for NavCad. For propulsor and thruster designers, new capabilities in PropElements include calculation of streamline properties for appendage and control surface optimization, as well as performance contribution prediction of "protective shrouds".

### SEATRONICS

Seatronics provides marine electronic equipment, and its capabilities include custom sensor solutions, subsea electronics equipment rental, service repairs and calibration support, lightweight observation remotely operated vehicles (ROV), and ROV tooling. Its rental fleet includes more than 6000 assets in four dedicated bases around the world.

The VALOR (Versatile and Lightweight Observation ROV) is an Obser-

vation ROV. It has significant payload, power capability and available bandwidth, allowing the ROV to manage complex tooling and sensor packages. A dedicated 10-kW power supply is available to the user via a dedicated auxiliary connector, enabling the use of more power-hungry tooling, such as cleaners and water-jetting tools, without the need for an additional umbilical. The VALOR has a 20-Gb/s Ethernet-based connection (expandable up to about 100 Gb/s) with throughput to five highly configurable sensor ports, Dual GigE cameras supplied as standard and three camera connectors. This allows for video and real-time 3D modeling to be distributed easily on a network connection. The VALOR can hold as much as 19 kg of tooling and sensor equipment in various configurations.

# Phantom® T5

Customizable to your needs

- Powerful maneuverability
- Incorporates an open architecture
- Integrates with a wide variety of sensors



- Hand-built on a rugged, resilient, non-corroding polypropene chassis
- Chassis accomodates heavier payloads



• [www.deepocean.com](http://www.deepocean.com) • (408) 436-1102 • [sales@deepocean.com](mailto:sales@deepocean.com)

# Blue Robotics Founder Rusty Jehangir

<https://bluerobotics.com>

Rusty Jehangir founded Blue Robotics in 2014 in his garage, using Costco foldable tables as a work bench to build his first 600 thrusters, starting with just north of \$100K in Kickstarter funding. Following eight years of rapid growth and expansion, Jehangir's facilities and support has changed mightily, but his mission remains the same: design, manufacture and deliver low-cost subsea robotics for multiple markets.

The numbers tell part if not all of the story, as in just over eight years the company has sold more than 70,000 thrusters, more than 3,200 BlueROV2 vehicles supported by an internal team of 58 employees and 50 distributors globally.

"From day one, our mission was to make low-cost enabling parts for marine robotics, starting with the thruster and that's still our mission today," said Jehangir in a recent interview with Marine Technology TV. "We have a lot more products now; around 280 total products in our online store, but they're all geared towards enabling marine robotics with low-cost, accessible, well-documented, easy-to-use products."

While the growth has been fast, Blue Robotics has endured its fair share of hurdles. "On the technical front, and this seems embarrassing to say for a marine robotics company, but I think the most difficult technical thing is to keep things dry and to keep them low-cost," said Jehangir. "There are a lot of ways to do that with expensive products, but doing it at a very low-cost price point is difficult."

Blue Robotics used "potted penetrators", basically epoxy around a cable through a bolt to seal a cable from the water, for a number of years, and Jehangir said they worked great until customers started pushing the products harder, resulting in reliability and consistency issues.

"One of our biggest technical achievements in the last year is coming up with the WetLink penetrator, a compression gland sealed cable penetrator. We think that problem is solved now for us, but it was an ordeal to get there," said Jehangir.

Another problem common in start-ups across industries is the business side, particularly determining exactly what type of company you want, or need, to build. For example, Jehangir designed and sold 600 thrusters off of his prototype to start, but had no experience with contract manufac-



turer or building them efficiently, in mass, himself.

"I thought I had started a marine robotics company, and didn't realize I had started a manufacturing company at the same time," he said. "I think it was probably three or four years in before we realized that that's really what we are. We're a manufacturing company and we need to be really good at it. So we've gone through a lot of growth internally to become good at manufacturing." Part of the Blue

Robotics plan is to make products that are low cost, high quality and flexible. "You don't have to buy a whole ROV to get a thruster. You can just buy a thruster or a watertight enclosure or a WetLink Penetrator and those components are not designed for one specific application. They're not designed for our BlueROV2. They're designed to be used in lots of different applications," said Jehangir.

This, in turn, opens up the market to include everything from middle school students building ROVs for the MATE competitions to artists making robotic swans to make light shows to the most discriminating and demanding clients, such as WHOI.

While Jehangir is focused on building his business, he's also intent on helping to build collaboration within the ocean exploration community, sharing details on interesting products and the projects for which they're used. And as the industry is built successfully on new generations of innovators, he offers this advice for anyone seeking to take the marine robotics plunge: "I think the way to ensure that you're successful is to find a hole in the market. Not to look where other people are competing and try to compete against them, but to look where nobody's competing, where it's just wide open. For us, that was our initial thruster. There's the \$30 bilge pump motor or there's the military-grade thruster, and there's this wide open gap in the middle. I think a large part of our success is just choosing the right market to be in and pursuing something that filled a market need."

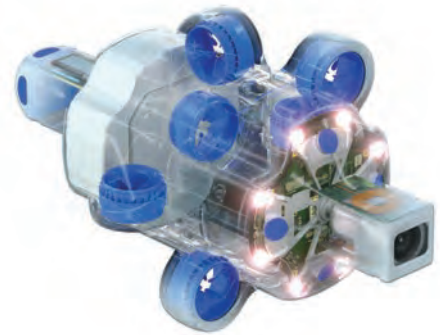
# Advanced Navigation

[www.advancednavigation.com](http://www.advancednavigation.com)

Advanced Navigation is an innovator in AI robotics and navigation technology across air, land, sea and space terrains. Underwater, its submersible drone, Hydrus, is helping to restore oceans to a flourishing state supported by our various subsea navigation and communication technologies. Its navigation system is found in many Plus AI autonomous trucks, delivering goods to global communities. Regarding, software, its cloud-based drone management platform helps patrol beaches for emergency rescues and shark tracking. Off-planet, we will navigate the next NASA Moon landing to deliver science and technology to the lunar surface. Advanced Navigation recently announced the development of Hydrus, whose design synthesizes numerous navigational, propulsion and data capture technologies with artificial neural network intelligence. Stemming from over 10 years of R&D in sonar technology and pressure tolerant electronics, Hydrus was designed in-house. The drone is beneficial to users in terms of overcoming complexity, the need for specialized skills or training and possible reductions in operational expenditure. Hydrus brings full autonomy with the accessibility and affordability of the drone revolution into

almost any sub-sea application.

Hydrus' design was ultimately made possible with the miniaturization and in-house vertical integration of its navigation and



communication systems: Doppler Velocity Log, designed for relative motion tracking and obstacle avoidance underwater; USBL, designed to provide absolute underwater position; Inertial Navigation System, AI aided data fusion from all navigation inputs; Acoustic and Optical Modem, tetherless command and control of the vehicle while underwater; and Imaging System, computer-vision aiding on the camera feed for object detection and classification. It weighs under 7kg and is less than 500mm long, powering for 3 hours with a depth rating of 3,000 meters.



## Ocean Sensor Systems

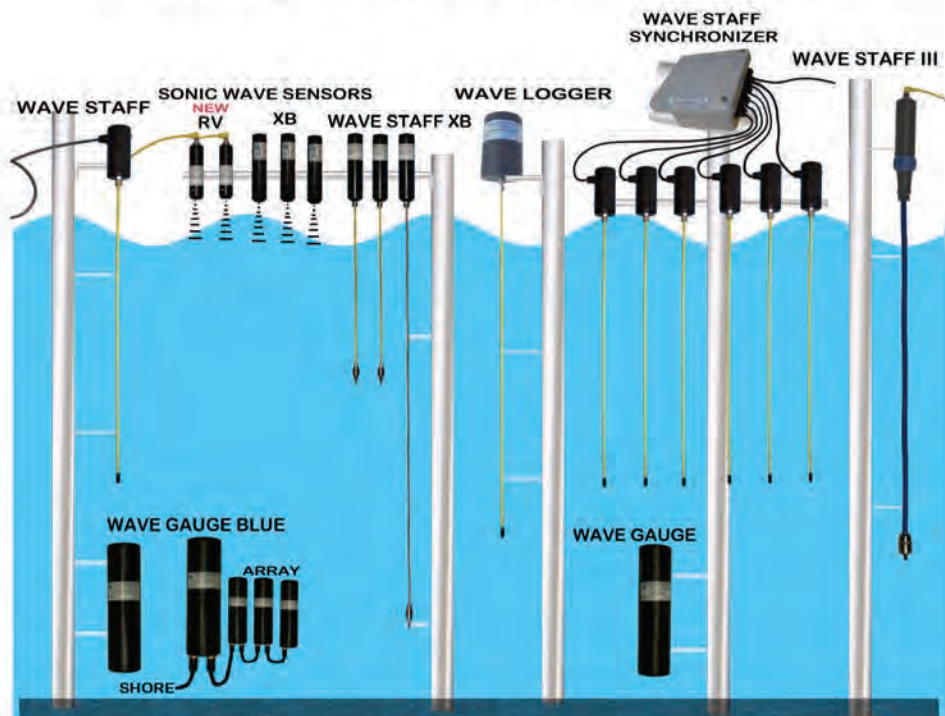
For Details Visit Us on the web or call 954-796-6583 USA  
[WWW.OCEANSENSORSYSTEMS.COM](http://WWW.OCEANSENSORSYSTEMS.COM)

**SENSORS FOR:**  
 Ocean, Harbors  
 Intracoastal  
 Lakes, Ponds  
 Wave Tanks

**MEASURE:**  
 Waves  
 Tides  
 Levels

**DATA VIA:**  
 Cable  
 Logger  
 Wireless

**WE SUPPLY:**  
 Tech Support  
 Software  
 Accessories  
 Custom Work



## GeoAcoustics Ltd.

[www.geoacoustics.com](http://www.geoacoustics.com)

GeoAcoustics is a pioneer in interferometric sonar for bathymetry and a leading supplier of Sub-Bottom Profilers and Side Scan Sonars. The company has been providing subsea sensors and equipment since 1978 and continues to develop innovative technologies to optimize marine surveying and environmental monitoring. Following a management buyout from then owner Kongsberg Maritime in December 2020, GeoAcoustics became independently owned and was returned to its former name, GeoAcoustics Ltd. The company is also a technology innovator. Working with the University of East Anglia, GeoAcoustics created an AI powered upgrade to existing automated filtering in the GeoSwath 4 bathymetric sonar software. The project stands out as its aim is to apply machine learning so that the AI can remove surplus and undesired data autonomously; during acquisition, the system is designed to log virtually clean data, without any user intervention in the cleaning process. This is made possible as the AI was developed to analyze and accept or reject outlying soundings. The user only needs pay attention to data quality and coverage, and

during post-survey processing the focus can be purely on georeferencing of the bathymetric data using deterministic calculations.

GeoSwath provides ultra-high-resolution swath bathymetry with up to 12 times water depth seabed coverage and a 240° field of view. The new AI-powered software is a free upgrade for all GeoAcoustics owners. Once applied, surveyors will receive high quality bathymetric data on board, just milliseconds after its acquired. This provides scope for more agile surveying as targets can be checked and anomalies verified without the need for a return survey. It also ensures that only minimal processing is needed during post-processing, so lowers costs and accelerates time to delivery for the survey company's customer. The new AI system will be released in Q4 2022.



## BIRNS

[www.birns.com](http://www.birns.com)

BIRNS has a nearly 70 year history of innovating and advancing technology for the subsea industry. When the company was created in 1954, it started out supplying lighting systems and other key marine equipment for the US Navy, and over the subsequent decades continued that naval partnership, and expanded with support of high profile projects for customers spanning the globe. Today it continues breaking many of the technological barriers formerly found in designing high performance connectors, cable assemblies, penetrators and lighting systems, and as a result, BIRNS products are trusted globally in a range of manned and unmanned vehicles and advanced extreme depth subsea systems.

The company's reputation for advanced interconnect solutions has been growing along with its expansion of capabilities for some of the planet's most demanding applications. The BIRNS Millennium™ 6km-rated connector series offers designers of a range of subsea systems significantly enhanced performance characteristics, including cable assemblies with data rates of an unheard of 9.4+/- 0.1 Gigabits per second. Performance testing proved that data consistently transmitted at this rate over the entire range of pressures from 0 to 8700 PSI/600 bar (6000m equivalent depth). The company has continued to lead the industry with new RF technology, providing coax cable assemblies with open face pressure ratings to 1433m, (6km mated) and UHF insertion losses of ≤0.7dB and maximum UHF VSWR of 1.7:1 at single frequencies to



3GHz. An exciting development to access this innovative connectivity technology was launched in 2022, with the company's new interactive ecommerce site. The enhanced capability website allows customers worldwide to directly and quickly specify and order BIRNS Millennium connector kits online. The company made significant site design investments, making the experience educational and intuitive, and providing tools that give a clear, swift path to selecting what is needed for a specific requirement. In addition to connector kits, the new site includes related high- and low-pressure caps, mounting nuts, O-rings and installation tools, along with associated wiring worksheets and downloadable configuration drawings. BIRNS introduced ecommerce options for its lines of ABS Product Design Assessment (PDA) certified NPT penetrators via ecommerce last year, and the addition to BIRNS Millennium series kits and accessories was a major advantage for its customers, providing 24/7 support and access as well as easily navigable product information to making purchasing decisions more seamless.

# Applied Acoustics

[www.applied-acoustics.com](http://www.applied-acoustics.com)

Family-run applied acoustics launched a new acoustic positioning offering, its first combined Inertial Navigation (INS) and Ultra Short Base Line (USBL) system. The Pyxis system is free of acoustic calibration and can operate without the need of external GPS or Gyro compass, aimed at reducing mobilization time and alignment errors.

The company reports that the engineering team have been working to improve the accuracy and performance of the entire Easytrak USBL product range. A new transceiver has been designed for the Alpha system, the 904C, which has increased the accuracy from 3.5% to 3% of slant range. The previous Nexus Lite system has been replaced with the Nexus 2 Lite, using the 2686 transceiver (previously part of the Nexus 2 system), which has increased the accuracy from 1% to 0.45% of slant range. And finally, the Nexus 2 and Pyxis omni-directional transceivers have been redesigned and now include seven internal elements instead of the previous 5, further improving accuracy and all-round performance.

The Alpha system now has an upgraded 904C transceiver which has a rugged stainless housing and is smaller than the



903C predecessor. The compact form not only allows for less motion in free hanging applications which can improve the accuracy, but it can be deployed by a single person and transported easily making the 904C ideal for small ROV or diver tracking and mobilizing on smaller vessels of opportunity. The 904C power supply and receivers have been redesigned, reducing noise and improving the detection of target signals which improves the repeatability of position. A new, more accurate compass allows for the compensation of motion to improve the accuracy when using the 904C standalone without external sensors.

## Two New ROS Innovations

### One Brighter SEASTAR™



- LED array produces 10K+ Lumens
- All components field serviceable using standard hand tools
- 120VAC or 24VDC full range, flicker free dimming
- Depth rated to 6000 meters

### One Smarter accu-positioner™

- Highly reliable design
- Controlled with COTS controllers, devices and ROS GUI
- High accuracy feedback / servo mode: +/- .1 degree
- Zero backlash
- Lightweight and compact
- Depth rated to 6000 meters



*For More Information and Technical Specifications  
Contact: [sales@rosys.com](mailto:sales@rosys.com) or Visit: [www.rosys.com](http://www.rosys.com)*



**Headquarters - San Diego, CA USA**  
Phone: (858) 565-8500  
Email: [sales@rosys.com](mailto:sales@rosys.com)  
[www.rosys.com](http://www.rosys.com)

## GEOMAR Helmholtz Centre for Ocean Research Kiel

[www.geomar.de](http://www.geomar.de)

GEOMAR earlier this year tested fuel cell technology for use on a long-term seafloor observatory, where it could also be required to power robotics. GEOMAR's solution is a fuel cell, developed in partnership with the Centre for Solar Energy and Hydrogen Research, Ulm (ZSW), as part of the German Federal Ministry of Economics and Technology funded ARIM-FUEL project (ARIM stands for "Autonomous Robotic Sea-Floor Infrastructure for Benthic-Pelagic Monitoring"). It's a proton exchange membrane (PEM) fuel cell, in which hydrogen and oxygen are fed to a polymer membrane electrolyte and platinum based electrodes, to generate power with heat and water as a by-product. GEOMAR's system comprises of 11 gas bottles of hydrogen and five bottles of oxygen and the fuel cell, developed by ZSW, which gives "about 120 kW of power we can use for our monitoring efforts at the seafloor," said Dr Sascha Flögel from GEOMAR. In addition, the system has a 4 kW rechargeable battery, which the fuel cell charges. To refill the fuel cell that GEOMAR has designed



costs a modest \$1250. The system can deliver 150 W to 1kW output, a significant increase compared to previous solutions that draw their energy from primary cells or rechargeable batteries, says GEOMAR. This will cover many requirements, which include for long-term deep sea monitoring, but also, in future, recharging autonomous underwater vehicles (AUVs) and a seabed crawler, using an inductive seafloor recharging unit, says Dr Flögel. The system is currently rated to 1200 m depth, due to limitations of some of the pH sensors and buoyancy foam that are part of the sensor suite GEOMAR wants to use with it. However, it's targeting 3000 m by 2023-24.

## Sir James S. Milne, Chairman and Managing Director of Balmoral Group

[www.balmoraloffshore.com](http://www.balmoraloffshore.com)

Earlier this year Jim Milne, chairman and managing director of Balmoral Group, officially became Sir James S Milne CBE, DL, DHC, Hon DBA, Hon FRIAS, upon receiving the honor of Knight Bachelor in the Queen's Birthday 2022 Honors List for services to business and charity. "For as long as I can remember I have strived to be the best I can be and, I think, have encouraged others to do and think the same way," said Milne. "I am very fortunate in that I have been surrounded by a loving family all my life and they have given me the strength and freedom to pursue my commercial, charitable and personal dreams. The good Lord has been watching and guiding me too, of course.

Sir James is often quoted as saying that he hasn't come a long way in life as his company's corporate headquarters are located less than a mile from where he was born and brought up on the family farm, just outside Aberdeen city at that time. He, like many, has experienced numerous highs and lows, both on a commercial and personal level and, somehow, has always bounced back. "You can draw your own conclusions from this", he says. "You might think I'm either a genius, completely mad or, perhaps more realistically, somewhere in the middle." He is a firm believer that the way to get on in life is to take calculated risks, make mistakes and learn from them - and admits to making quite a few in his time.

Sir James continued: "I do believe, however, that I was a born



entrepreneur; growing lettuce and mushrooms; buying, renovating and selling cars while at school before acquiring an 84 x 21ft. ex-RAF hut from Kinloss to start up my first glassfiber manufacturing operation on the family Home Farm of Tullos."

Today Balmoral Group operates from a 45-acre site in Aberdeen and has engineering and manufacturing facilities in Newcastle, South Yorkshire and South Wales. "85% of what we produce in the UK is exported worldwide. From our offshore energy products for the hydrocarbon and renewable sectors, to our anaerobic digestion and water/wastewater products, you will find Balmoral products on every continent in the world," said Milne.

# Armach Robotics

<https://armachrobotics.com>

Armach Robotics has set out to change the way vessel owners maintain their fleets through a proactive, intelligence based, in-water hull cleaning service. Armach is pioneering an intelligent solution to a universal maritime problem. Armach harnesses the power of Greensea Systems Inc.'s, open architecture platform, OPENSEA, for proprietary navigation and operational software that allows Armach to efficiently and quickly clean ship hulls. The resulting clean hull optimizes ship efficiency, lowers fuel cost/consumption and provides a complete hull condition report giving shipowners new insight into the condition of their ships' hulls. Armach Robotics' technology is ready to meet the demand for cleaner, more efficient shipping operations, moving the industry forward with a disruptive, high tech solution to cleaner ship operations. Armach boasts an experienced leadership team, with operations based in Plymouth, Massachusetts.

Armach offers a subscription based proactive cleaning solution that overcomes many shortfalls of current methods through the use of the Armach Hull Service Robots (HSR). The HSR is a single man deployed hybrid flying and hull crawling robot, approximately 1 meter long and weighs under 35kgs. The cleaning head brushes have been extensively tested to ensure they work optimally with any coating system, effectively removing the microfouling while not damaging or accelerating the wear rate of the coating. The HSR is equipped with a forward looking sonar, and forward and rear looking cameras to document the condition of the hull, pre and post cleaning. Autonomy and precision on-hull navigation are built on the OPENSEA and SafeC2 platforms from Greensea. A vessel can be completely cleaned in a single day, and through the use of autonomy and reduced onsite infrastructure and manpower, the annual cost is significantly lower than a reac-



tive solution. Providing complete coverage of the hull is critical to a successful proactive cleaning while approach avoiding repetitive contact with areas already cleaned, as this is suboptimal for the coating system. Finally the data

collected during the service provides proof to the owner and operator that the complete hull was addressed. Meaningful hull data output can be incorporated into existing and future performance monitoring systems, allowing for real world data optimizing the service routine and enabling increased performance.

Armach Robotics launched the first production Hull Service Robot (HSR) following an extensive technological development phase, and unveiled its first post-prototype HSR in May, 2022. Greensea Systems Inc. has been awarded a two-year Phase II Option Period by the US Navy's Office of Naval Research to continue the technology development for an Autonomous Hull Cleaning Vehicle. Armach Robotics is providing the robots and robot operators to conduct field operations throughout the period of performance.

# EMPOWERING

**SAAB SEA EYE**



**SAAB**

# Kraken Robotics

[www.krakenrobotics.com](http://www.krakenrobotics.com)

Since opening its doors in 2012, Kraken has grown from six employees in Newfoundland and Labrador to now having 214 employees globally with offices in Canada, US, Germany, Brazil, Scotland and Denmark. More than 140 of these employees are employed at its Canadian offices, located in Mount Pearl, NL, Dartmouth, NS and Toronto, ON. Kraken is one of Canada's leading marine technology companies and is projecting to grow by an additional 20+ people in 2022. Kraken continues to push the boundaries of innovation, particularly in the defense sector. Kraken has developed technology platforms specifically for MCM and are now selling those platforms to the Canadian Navy and other NATO Navies globally.

In 2021, Kraken acquired two companies: 13 Robotics Ltda of Brazil (13R) and PanGeo Subsea Inc. (PanGeo). Through the acquisition of these companies, Kraken added more than 60 employees. The 13R team, with offices in Rio de Janeiro and Salvador, Brazil, consists of software developers and engineers who have significant experience in underwater robotics and autonomous systems. PanGeo is a services company specializing in high-resolution 3D acoustic imaging solutions for the sub-seabed with offices in NL, NS and Scotland. In 2021, Kraken created a Robotics-as-a-Service division and the acquisition of PanGeo will help eliminate barriers of entry as the company focuses on growing its service business. Furthermore, PanGeo brings a portfolio of clients to Kraken that will undoubtedly lead to new Service revenue opportunities. Along with the employees from 13R and PanGeo, Kraken also hired 17 new Canadian based employees during 2021. Furthermore in 2021, to support Kraken's growing operations in NL, the company expanded its facilities by leasing an additional 13,000 sq. ft. Kraken now occupies more than 33,000 sq. ft. of office and production space in NL. As well, Kraken's NS facilities expanded by 2,486 sq. ft. of space during 2021. In 2022, Kraken is projecting to add a minimum of 15 new employees to fill highly skilled roles including software development, engineering, and offshore operations.

Kraken's Synthetic Aperture Sonar (SAS) aims to dramatically improve seabed surveys by providing ultra-high-resolution imagery at superior coverage rates. Its AquaPix SAS provides significantly higher resolution when compared with real-aperture sonar and it maintains constant ultra-high-definition resolution across the entire swath. This



equates to the users being able to survey larger sections of the ocean in less time and at higher quality than ever before. With post-processing we can achieve 1.9 x 2.1 cm resolution, making it the highest quality resolution commercially available on the market and less expensive than traditional military systems as its AquaPix SAS is rated for both commercial and military sales. To put that into perspective, a Canadian Toonie is larger than 1.9 x 2.1 cm so that means when you zoom in on an object, we can see detail at that level of resolution. Our internal company mantra is "Innovate or Die."

Kraken's commitment to grow the company both domestically and internationally led to the creation of two new recurring revenue models called Robotics-as-a-Service (RaaS) and Data-as-a-Service (DaaS). These new revenue models are coming together under a project known as OceanVision. Through OceanVision, we have created a robotic data analytics-as-a-service business model. This service will involve the creation of a dedicated team of Atlantic Canadian trained and employed highly qualified personnel, equipped with leading edge technologies. The new technologies and innovative data processing workflows will provide a step-change in seabed survey efficiency and significantly decrease overall costs. OceanVision will use SAS data it collects from surveys it conducts in areas of interest with a plan to sell that data multiple times to different interested parties, whether that be in defence, fisheries, offshore oil and gas, offshore wind, marine research, etc. This is a cost-effective way to achieve the data each of those clients requires as they do not need to pay for an entire survey, just the data. This recurring revenue model is expected to make up 20% of Kraken's revenue in the coming years. It is currently anticipated that RaaS / DaaS will be for the commercial industry but there are defense related opportunities too.





Marcz/Adbestock

# Tech Talk: OSV Charging Station

Maersk Supply Service, a part of A.P. Moller-Maersk, is launching its offshore vessel-charging venture, Stillstrom, to support the decarbonization of the maritime industry by eliminating idle emissions. Together with Ørsted, Stillstrom will demonstrate the world’s first full-scale offshore charging station for vessels at an offshore wind farm. In Danish, “Stillstrom” means “quiet power” and today it is an early-stage technology spin-out whose full-scale product launch will reportedly be the first-to-market in offshore charging, enabling idle vessels to power from electricity. The first full-scale charging buoy will, as previously announced, be demonstrated with offshore wind leader Ørsted in Q3 2022. The power buoy will supply overnight power to one of Ørsted’s Service Operations Vessels (SOV), thereby supporting Ørsted’s target of climate-neutral operations in 2025. Ørsted will be responsible for the grid integration of the charging buoy.



Photo Courtesy Maersk Supply Service



## SWiFT CTD

Measured CTD, with all the benefits of the SWiFT

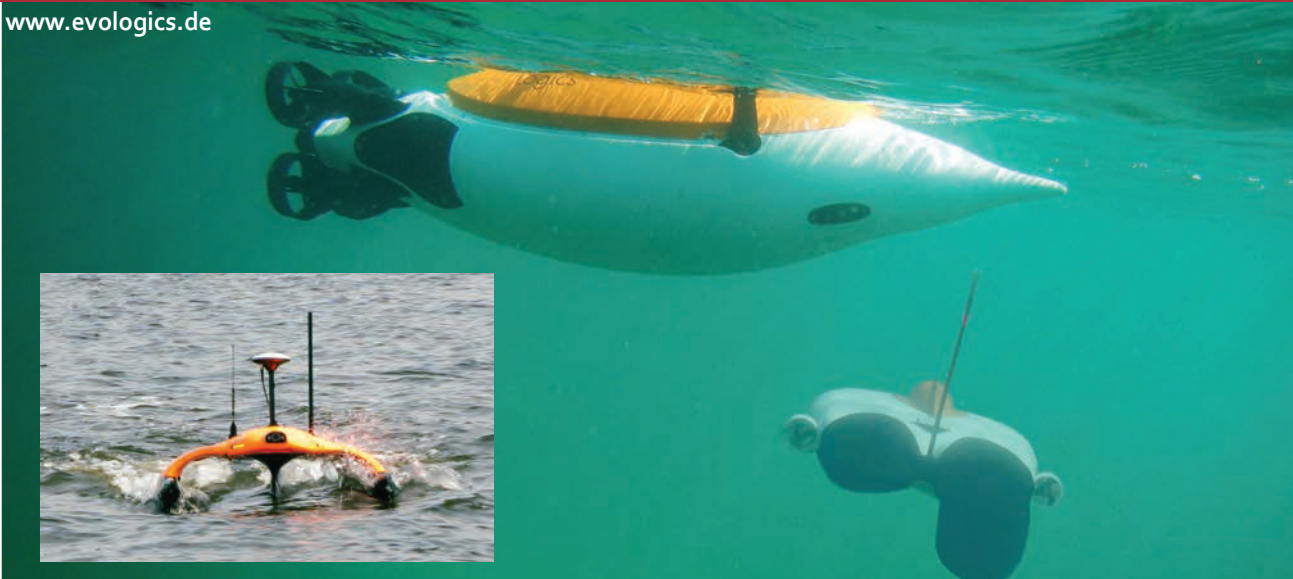
To find out more contact [sales@valeport.co.uk](mailto:sales@valeport.co.uk)  
+44 1803 869292 | [www.valeport.co.uk](http://www.valeport.co.uk)

- Bathymetry
- CTD & Environmental
- Current
- Sound Velocity
- Tide

- AUV, ROV & ASV
- HYDROGRAPHY
- HYDROMETRY
- METROLOGY & POSITIONING
- OCEANOGRAPHY
- PORTS, HARBOURS & DREDGING
- RENEWABLE ENERGY

# EvoLogics GmbH

[www.evologics.de](http://www.evologics.de)



EvoLogics GmbH is a German-based high-tech enterprise. The company was founded in 2000 by a group of international scientists and R&D experts aimed to develop innovative key technologies for the maritime and offshore industries through interdisciplinary cooperation between engineering and life sciences. EvoLogics GmbH designs and manufactures underwater information systems and novel robotic solutions based on bionic concepts, combining cutting-edge engineering with the best ideas found in nature. The advanced product features have become enabling technologies for monitoring, exploration and production. EvoLogics are experts in cutting-edge underwater communication and positioning systems, as well as novel robotic solutions.

The company's advanced spread-spectrum technology allows it to deliver optimal results for various subsea applications. EvoLogics products include several series of underwater acoustic modems, underwater acoustic positioning systems (USBL, LBL), the Sonobot surface vehicle for surveying and monitoring, as well as the Quadroin, penguin-shaped AUV, with other uncrewed vehicles currently in development and prototyping stages.

EvoLogics offers solutions for multiple underwater communication, positioning, navigation and monitoring applications. EvoLogics' developments are based on the patented S2C (Sweep Spread Carrier) technology - the acoustic telemetry that provides an independent bidirectional data link along with positioning, broadcasting and networking capabilities. S2C devices can simultaneously facilitate te-

lemetry and navigation of unmanned underwater vehicles. They enable retrieving information from various sensors and allow controlling complex processes by seamlessly combining communication with highly accurate positioning. Moreover, EvoLogics caters to the needs of scientists, developers and commercial customers with a series of underwater acoustic devices and software tools that offer an open development and testing framework, providing endless opportunities for new implementations.

S2C systems have been carefully designed for operations in harsh underwater environments and enhanced with special algorithms for signal processing and data management. The company's extensive experience with sensor integration allows it to provide customers with turn-key solutions ranging from initial deployment up to equipment recovery.

EvoLogics' novel robotic solutions include the SONOBOT 5 uncrewed surface vehicle. The USV is a fast, compact and robust platform for planning and executing bathymetric and side-scan sonar surveys that can deliver accurate geo-referenced bathymetry and high-quality imagery with minimum transport, launch and recovery efforts.

The company recently introduced innovative uncrewed underwater vehicles with cutting-edge bionic designs, inspired by real-nature counterparts. Envisioned as sensor carriers for automated monitoring missions, these include the Quadroin and Pogy robots for various types of surveys, currently in the trials for self-coordinating swarm operations.



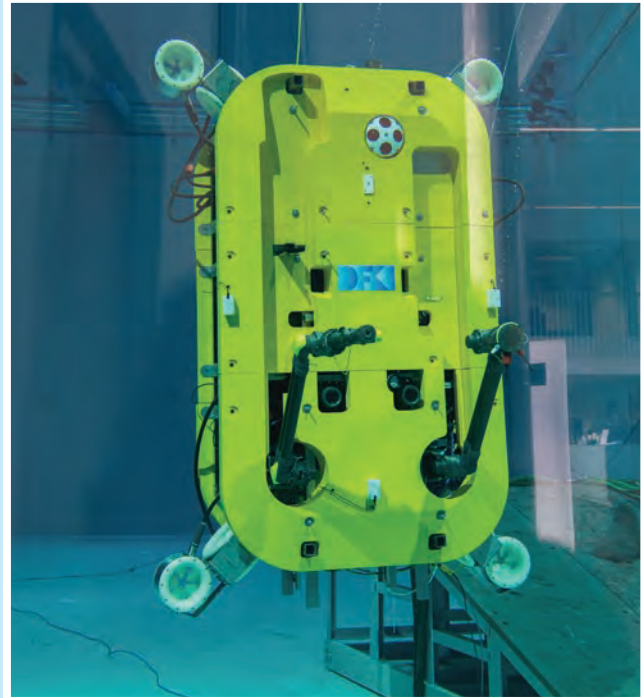
MarcusAbbeStock

# Tech Talk: Cuttlefish AUV

A consortium led by the **German Research Center for Artificial Intelligence (DFKI)** developed a holistic AUV solution in the Mare-IT project: a two-armed AUV dubbed “Cuttlefish” for complex inspection and maintenance tasks, embedded in an IT infrastructure that enables both intuitive control and monitoring of the system and effective information flow with the plant operator. The development is aiming first at the routine maintenance in offshore energy infrastructure, an autonomous solution offering longer persistence courtesy of in water residency capabilities.

The proposed solution comprises a two-arm AUV that can operate both autonomously and remotely and, thanks to two integrated manipulators, can be used for maintenance work and repairs on underwater structures. In addition, the partners are providing a powerful IT infrastructure that not only enables intuitive control and monitoring of the robot underwater but also ensures the smooth bidirectional flow of information. The AUV “Cuttlefish” has two deep-sea gripping systems attached to its ventral side that allow it to manipulate objects underwater. In doing so, thanks to its special design and AI-based control, it is possible to change the center of gravity and buoyancy during a dive and to adopt and maintain any orientation in a stable manner. In addition to fully autonomous operations, the vehicle can be operated in a hybrid mode – so-called supervised autonomy – using a fiber optic cable.

**WITTENSTEIN cyber motor GmbH** developed and produced the thruster drives, with a thrust of up to 500 newtons and suited for water depths up to 6000m. **SAP** investigated how and under what conditions autonomous systems such as AUVs can be integrated into IT infra-



structures such as cloud systems. **ROSEN Group** developed four measurement technologies for AUVs to check the condition of various subsea structures: Magnetic field sensors to detect ferromagnetic structures, sensors to measure electric fields of cathodic protection systems, and ultrasonic and eddy current sensors to measure local wall thicknesses using manipulators on the AUV. In addition, a communication buoy was developed to ensure data transmission from the robot through the water column.

**SENSOR TECHNOLOGY**

Global Leaders in Piezoelectric Based Acoustic Tools and Systems

705-444-1440 • [www.sensortechcanada.com](http://www.sensortechcanada.com)

Patania II on the seabed  
at 4500m water depth

# GONE DIGGING

*Deep-sea mining may prove pivotal  
for climate change*

*By Celia Konowe*

**D**uring the past few years, much of the world has turned its eye towards adopting more sustainable practices and transitioning to net-zero and even carbon-zero emissions. Recent examples range from double-digit year-on-year electric vehicle (EV) sales percentage increases driven by individual consumer behavior to government pledges at the national, state and local level to lower emissions during the next three decades. Companies and industries have begun flocking towards this transition, aware of the opportunity to become leaders among their peers and fearful of becoming an outlier through relative inaction. This can be seen most clearly in aviation, whose biennial Farnborough International Airshow in July was dominated by discussions surrounding hurdles to a production ramp up of sustainable aviation fuels and the even longer-term pursuits of electric and hydrogen propulsion.

With a greener world comes the need for significant technological advancement, and more technology means more materials. As natural resources for EVs, solar panels, batteries and countless other important products begin to wane on land, key stakeholders have begun to look below the waters for minerals and rare earth elements (REE).

Deep-sea mining (DSM) arguably has become one of today's most controversial marine activities. There is no denying that any human activity that requires taking resources from the earth is likely to cause damage—climate change and many of the environmental issues faced can be traced back to the Industrial Revolution and centuries of human exploitation. Early volleys in the deep-sea debate begins have included many scientists and governments agreeing that it's premature to begin mining; too little is known about the seabed and its ecosystems, and the long-term impacts of mining are impossible to determine at this point. On September 8, French Polynesia became the most recent territory to call for a ban on DSM, calling out their “cousins of the Pacific”—Kiribati, Nauru and the Cook Islands—for pushing forward with mining despite only having explored about 5% of the seabed. “If we have to examine what's on the ocean floor, it should be solely for the acquisition of knowledge, not for exploitation purposes,” said Minister for Marine Resources Heremoana Maamaatuaiahutapu in a television interview.

French Polynesia is not alone with numerous groups worldwide, like the **Deep Sea Conservation Coalition (DSCC)**, also fighting for a moratorium. However, this is only one side of the battle. On the other are nations like Nauru, who started the countdown to DSM in June 2021 by giving the **International Seabed Authority (ISA)** two years to finalize regulations on industry activity. The ISA was established under the 1982 United Nations Convention on the Law of the Sea and has been developing a mining code since 2014. Many DSM stakeholders, like Nauru, feel that the ISA has had enough time to assess risk, and that the potential gain from deep sea minerals and REE is more important. With only a year left on

Nauru's ticking clock, DSM stakeholders face a big question whether environmental damage is worth the risk and how to minimize impact should the industry move forward.

## A nod to nodules

Scientists have been exploring the effects of DSM on the environment and testing the least impactful techniques long before Nauru's announcement. Much of the research and technology at the forefront of the industry focuses on polymetallic nodules, which is one of three DSM techniques. These nodules are potato-sized and multi-metal, found largely in the Clarion-Cliperton Zone (CCZ) in the Pacific Ocean (any mining interests in this area are managed by the ISA). They consist of manganese, nickel, cobalt and copper, and it's estimated that in the CCZ alone, there is 1.2 times more manganese, 1.8 times more nickel, and 3.4 times more cobalt than in all known land reserves combined. “The multi-metal nature of the nodules means that a polymetallic nodule area is, in effect, two or three land-based mines in one, which means there is the potential to significantly reduce waste and CO2 emissions per ton of metal mined and minimize a number of other negative environmental and social effects associated with obtaining metals from our planet, such as deforestation and relocation of people,” explained Dr. Kris Van Nijen, managing director of **Global Sea Mineral Resources (GSR)**. Polymetallic nodules are promising in their broad makeup and versatility—and despite lying almost five kilometers below the surface, there are few obstructions to collecting them, he explained. “There are no forests that need removing, no people who need relocating and no local power stations or transport infrastructure that needs building.”

The Cook Islands, alongside Nauru, have also begun to prepare for large scale DSM by collaborating with partners to explore the abundance of nodules in their exclusive economic zone (EEZ). **Moana Minerals Limited** is a company based on the Islands that focuses on nodule collection for the clean energy transition and exploring the EEZ for evidence-driven decisions. “This is all in line with our plan to work cooperatively with the Cook Islanders to ensure maximum local benefit is derived,” CEO Hans Smit said. “This is done through the use of local industry and businesses, employment of Cook Islanders and training programs to advance and grow the local workforce.” As part of their commitment to the Islands, Moana Minerals has embarked on a three-year exploration to understand ecosystem health by identifying the impacts of its mining systems so that its engineers can develop mitigation techniques. The nodules play a crucial role for achieving a happier, healthier future, Smit argued. “Without these metals the world will struggle to achieve the goals set for transitioning to alternate energies and to address climate change. These nodules are a resource that can be accessed without serious harm and certainly without destroying our oceans as some would like us to believe.”



© Moana Minerals Ltd / Ocean Minerals LLC

## Quarry-some impacts

Nonetheless, human interference almost always poses an environmental risk. DSCC estimated that throughout a 30-year mining license period, each nodule-collecting operation would strip 8,000-9,000 square kilometers of seabed, leading to the possible extinction of species. In the second technique, when mining for cobalt-rich ferromanganese crusts, the outer layer of seamounts is stripped, destroying sea sponge and coral. The third type of DSM, which focuses on hydrothermal vents, would devastate these fragile and largely unknown ecosystems. Despite these risks, the industry has gained too much momentum, and scientists have been looking for ways to make the unavoidable as harmless as possible.

Dr. Daniel Jones, associate head of the Ocean BioGeosciences Group at the **National Oceanography Center**, has set out to better understand how ecosystems will respond to and

Free Fall Grab being recovered after safely travelling to the seafloor 5,124 meters below the vessel.



The results of a successful deployment of the free fall grab.

recover from mining disturbance through a project called the Seabed Mining And Resilience To EXperimental impact, or SMARTEX. The collaboration will leverage analysis, modeling and vessels and marine robotic systems from the UK Natural Environment Research Council. SMARTEX's work is unique in that its scope spans multiple decades. "I discovered information about the mining tests done in the late 1970s and had the idea of reinvestigating these so we could understand recovery processes over a reasonably long timescale of four decades," Jones explained. "This would enable us to provide better evidence on the long-term impact of mining."

The team is currently preparing for the first of their two expeditions to the CCZ, leaving in February 2023 from Costa Rica. Their work will be supported by a robust lineup of equipment, ranging from acoustic mapping to oceanographic moorings. Two key pieces of tech include their remotely operated vehicle (ROV), ISIS, and their autonomous underwater vehicle (AUV), Autosub 5. "The ROV will enable us to obtain amazing high-resolution images of the seafloor and the marine life inhabiting it. It will also allow us to collect specimens of some of the unusual animals, collect samples precisely in disturbed areas and enable us to do experiments on the seafloor," Jones

said. The AUV will gather seafloor images to quantify the density and distribution of marine life. Multibeam bathymetry and side-scan sonar will be used to make detailed maps, and the addition of a Robotic Cartridge Sampling Instrument will allow for evidence of life to be collected through DNA sampling.

### Sedimental value

Another risk of DSM is sediment plume. There are two types of plumes that occur during nodule mining—first, the collection vehicle skims the seabed, stirring up sediment and picking up nodules to send to a surface vessel above. The second plume is created as the surface vessel returns unwanted sediment and water from nodule collection back to the ocean. The disruption of sediment can impact filter feeders and species that use echolocation or bioluminescence to communicate and navigate. Dr. Thomas Peacock, a mechanical engineering professor and Director of MIT's **Environmental Dynamics Laboratory**, has been collaborating on a project to monitor and track sediment plume from the mining process. "The goal," he explained in video about the research, "is to understand if a sediment plume is released from a surface mining vessel, how far and in what concentration will that sediment

## Save time and money locating subsea cables

with a JW Fishers CT-1 Cable Tracker.



- Locate and track cables
- Find faults and breaks
- Use on land & underwater
- Audio and Visual output
- Commercial construction
- Easy to read display
- Calculate burial depth
- Starting at \$15,995



JW Fishers Mfg., Inc  
(800)822-4744  
(508)822-7330

Email: [info@jwfishers.com](mailto:info@jwfishers.com)  
[www.jwfishers.com](http://www.jwfishers.com)

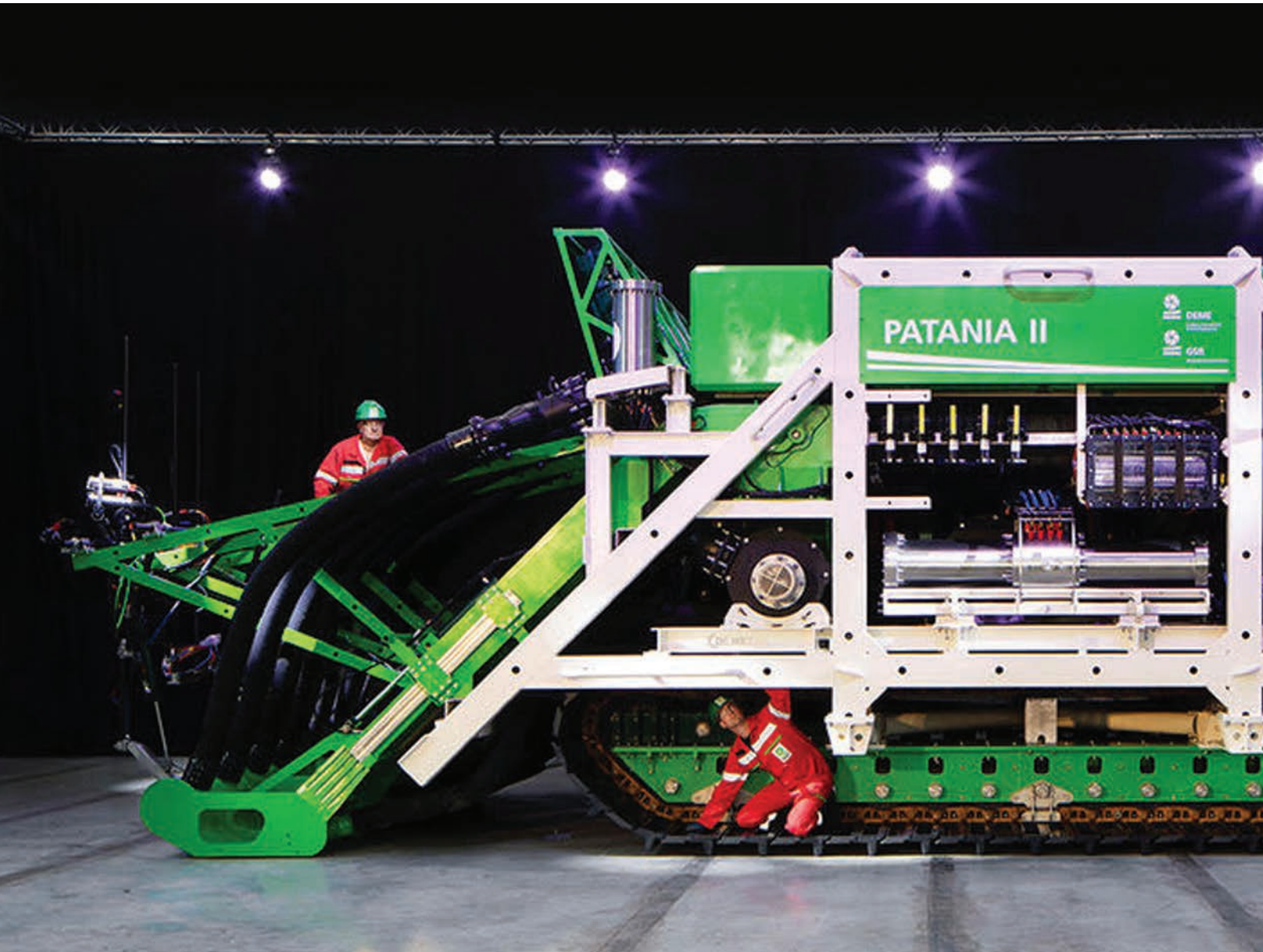


travel. We can use that information to then determine how that will impact the ocean biology.” By tracking actual sediment plumes created by DSM in the Pacific, Peacock hopes to determine if the second plume can be returned in the mid-water column or closer to the seafloor, and how this may impact ecosystem processes and organism function.

Dr. ir. Rudy Helmons, assistant professor for offshore and dredging engineering at **Delft University of Technology**, and adjunct associate professor for deep-sea mining at Norwegian University of Science and Technology, is experimenting with the nodule collection process, as well. In a previous EU H2020 project, Blue Nodules, the collection technology was proven as effective, with a hydraulic or mechanical nodule collector skimming the seafloor, separating nodule from sediment, and

discharging excess water and sediment behind the vessel. In Helmons’ current project, Blue Harvesting, he’s adapting this technology to have minimal environmental disturbance by reducing water and sediment intake. The lab has also investigated optimal discharge conditions to minimize plume dispersion and in the upcoming months, will test a new design of the hydraulic nodule collector.

The new design uses the Coanda principle, Helmons explained. “If you blow a fast flow along a curved object, it tends to follow the curvature of the object rather than moving straight ahead. A side effect is that while the flow remains attached to a curved object, it entrains more fluid to be able to do so. In our new design, we replaced part of the water that it would entrain by recirculating water that goes into the collec-





tor. That way, we are able to reduce the total amount of clean water that will enter the system by more than 50%.”

In terms of environmental impact, Helmons acknowledges that the mining industry can never be sustainable; these resources don't grow or regrow—at least, not on human timescales. “I would explain that mining can be done in a responsible way, by being aware of its potential impact and its consequences. You should only mine for those materials that are really necessary to help society to progress, not just for monetary gains. That said, there will always remain an uncertainty on the long-term impact.”

“We do not yet know how what threshold values can be used to determine what environmental pressure is acceptable—what dosage is harmful? And a more challenging question is,

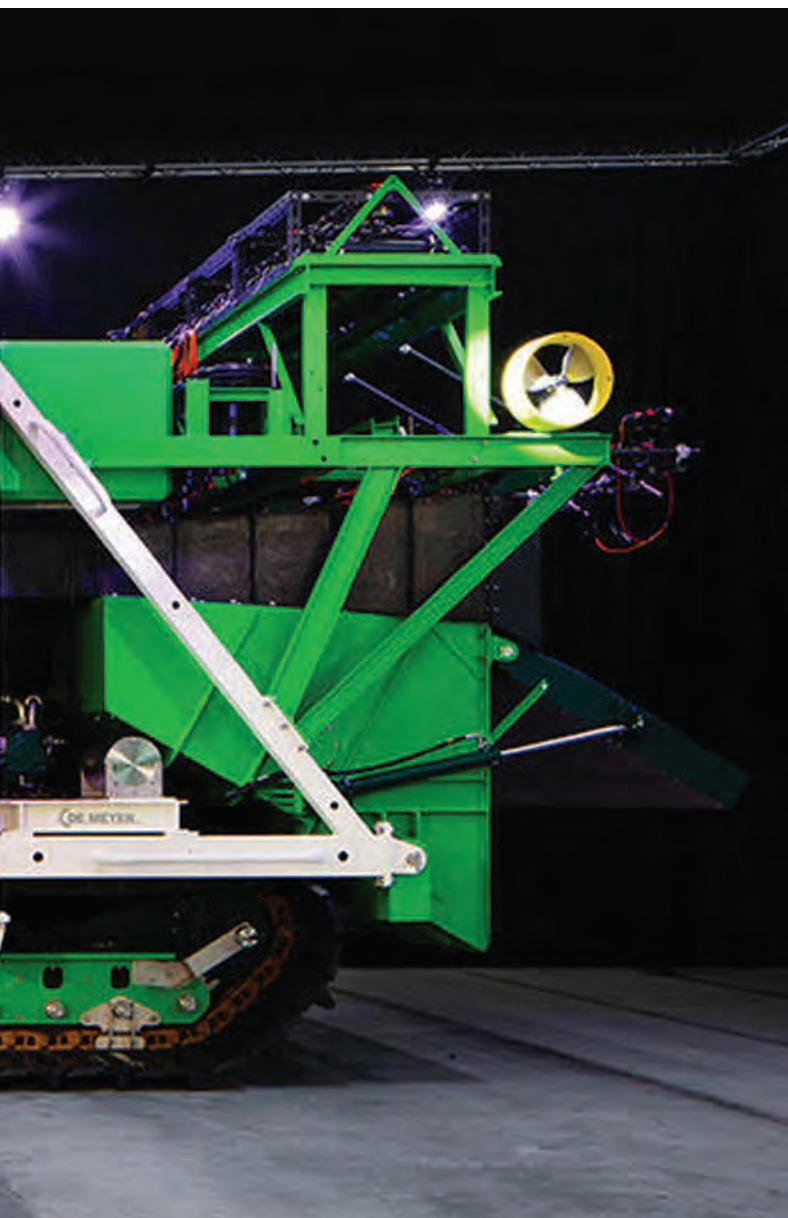
how much harm will be acceptable to society or humankind as a whole?” Helmons posed. “We are limited to what extent we are able to predict the exact impact caused by a mining operation before doing it.”

GSR's Patania II vessel shares a similar use of the Coanda effect to collect polymetallic nodules. Beginning in 2017, GSR trialed and developed different components of its nodule collector, fully testing Patania II for the first time in the CCZ in 2021. The collector head is unique in that it never touches the seafloor. “As the collector moves across the seabed, it uses jet water pumps to lift nodules into a collection drum. The collector head is a precision-engineered device that has been designed to collect nodules while minimising disturbance of the surrounding sediment,” the company explained in a press release.

A key part of GSR's work, Van Nijen pointed out, is in situ component testing to not only validate the technology, but also assess environmental effects and ways to reduce them. “Since 2018, GSR has been collaborating with the European JPI Oceans research project, Mining Impact. Scientists from 28 European institutes have also joined efforts with the German exploration contract holder, BGR, to independently monitor the Patania II technology trials to help understand the environmental effects of collecting mineral resources from the seafloor.” While most of the data from trials are still under analysis, Van Nijen was able to share some updates from Patania II's 15 dives and 107 hours of seabed operations. The AUVs proved to be crucial monitoring tools to document seafloor imagery, topography and sediment turbidity. Sediment plume predictions were correct in that most of the cloud would travel south-south-east and by examining the concentration of sediment at different altitudes, most stayed at low altitude, between the seabed and five meters. “The blanketing on the seafloor, created by the sediment plume, was also studied using the AUV,” he added. “Sedimentation was observed up to 1.5 to 2 kilometers away from the trial site towards the south. Past this distance, nodules are again clearly visible, which indicates that the sediment blanketing and most of the total mass of the resuspended material is settling quickly and near the mining area.”

### Mission possible?

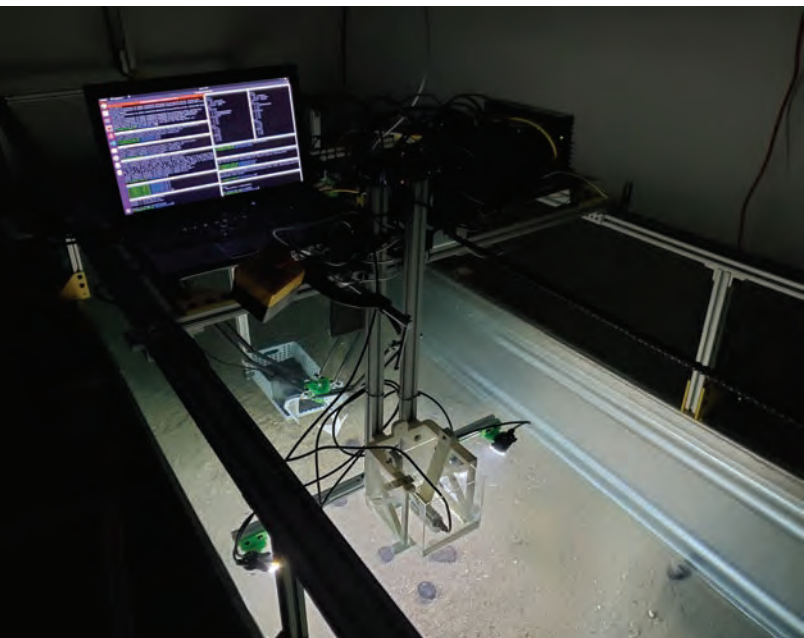
The challenge of sustainable DSM may be daunting, but one that is being addressed by companies determined to find a balance between the two ends of the spectrum. Some, like **Impossible Mining** (IM), strive to tackle multiple industry issues in one fell swoop. IM was founded in response to three key problems within DSM, explained Renee Grogan, chief sustainability office and vice president of external relations. The first is that the available supply of critical metals needed for a full-scale transition to a green economy is short of the demand. The second is that some companies and governments are consenting to deep-ocean dredging technology, as opposed to less





© Impossible Mining

Bioextraction team working



© Impossible Mining

invasive techniques. Thirdly, traditional mineral processing is environmentally damaging in its use of hazardous reagents (like arsenic and cyanide), high electricity demand as well as creation of tailing dams, which are toxic waste ponds.

IM's robotic collection system is like others that hover above the seafloor, minimizing interference with sediment and ecosystems. However, the company plans to use AUVs with artificial intelligence (AI), remote sensing and precision manipulators to harvest nodules individually. "The AI system will identify nodules that are host to observable life such as corals and sponges, and avoid contacting those nodules, leaving untouched both the nodules, as well as the organisms living on them," Grogan explained. This system is currently in its proof-of-concept phase, with the shallow-water prototype being deployed later in 2022, followed by a deep-ocean prototype in 2023. IM hopes to reach full-scale production by the end of 2024.

Its bio-extraction process offers a one-of-a-kind technique, as well. The processing technology will extract minerals from the nodules using naturally occurring bacteria to dissolve the rock into solution, eliminating the use of toxic chemicals and tailings, and lowering the energy footprint. This process is in the same phase as the robotics, with all technology currently lab based. "We have plans to construct a pilot plant facility in 2023, to develop the necessary infrastructure required with scaling of the microbial processes and integration of the bio extraction into other parts of the mineral processing chain, such as crushing and grinding (at the front end), and metal separation (at the back end)," Grogan shared.

## Seabed battle lines

The DSM industry's controversy is far from over, even if the ISA issues a set of regulations before Nauru's deadline. For some, this is a wakeup call that how humans treat the planet needs to change and that DSM presents too high of a risk to critical and fragile ecosystems scientists have only begun to understand. For others, this warning signals the urgency to move forwards with DSM to retrieve the materials necessary for a societal shift to green energy, regardless of potential environmental impacts. The emerging common ground can be characterized by the realization that the state of the earth is too dire to pause or postpone the transition to clean energy. In turn, the DSM industry will be expected to continuously assess and minimize environmental impacts through diligent research and technological advancement.

"We, collectively, need to do a better job with respect to thinking about the planet holistically and make choices about how to obtain resources with least harm to the environment and to the planet's inhabitants in their entirety," Van Nijen said. "Land and sea cannot be considered in isolation from each other. We face a whole-planet problem that needs a whole-planet solution, and the deep sea should be part of the discussion."

# Iridium: Connectivity & USVs

[www.iridium.com](http://www.iridium.com)

Speed and reliability of communication and connectivity is key to accurately and rapidly transmit data from the field – whether it’s from traditional crewed ships, USV or AUVs – to the shore, and Iridium is a big and growing player in the field. At the recent SMM 2022 in Hamburg, Germany – the world’s largest shipbuilding technology event – Iridium had an XOcean USV displayed on stand. “The USV market, the uncrewed vehicle market, is an emerging market,” said Wouter DeKnopper, VP & GM of Maritime, Iridium. DeKnopper said that the need for reliable comms at sea spans the spectrum, from science and academia to commercial operations, with the XOcean USV as a case in point. “We are working with real companies, that have real applications out in the field, and XOCEAN is one of them. They are deploying the USVs for, for instance, for wind farm inspections. The Iridium CERTUS technology lends itself very well to USV applications. (There are many reasons, including) our L-band truly global network. Also, the hardware is really small and compact,” helping it to survive the harsh environments where the USVs operate. “So with our small, compact, no moving part, antennas that also provide very low-latency service and broadband connectivity, it’s the ideal fit for the applications that the USVs need to perform.” The applications on the XOcean USV span from the command, control and management of the USV itself, tracking the USV and monitoring its performance. It also includes the relay of information captured by onboard sensors and video, so the that the onshore team is able to collect, collate and analyze data and information more rapidly.

“One of the reasons that Iridium is being looked at as the provider of choice for these autonomous solutions is one is that you got to have critical communications that are resilient,” said Bryan Hartin, EVP Sales & Marketing, Iridium. “If you’re doing command and control of an autonomous vessel, you’ve got to have the trust that that communication link is going to be maintained in all kinds of conditions. So we’re a natural choice for these kind of solutions. The other aspect of this is the fact that we have world-class value-added manufacturers that have developed, designed and manufactured products that can withstand all the harsh environments when you’re out at sea.”



Photo by Bartolomej Tomic

At the recent SMM 2022 – the world’s largest shipbuilding technology event – Iridium had an XOcean USV displayed on stand.

©2022 HydroComp, Inc.

## Below The Surface Is What Matters

Under the surface of the water, the results from our calculations and knowledge are hard at work. HydroComp connects your ingenuity with improved outcomes:

- > Thruster Design
- > Vehicle Hydrodynamics
- > Propulsion Energy Budget
- > Performance Improvements
- > Silencing Propeller Noise
- > Electric Motor Drives

**Let us expand your sea of opportunities by providing design software and services for your team!**

[hydrocompinc.com/uv](http://hydrocompinc.com/uv) ■ 603.868.3344  
NavCad® ■ PropElements® ■ PropCad® ■ PropExpert®

**HYDROCOMP** INC.

## Cellula Robotics

<https://www.cellula.com/>

Cellula Robotics is an engineering solutions company that specializes in the turnkey design and production of subsea robotic systems with extensive experience in projects that require integrated mechanical, electrical, hydraulic, and software elements. Cellula focuses on developing autonomous vehicle technologies, such as Solus, a family of autonomous underwater vehicles (AUVs) developed under Defence Research Development Canada (DRDC). Solus-LR, the AUV's fuel cell powered, long range configuration, has a range of over 2000km submerged. Following an overhaul of the fuel cell system in 2021 to improve reliability and endurance, Solus-LR has now completed hydrogen fuel cell powered missions in Indian Arm, Canada. The vehicle design can be customized to meet specific mission objectives. Solus-LR, the 3000 msw-rated configuration, is fuel cell powered with 250kWh usable



energy, enabling 2000 km mission ranges. Solus-LR's suction anchor module also allows station keeping in a low-powered state, in currents of up to 4kts. Cellula's Imotus-S AUV is built on a modular, scalable architecture enabling a highly functional and affordable solution to performing inspections in open water, including ship hulls, infrastructure inspections, and vertical profiling.

## Fugro

[www.Fugro.com](http://www.Fugro.com)

Fugro has already proved the ability to deploy ROVs from its 12m Blue Essence USV. It is focusing more on offshore wind operations and maintenance (O&M) with this vessel, which also has multi-beam capability. Its first Blue Essence, Fugro Maali, entered service in 2021. By the end of this year, Fugro expects to have four Blue Essences operational, across Australia, Europe and the Middle East. Fugro anticipates that it will complete its first wind farm operations, with a Blue Essence, in a trial at Vattenfall's Aberdeen offshore wind farm, also known as the European Offshore Windfarm Deployment Centre, involving visual and CP inspection using its eROV Blue Volta on turbine bases..

"We believe 85% of the O&M task can be done with an uncrewed vessel in nearshore wind farms," says Daniel Jones, Director IRM Services Europe & Africa, Fugro. "Certain technologies still require further development. Flooded member detection for turbine bases requires radioactive gamma source technologies, for example, and we're looking at alternatives. But there's very little else you can't do with the eROV (with 350 m water depth capability)."

For deeper offshore and floating wind, Fugro is lining up its greater endurance, station keeping and payload capability 18m Blue Eclipse class with a larger eROV, the Blue Amp (with 650 m water depth and light manipulator capability – mostly geared towards cleaning). It's due to be integrated by the end of June 2023, including sub bottom profiling, a dual



head multibeam to provide greater swath and a larger depth of burial system, as well as side scan sonar and cable tracking (TSS 660) on the Blue Amp eROV. The Blue Eclipse could also potentially house a UAV, but over the horizon control needs to be at an appropriate level, says Jones.

Next, Fugro has the Blue Prism, geared towards marine site characterization. It will have the same capability as the Blue Eclipse, but will be focused on pre-installation and post-decommissioning surveys. Geotechnical capability is a future vision. "Our view is that you can't currently fit everything on one vessel," says Jones. "One could be fit for wind farm asset integrity, but might not be appropriate for construction or UXO survey."



# Jaia Robotics

MARINE  
TECHNOLOGY  
TV



The need to work and explore in the world's waterways more efficiently and cost-effectively is inspiring a generation of innovation. Ian Estaphan Owen and Jason Webster co-founded JAIA Robotics in December 2020, a company which offers a compelling Micro vehicle solution. Jaia Robotics is U.S.-owned, based in Rhode Island and specialized in developing low-cost, micro-sized autonomous marine vehicles called JaiaBots. JaiaBots are multi sensor configurable, designed to make aquatic data collection affordable and available for all that need it.

The company is both a seller of vehicles and an operator, providing a "JaiaBots as a Service" (JaaS) data collection services for clients that want the data but not the capital investment to own the JaiaBot systems. The field team will work with customers to identify their needs, configure the system sensors to collect the required data, plan the missions and operate the vehicles. While much of the industry is laser focused on the large, complex deeper, longer endurance system, Jaia Robotics has more modest goals. "Jaia Robotics is focusing on democratizing aquatic data collection," said Owen. "With the ability to collect data over really wide areas, using multiple robots, working in pods with sensor technologies that are getting smaller and smaller."

As the Jaia team started with the theoretical "blank sheet of paper," one particular challenge was balancing performance versus cost while not always opting for the cheapest option. As the system became more ruggedized, another problem cropped up: weight. "We've identified low risk parts, reducing that weight. And our vehicles, which are priced at \$10k each, weigh six pounds and are 35 inches long." While the bots are small, Owen's plans for the company are anything but, as he eyes multiple opportunities in the traditional commercial market and academia. "Based on our financial plans, years four and five, we go global, and we are looking to see Jaia robotics be a business that has revenues in excess of \$70 million in five year's time," said Owen.



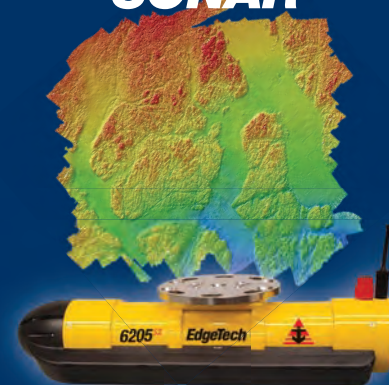
**EdgeTech**

The Leader in Underwater Technology

WITH NEW  
GAP FILL SONAR

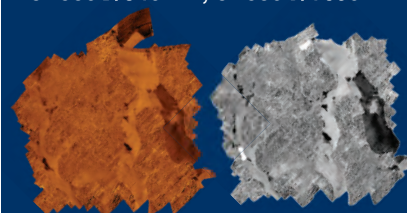
**6205<sup>S2</sup>**

## SWATH BATHYMETRY & SIDE SCAN SONAR



4<sup>TH</sup> GENERATION.

540B/850kHz, or 540B/1600kHz,  
or 850B/540kHz, or 850B/1600kHz



- Co-registered dual frequency side scan and bathymetry
- Unrivalled swath coverage in shallow water
- IHO SP-44 Special Order compliant
- Swath sectors of up to 200°
- Motion tolerant side scan
- Integrated mini SV
- Optional, OEM embedded INS
- Optional, CHIRP Sub Bottom Profiler

**EdgeTech**.COM

info@edgetech.com  
USA 1.508.291.0057

# Massa Products Corporation

[www.massa.com](http://www.massa.com)

Dawn Massa Stancavish shared with Marine Technology TV her insights and experience as a female, third generation leader of **Massa Products Corporation**, an innovative sonar and ultrasonic products engineering company founded by her grandfather and run by her father for many years.

Following in the footsteps of an invention and engineering pioneer is neither straight nor easy. Following in the footsteps of your grandfather and father, taking the helm of a 77-year-old iconic company in the midst of a global pandemic, as a female leader in a male-dominated business, makes the path a bit more perilous.

Massa Products Corporation is self-proclaimed as “the eyes and ears for naval ships and submarines,” founded by Frank Massa, who pioneered the field of electroacoustics. Today Massa engineers and manufactures sonar and ultrasonic products for use in the water and air, selling to commercial, industrial and military markets. At a glance, Massa is an engineering and invention company to its core. But once you dig deeper, it is far more, with the ability to discuss, design and manufacture products for disparate industries, cradle to grave, all centered on using an electroacoustical solution. Massa designs, develops, and manufactures new, and modified products, hundreds of transducers and systems that operate in fluid and gas at different frequencies spanning from 5 Hz to 500 kHz; used in various environments and applications including anti-collision, measurement, liquid level (C1D1 Hazardous and not), flow, anti-theft, web break, bowling scoring systems, active and passive sonars, and more.

“I’ve embraced fully the founder’s mentality,” said Stancavish. “Innovation is critical in this business. A lot of businesses that do sonar in the ocean don’t do the ultrasonics for air. And a lot of our competitors that do the ultrasonics in air don’t have the underwater experience and longevity or capability that we have. Embracing all of that and embracing the science of sound itself has been very important. A lot of people focus more on the electronic or the signal processing side; we focus on design and the construction of the transducers.”

Holistic is also an apt description for the way in which Massa Product helps to engineer solutions for its client’s needs, as it’s far more than simply developing technology for the sake of technology. “We also do the software and signal processing to different degrees and different appli-

cations, but understanding not just what the application is and what the desired results are, but to design the actual transducer to be able to achieve those results while minimizing the need for extra expensive or overly complicated electronics and software,” said Stancavish. “So we have a design system for new products – from transducers through electronics through software – designed to do what the customer really wants.”

This approach, in turn, has helped Massa maintain its competitive technological edge while helping it expand its own footprint in industries and applications where electroacoustics is not traditionally applied. “I haven’t run into a lot of other companies that have focused on the electroacoustics and the science of sound to advance the products. And the fact that we design engineer manufacturer all in-house, we’re not focused just on the innovation itself, but also how to make it so it’s mass producible.”

With a solid history and present, Stancavish now has her eyes trained on the future of her family’s company and the unique solutions it delivers. While unable to give explicit details of what’s in the works, she said “What I can say is that we’re pushing the boundaries of what’s possible with our technology. We’re creating some new designs for use in water, for use in air and in new applications where our technology isn’t currently seen. So over the next 10 to 20 years, it’s my goal to continue to grow the markets where our technology is possible and considered. Because right now there’s some few known spaces that ever everybody is in, but we’ve been learning a lot about some other spaces” where Massa can introduce or further expand its technological solutions.



# Blueprint Subsea

[www.blueprintsubsea.com](http://www.blueprintsubsea.com)

Blueprint Subseaspecializes in imaging sonars, acoustic positioning beacons and diver navigation systems. Its mission is to provide the subsea community with high-quality acoustic products at an affordable price.

Blueprint Subsea has been designing and manufacturing subsea acoustic sensors for the past 16 years. Since its modest beginning it has grown to a 35-person team and a portfolio of four comprehensive product lines selling to an international market. Its facilities house engineering, sales and production departments, and are equipped with a custom built acoustic test tank and pressure test chamber.

Blueprint Subsea's range of compact, robust, intuitive and affordable underwater acoustic products have been meeting the rigorous demands of the global subsea, offshore and defense markets since 2006. The company specializes in imaging so-

nar, acoustic positioning beacons and diver navigation systems. Products include:

- StarFishsidescan sonars: Designed for shallow waters; Single person deployment; ideal for survey work and Search And Rescue (SAR)
- Oculus multibeam imaging sonars: Single and dual-frequency models; Designed for ROVs and AUVs; Operating ranges up to 200m, depth ratings down to 4,000m
- SeaTrac USBL acoustic positioning systems: Real-time ROV, AUV and diver tracking
- Artemis diver navigation systems: Covert navigation, sonar imaging and acoustic communication; Ideal for Special Forces and Emergency Services Designed, manufactured, and tested in-house in the UK's Lake District, we deliver high-quality, low-cost, innovative solutions.

# Geoquip Marine

[www.geoquip-marine.com](http://www.geoquip-marine.com)

Offshore geotechnical data acquisition, analysis and reporting specialist Geoquip Marine has confirmed the expansion of its fleet with the addition of a further Integrated Geotechnical Survey Vessel (IGSV) the Geoquip Elena. Geoquip Elena is setup as a specialist deep-push Cone Penetration Testing (CPT) vessel and has been acquired to add vital capacity to the demand from offshore windfarm developers, especially in Europe and North America. Geoquip Elena is a 4000 ton IGSV, 91m in length and 19m in breadth. It was built at Vard-Brattvaag, Norway in 2002. Geoquip Elena is fitted with one of Geoquip's 200kN seabed CPT units, which can operate a range of seabed penetration test equipment. Once operational

on the seabed the CPT unit relays data to an operator on board in real-time where it is then processed. The 200kN system provides a continuous profile of tip resistance, sleeve friction and pore water pressure, which can be used for the derivation of shear strength in cohesive soils and the relative density of non-cohesive soils. The rig can reliably push to depths in excess of 40m and is therefore ideally suited for gathering data for the construction of foundations for offshore windfarms.

Geoquip Elena joins five other DP2 and four-point moored vessels in the company's fleet, which provide a highly versatile range of offshore geotechnical investigation services in all parts of the world.



## Boxfish Research

<https://www.boxfish.nz/>

In 2021, Boxfish Research launched Boxfish Luna, a drone for underwater cinematography and ARV-i, a new class of underwater observation vehicle developed in partnership with Transmark Subsea. Boxfish Luna is an underwater drone with a full frame 4K or 8K camera for professional cinematography and natural history filmmaking. Boxfish Research redesigned its ROV to integrate the advanced imaging of a Sony A7SIII camera and a new 200-mm precision optical dome to capture up to 8K video and 50MP digital stills underwater. Boxfish Luna is actively stabilized with six degrees of freedom of movement. Extending the underwater drone's depth capacity to 1000 meters (optional) means Boxfish Luna is also an excellent underwater vision solution for deep-sea research and cinematography. Additionally, the drone users can install up to eight accessories or sensors, such as sonars, USBL and grabbers, to facilitate scientific research and sample collection.



## HII's Hydroid's Remus 300

[www.hii.com](http://www.hii.com)

In the shallower water domain, but targeting similar modularity, flexibility and intelligence is HII's REMUS 300. First unveiled by Hydroid in 2020 (before its acquisition by HII), with a prototype for the U.S. Navy, HII's REMUS 300 is being delivered to customers, mostly in the military domain.

The 2.5m-long, 19cm-diameter dry hull-design vehicle is designed for work at up to 5 knots down to 300 m, with modular battery options allowing up to 10, 20 or 30 hours endurance. It has iXbluePhins C3 INS, Teledyne DVL and acoustic LBL aiding for navigation, plus side scan sonar, with a raft of optional payloads. It has a common operating system for interoperability with all other REMUS vehicles and an open-architecture and modularity to en-

able easy integration of hardware and software, with optional development kits to enable third-party integration, said Duane Fotheringham, president of the Unmanned Systems business group in HII's Mission Technologies division. It has sealed replaceable, modular sections that can be changed in damp environments in the field. "We can pull it on deck and in 10 minutes put in a new battery pack and send it on another mission," he says.

The navigation and electronics systems, once in the same pressure housing, are now so compact they have been split into separate modules, increasing modularity and the open architecture, while a data distribution system means new payloads can communicate with each other via a single BUS. But, in ad-

dition to modularity and flexibility, it's all about advanced autonomy. "We can now put a lot more processing power into the vehicles, which allows us to do edge processing, increasing the autonomous capabilities," said Fotheringham. "Some of the things we are working on include health monitoring and how to understand, in mission, something is not working properly and then complete that mission using ML to solve those problems.

If the side scan sonar fails, how to re-plan the mission to still get data. Automatic target detection and in mission sonar processing are the biggest changes we're seeing. Longer missions without a person in the loop and increasing the odds of mission success."





# Tritech

www.tritech.co.uk



Tritech provides the subsea industry with robust, reliable solutions for the harshest environments and most difficult applications. Our product portfolio consists of a suite of Mechanically Scanning and Multibeam Imaging sonar, profiling solutions and oceanographic bathymetric and depth sensing products. Tritech also sells navigation and tracking solutions for small subsea vehicles. We have three UK locations comprising a sales and support office in Aberdeen, design office in Edinburgh and a large manufacturing facility in Ulverston in England's Lake District.

Tritech recently released the Micron Gemini which is the smallest Multi-beam sonar in the world. The compact size and improved image makes the tiny sensor ideal for small ROVs and diver applications. The Micron Gemini also has a built in pressure sensor and optional AHRS.

*As this edition went to press it was announced that Tritech had been bought by General Oceans AS: an umbrella company specializing in underwater technology that includes Nortek, Reach Robotics and Strategic Robotic Systems.*

## DIGITAL VIDEO RECORDING & INSPECTION SYSTEMS

DEVELOPED FOR USE BY PERSONNEL WITH ALL LEVELS OF EXPERIENCE WHEN COMPLETING VISUAL INSPECTIONS ON SUBSEA STRUCTURES, WHICH REQUIRE REAL TIME EVENT LOGGING

- Standard Definition, High Definition or 4K digital video recording.
- Various formats 720p, 1080p & 2160p.
- Automatic Blackbox video recording.
- Digital overlay c/w variable transparent logos and fields.
- Full HD video stills and video clips.
- Real Time Event Logging.
- Automatic generation of Dive Video, Photo and Anomaly logs.
- Built in Inspection Editor to view all collected data and review overall inspection progress.
- Remote workpack generation and import tool.
- Four Serial communication inputs for logging and overlay display (i.e. GPS, Telemetry, CP).
- Four channel internal video switcher.
- Integrated digital video overlay.
- Configurable survey hot keys.
- Export JPEG video snapshots.

4K HD SD



4U RACK MOUNTED



THE EDGE DVR LAPTOP  
an industry first

DIVING WORKCLASS & INSPECTION ROV PLATFORM & PIPELINE INSPECTIONS CONSTRUCTION & DECOMMISSIONING

DIGITAL EDGE SUBSEA

www.digitaledgesubsea.com

## HYDROMEA



**SEND DATA  
WIRELESSLY UNDERWATER  
AT THE SPEED OF LIGHT**

**Data Rate** : 10 Mbps  
**Range** : 50 m  
**Depth Rating** : 6'000 m  
**Transparent Link** : no API required

**LUMA™**  
Wireless Optical  
Communication  
Modems

<https://hydromea.com>  
[sales@hydromea.com](mailto:sales@hydromea.com)

## Ocean Infinity

<https://oceaninfinity.com/>

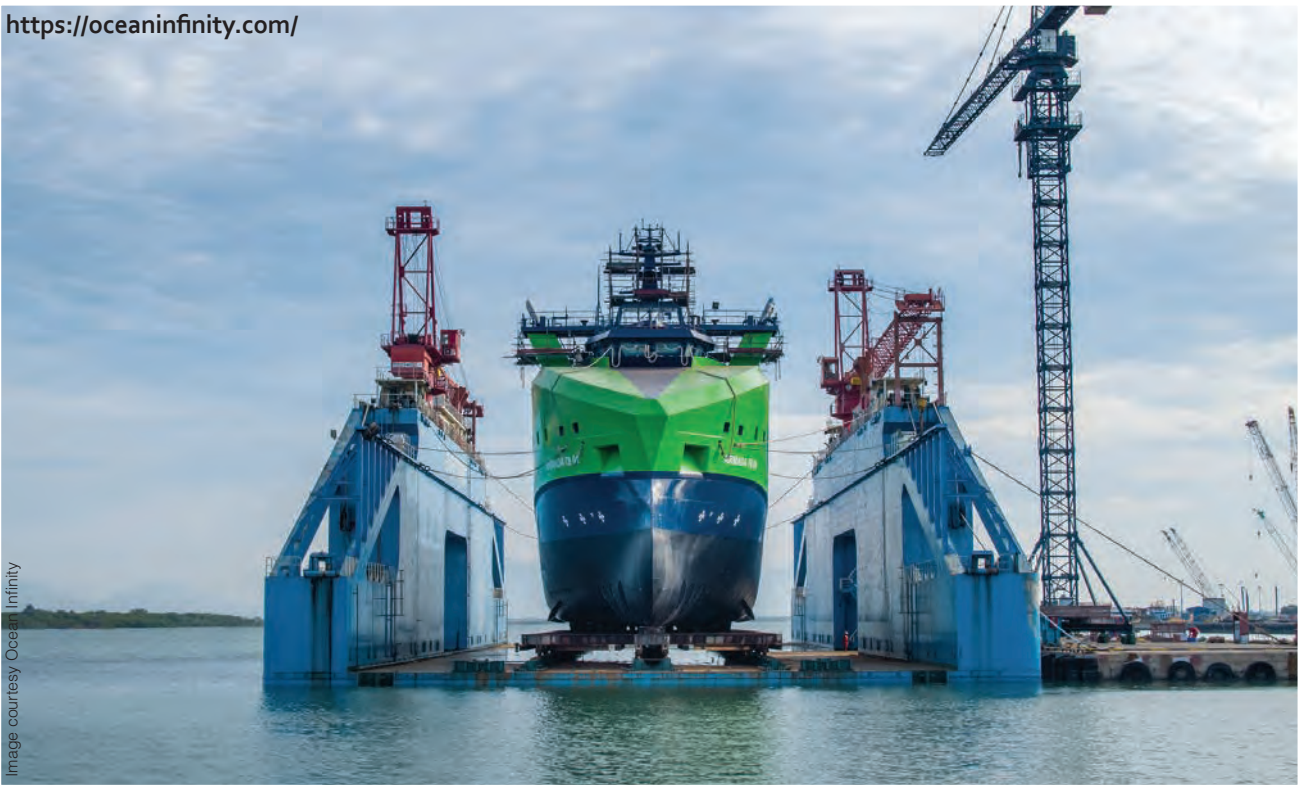


Image courtesy Ocean Infinity

Ocean Infinity is going even bigger with its emerging Armada Fleet. Ocean Infinity's first 78m vessel is undergoing commissioning and expected to start work early next year, initially targeting projects in European waters. This will be under a lean crew, which is expected to accompany it for at least a few years. Its first two, 21m vessels maybe out late this year/early next year. The second two 21m vessels will follow, followed by its 36m vessels. As well as greater fixed sensor payloads, these vessels will have capability to tow traditional side scan sonar and magnetometer sensors and host ROVs and AUVs, says Michael King, Sales and Business Development, Ocean Infinity. UAV support is also in the plan.

Shorter-term, the company has a fleet of 8m L3Harris C-Worker USVs and, following its acquisition of iXblue Australia, two DriX on order for delivery later this year.

Ocean Infinity's larger vessels are "a very different ball game", says King. "Once you've got those platforms in place you can use them for an awful lot of things," not least operating in deeper, harsher waters, but also for longer with fewer port calls. But the "whole robotics control and network infrastructure" is also critical.

Phil Hart, Survey Systems Integration Specialist, at Ocean Infinity, says it's enabling as much acquisition and processing work flow as possible to be done on the vessels, only transmitting small amounts of data for quality control in near real time to validate collected data specification and quality. It's also about using and share communications bandwidth smartly, so there's a hierarchy of control with navigation at the top, followed by dynamic things like ROV control.

"Once we have that really robust control infrastructure, we can cover the ship, as well as the subsea environment with ROVs and geophysical and hydrographic sensors," King says. "We can cover the aerial and topside environment with drones and laser scanning and bring that all into one operational solution, all monitored through one connection to the remote control centre, giving a complete holistic view of an offshore wind farm. That's what we're trying to achieve, but it's a long-term future goal."

Changing the way data is gathered and handled also opens up new ways of working and operating – from moving away from vessel chartering for a survey to cloud-based data processing and multi-client missions, adds Jones.

# Falmouth Scientific, Inc.

[www.falmouth.com](http://www.falmouth.com)

Falmouth Scientific, Inc. (FSI), a provider of sensor and survey solutions for applications in salt and fresh water environments, has a long and storied history intertwined with many other companies and innovators in the space. Celebrating its 33rd year in business, FSI's sensor-based standard product areas include advanced seismic, sub-bottom, and side scan sonar imaging systems; current, wave, and tide meters; electro-acoustic transducers; and acoustic relocation systems. At FSI's core is innovative system and design engineering, on-site assembly and production operations, and electrical, acoustic, environmental and system testing facilities.

FSI was founded in 1989 based on a WHOI technology licenses, and since its founding, the focus on FSI products and services has been on acoustic technologies over a variety of product segments.

As part of the focus on acoustic systems, FSI acquired Hegg Marine Solutions (HMS) in 2010 to establish a geophysical line of acoustic products. HMS was founded by Fred Hegg, Falmouth Scientific's current Vice President of Business Development. "We began to develop products under the brand of Hegg Marine Solutions, or HMS, now wholly owned by



Falmouth Scientific," said Hegg.

HMS is a brand under the FSI umbrella for sub-bottom and side scan sonar system technologies as well as field support services. The main products are the HMS-620 Bubble Gun family of seismic systems, The HMS-622 CHIRPceiverSubottom and the HMS-624 Sidescan. There is also a combined sidescan and sub-bottom available the HMS-6x5 in 2000m-6000m configurations. Most recently, Falmouth Scientific moved into a new custom 10,000 sq. ft. facility to provide an efficient manufacturing and engineering workspace to continue the manufacturing and engineering of acoustic sensors systems and transducers.

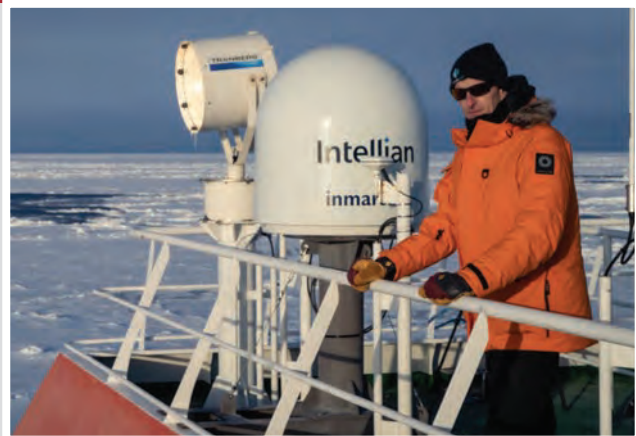
# Inmarsat

[www.inmarsat.com](http://www.inmarsat.com)

Powered by Inmarsat's Ka-band Global Xpress network, Fleet Xpress aims to offer seamless, global spot-beam coverage for consistent and reliable service with no drop-out at satellite handover. Unique, steerable beams provide additional, high-speed capacity where it is most needed, while back-up from FleetBroadband ensures 100% network availability adherence. These unparalleled capabilities make Fleet Xpress the connectivity solution of choice for a variety of specialised maritime applications, including remote and data-intensive research and subsea operations.

This year, Inmarsat has supported two major research projects in remote locations. In March, digital content agency Little Dot Studios broadcast the discovery of Antarctic explorer Sir Ernest Shackleton's lost ship, *Endurance*, from 3,000 metres below the surface of the Southern Ocean. Thanks to the high bandwidth and data speeds of Fleet Xpress, the live video delivered to online viewers and international media outlets was crisp and clear despite the significant data demands, the remote location and an elevation angle of just four degrees.

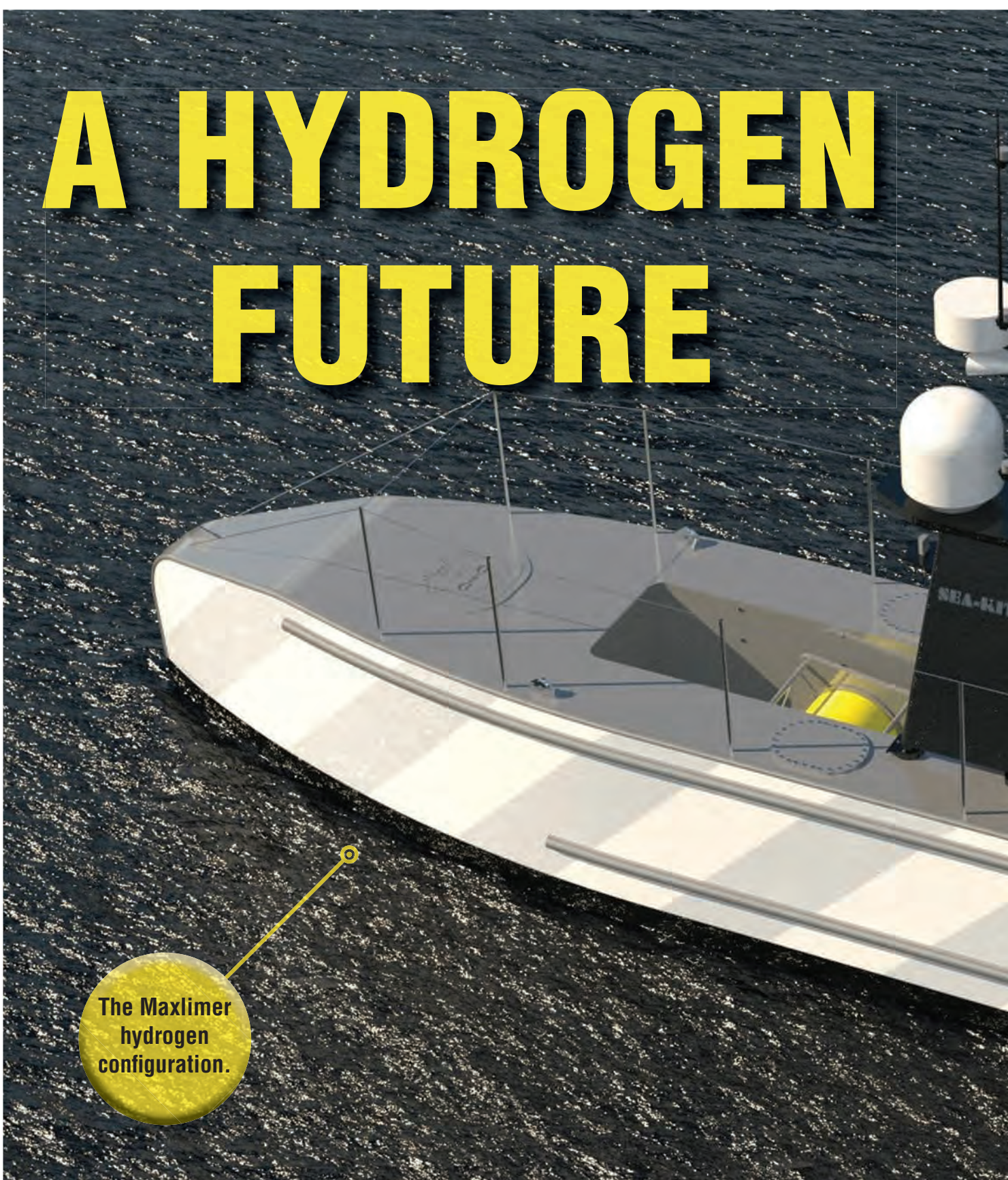
It is in a similar vein that Inmarsat Fleet Xpress is supporting OceanGate Expeditions' 2022 Titanic Survey Expedition, in which a multi-disciplinary team of scientists, maritime archaeologists and marine biologists embarked on the expedition to document the wreck, its archaeology and its marine



ecosystem for future generations. In what is Inmarsat's second year as satellite service provider to the Titanic Survey Expedition, Fleet Xpress is enabling OceanGate's crew to connect instantly with scientific and operational resources anywhere in the world and share important findings in real time.

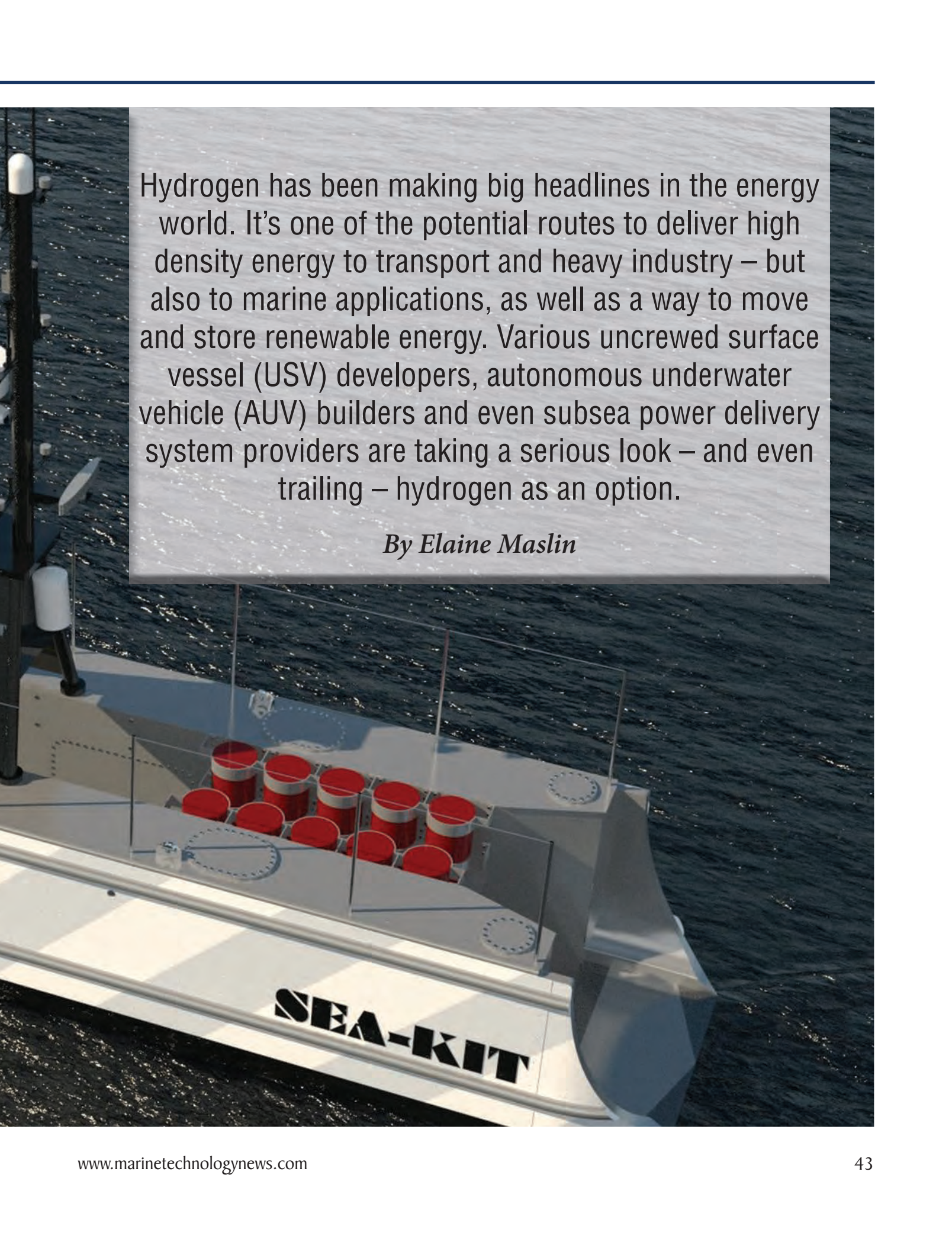
Building on this rich safety heritage, Inmarsat is due to launch two new multi-beam, high-throughput payloads in 2023. As the world's first mobile broadband satellites dedicated to the High North, GX10A and 10B will allow Fleet Xpress users to benefit from continuous connectivity – and therefore enhanced safety – while operating in remote polar waters.

# A HYDROGEN FUTURE



The Maxlimer  
hydrogen  
configuration.

Courtesy SEA-KIT International



Hydrogen has been making big headlines in the energy world. It's one of the potential routes to deliver high density energy to transport and heavy industry – but also to marine applications, as well as a way to move and store renewable energy. Various uncrewed surface vessel (USV) developers, autonomous underwater vehicle (AUV) builders and even subsea power delivery system providers are taking a serious look – and even trailing – hydrogen as an option.

*By Elaine Maslin*

## SEA-KIT

Two UK firms, SEA-KIT and ACUA Ocean are working on hydrogen power systems for their USVs. SEA-KIT, through the Clean Maritime Demonstration Competition funded by the UK's Department for Transport (DfT), is working on installing a PCB (printed circuit board) based hydrogen fuel cell, engineered by **Bramble Energy**, on its 12 m-long demonstration vessel Maxlimer USV. It's aiming for a demonstration by the end of the year, says Commercial Manager David Ball.

Currently, SEA-KIT USVs have a dual diesel-electric hybrid drive, with propulsion coming from an electric motor powered by battery banks that are charged by in-situ diesel generators. This project will replace one of the diesel generators with new

hydrogen fuel cell technology and demonstrate an offshore operation with zero carbon emissions.

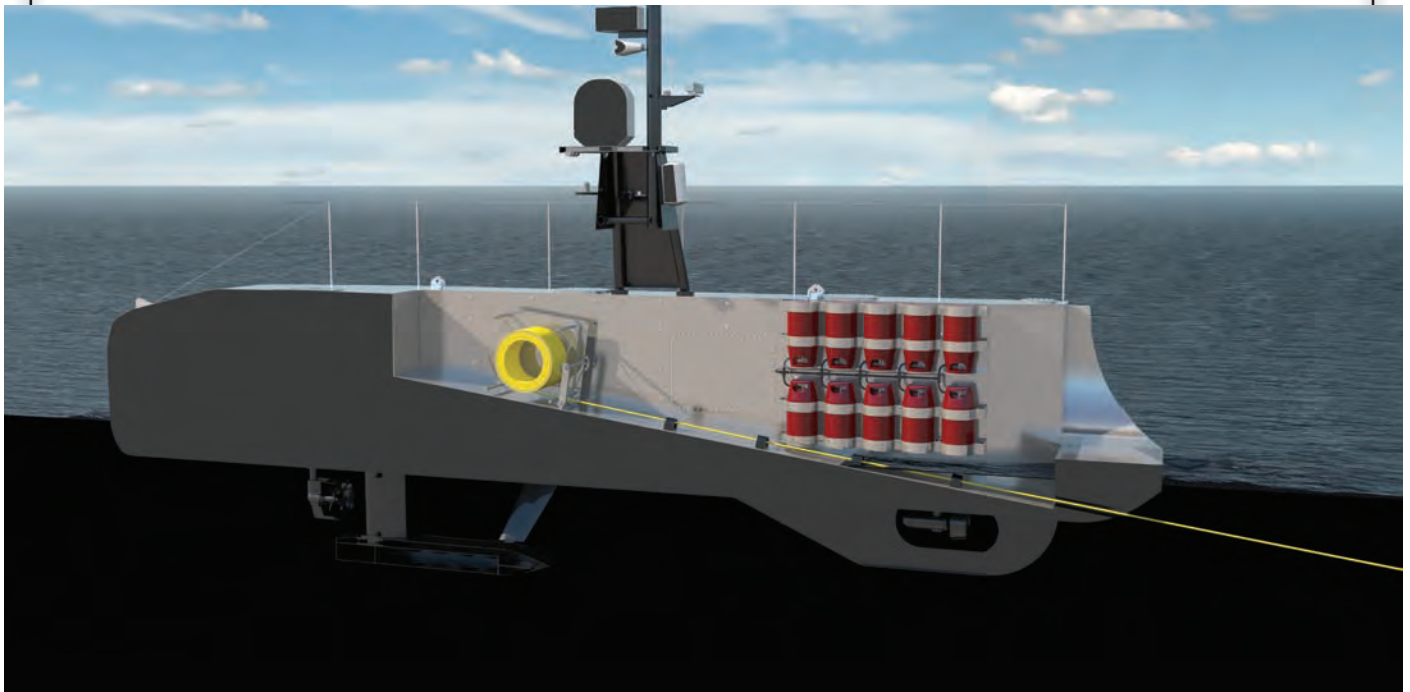
Bramble Energy, also based in the UK, is designing a marinized, customized version of its PCB fuel cell. The use of PCBs, as opposed to metallic or graphite end plates, makes the technology more suited to rugged, marine environments, says the firm. Bramble Energy's PCBFC system will sit inside an enclosure within the USV to prevent sea water ingress and corrosion.

The build is nearing completion at a newly built test facility at Bramble Energy. After successful bench testing and verification society inspection, it will be installed into the USV.

SEA-KIT says data from the bench testing and sea trials will be used for the design and build of similar USVs, as well as for larger uncrewed vessel builds.

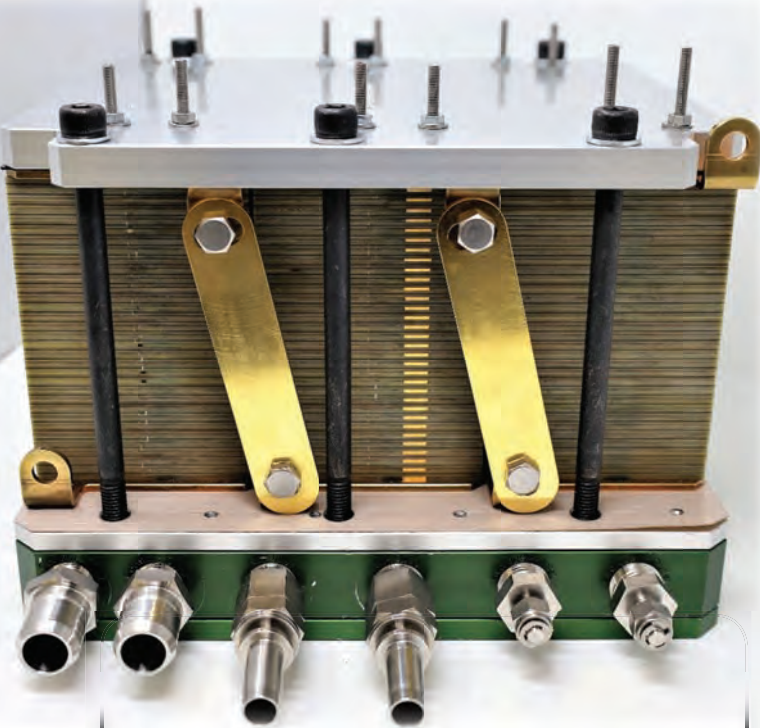


**Bramble Energy's PCB fuel cell, being developed for integration into SEA-KIT's Maxlimer.**



Courtesy SEA-KIT International

Courtesy Bramble Energy



**Bramble Energy Liquid Cooled Fuel Cell Stack.**

## ACUA OCEAN

ACUA Ocean has received DfT funding through Innovate UK to build a hydrogen powered USV (H-USV) for long endurance operations, as part of swarm operations at sea.

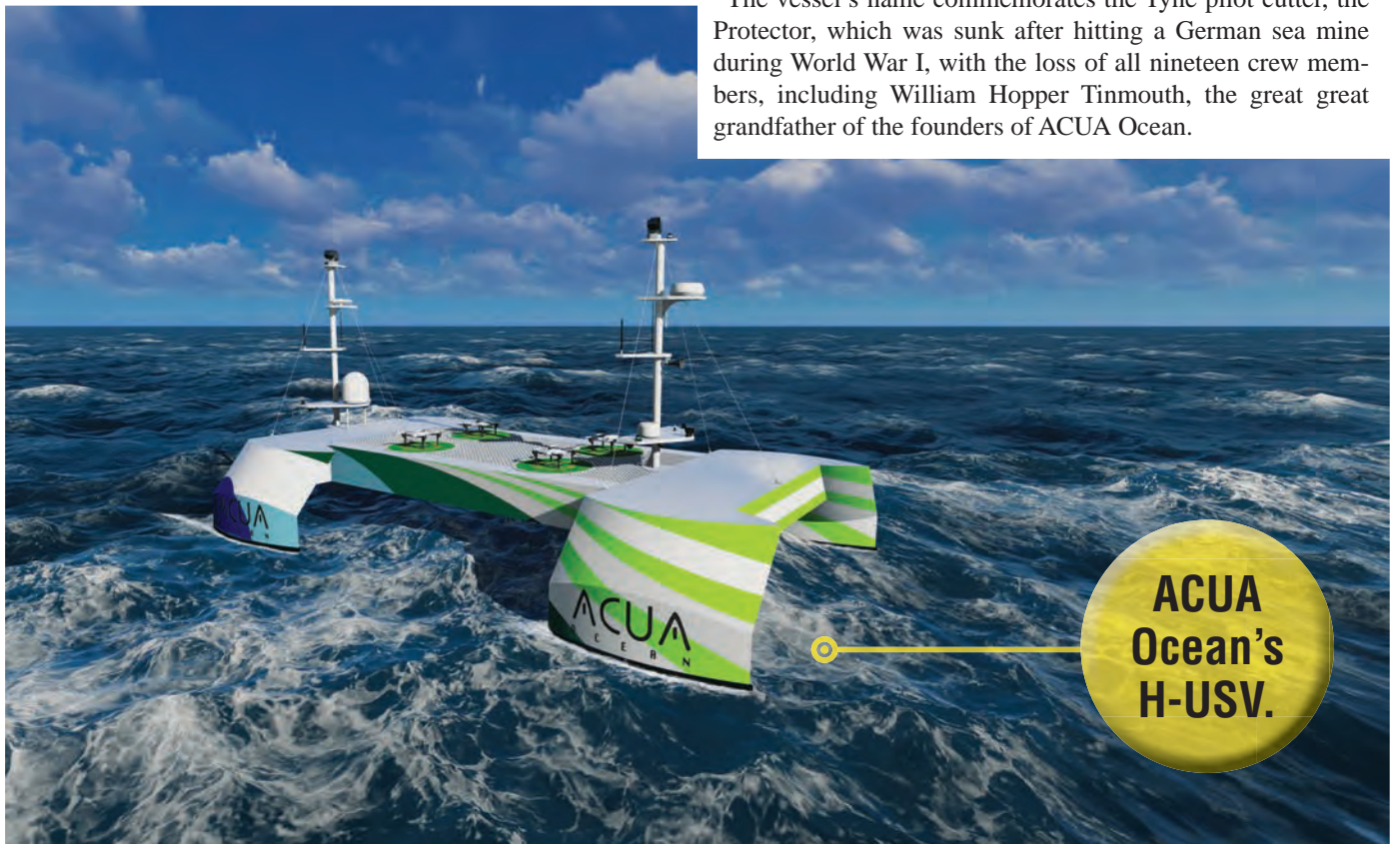
It completed work on the subsystems and has plans to launch a prototype to be named Ocean Protector and perform site acceptance testing in 2023, followed by swarm demonstrations in 2024 and swarm deployments in 2025. The vessel is being developed in collaboration with local naval architecture firm Ad Hoc Marine Designs and features a small waterplane area twin hull for stability (SWATH).

ACUA Ocean is targeting up to 60-day deployments while operating at four knots, though it says a peak speed of 18 knots can be achieved for monitoring and interceptions, using liquid hydrogen fuel capacity of 6,000 litres.

The ACUA Ocean design has received approval in principle (AIP) from classification society Lloyd's Register for its hydrogen system, its control engineering system, and its electrical power distribution systems, following the factory acceptance testing of the prototype systems undertaken in March this year.

The prototype is being built by a consortium of UK shipbuilders, with shipfitting and electrical outfitting contracts being awarded to Lowestoft-based firms SMS and Trident Marine Electrical, while the hydrogen fuel cell is being developed by Proton Motors.

The vessel's name commemorates the Tyne pilot cutter, the Protector, which was sunk after hitting a German sea mine during World War I, with the loss of all nineteen crew members, including William Hopper Tinmouth, the great great grandfather of the founders of ACUA Ocean.



Courtesy ACUA Ocean

## ENDURUNS

Over in Europe, combining hydrogen powered, long-endurance AUVs with hydrogen powered support USVs is the goal of the collaborative ENDURUNS project.

The consortium includes space, defense, marine and drone technology companies, universities, institutions, consultancies, a certification body and a port from Greece, the UK, Korea, Denmark, Italy, Spain, Switzerland, Lithuania, Belgium and Cyprus.

Their goal is a 5.5m-long, hydrogen fuel cell powered hybrid AUV, with a Li-ion battery for supplementary power, in case of failure or emergency, and energy management for the propulsion system and sensors.

It will be partnered with a USV that will follow the AUV at the surface to transmit data from the AUV to onshore, also allowing for mission parameters to be changed. According to the ENDURUNS website, it will also retrieve data

“from data bubbles” (pencil-like capsules containing SD cards) that can be ejected from the AUV when needed or in an emergency.

The prototype AUV, being developed at Graal Tech in Italy, with completion expected by Q1, 2023, is planned to have a glider mode, to conserve energy, using propelled mode when performing seabed surveys or inspection tasks.

The 8m-long prototype USV will be electrically powered using a combination of hydrogen PEM fuel cell, Li-ion battery and thin film solar cells. It will provide the required high-resolution geotagging data, mission maps and mission locations and will be able to dock and recharge the AUV's battery when its hydrogen has been exhausted.

This summer, the USV left the shipyard of Tuco Marine - ProZero Workboats in Denmark and arrived in Chania, Crete. There, it will have its systems, including instrumentation and the hydrogen PEM fuel cell, integrated, followed by testing over winter.

**The ENDURUNS AUV,  
being developed at  
Graal Tech.**



Courtesy ENDURUNS



## CELLULA ROBOTICS

Developing a hydrogen powered AUV has also been a goal for Canada's Cellula Robotics – and this summer it got its system into the water. Its goal is to get to 2,000 km endurance with its hydrogen fuel cell powered Solus-LR vehicle. Cellula's SeaWolf project, with the Australian navy (also called Solus XR), is even bigger (12m-long) and with more oxygen and hydrogen, and targeting 5,000km.

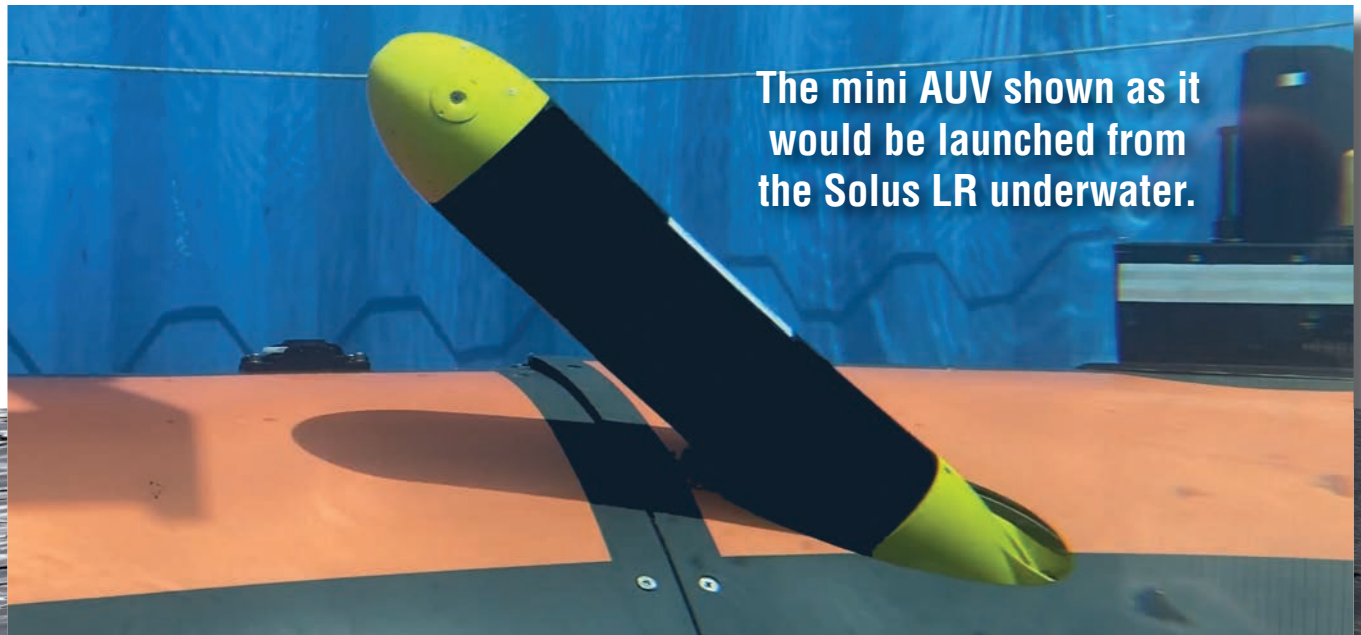
Earlier this year, the company performed its first endurance pool tests on its fuel cell. It ran for more than three days without any issues. Then, in July, it took its 8.5m-long Solus-LR vehicle, complete with integrated fuel cell capable of carrying

250 kWhr of energy, out for at-sea testing.

This involved two and a half weeks of testing in Vancouver's Indian Arm Inlet, including trailing deployment of two, 70cm-long (including antenna) micro-AUVs from the Solus-LR while submerged and underway, all powered by the fuel cell.

As fuel cells prefer steady state running, cycling between on and off and running hard was quite a stress test, says Alex Johnson, AUV Product Manager at Cellula. "It was very exciting and almost to the point where we didn't have to think about it anymore – it was just something that worked."

Cellula was then due to run a 24-hour endurance test, covering 130 km, in September (after going to press).



The mini AUV shown as it would be launched from the Solus LR underwater.

Cellula's Solus LR during trials this summer.

## TELEDYNE ENERGY SYSTEMS

To support underwater vehicle repowering, Teledyne Energy Systems has been developing a seabed Subsea Supercharger, based on PEM fuel cell technology. It's set to test this system with an AUV later this year.

The Subsea Supercharger system comprises of a fuel cell stack, product water management and the reactant (hydrogen and oxygen) supply. The system is configurable for more than 3 MWh of energy capacity, says Teledyne, and is designed to be deployed down to 1,000m water depth and provide up to 8 kW of steady state power.

Earlier this year, it worked with Innova to put its Subsea Supercharger through validation testing at the Norwegian Center for Offshore Education, Tau Autonomy Center a subsea testing facility not far from Stavanger, Norway.

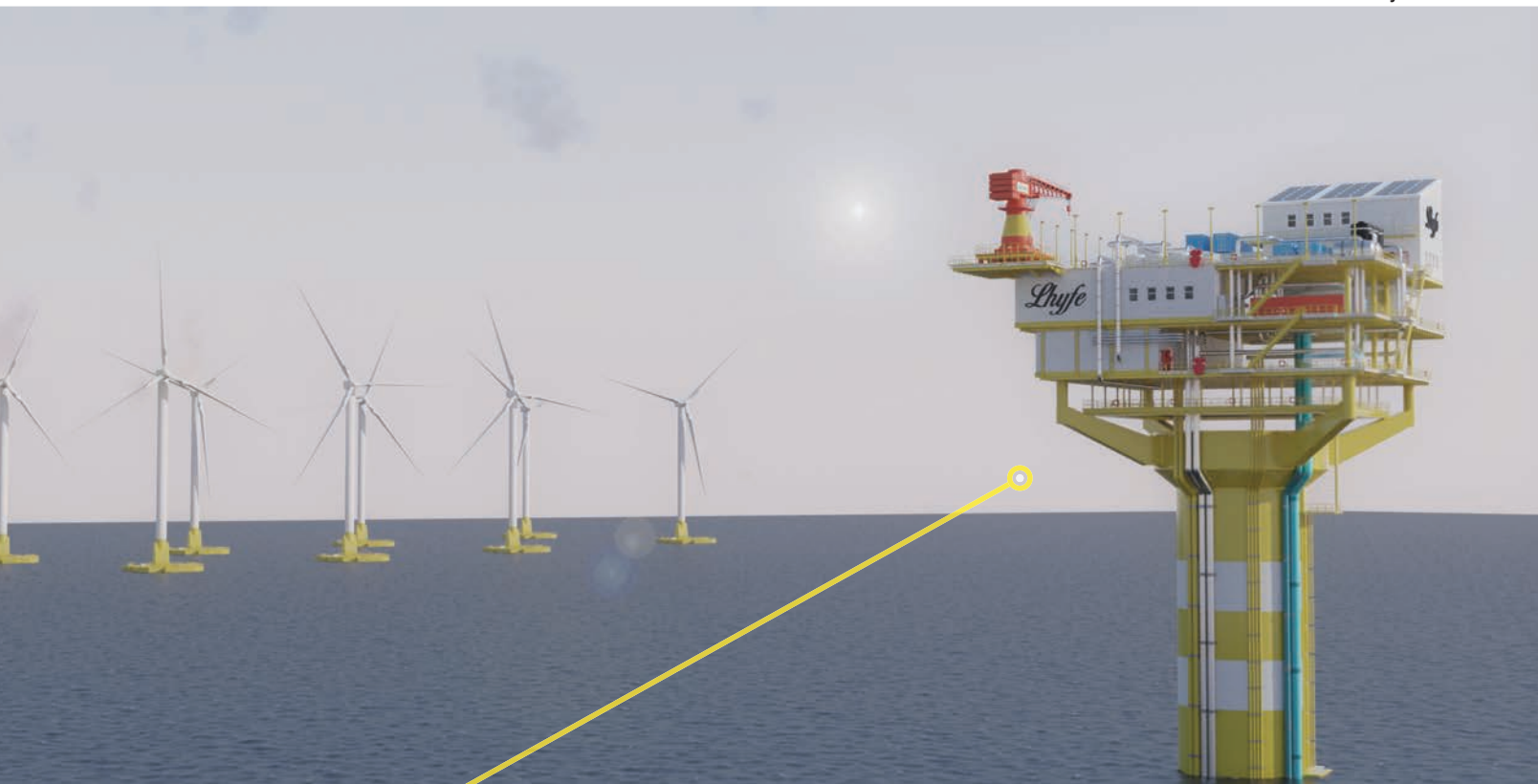
The validation tests in Tau included putting the system to use powering a subsea hydraulic pumping unit developed by Innova. "The two systems were integrated and successfully deployed to a depth of 235 m (770 ft) where subsea control fluid was pumped to a pressure of 180 bar (2,600 psi) for 30 minutes, six times a day," says Teledyne. "During the test, the Subsea Supercharger seamlessly transitioned from 'Sleep-mode' to 'On', in response to power demands from the pumping unit as it repeatedly cycled on and off," says Teledyne.

Teledyne Energy Systems said it's now planning a demo that will involve an AUV on a scientific mission in the Great Lakes region, in North America, docking with its Subsea Supercharger. This exercise will occur around November of 2022 and recharge the vehicle which will then be redeployed.

**Teledyne's Subsea Supercharger with Innova subsea hydraulic pumping unit, developed by Innova.**



Photo from Teledyne



**Lhyfe  
offshore  
electrolyzer**

**LHYFE**

Finally, it's ok supplying hydrogen to these fuel cells. But where does the hydrogen itself come from? French firm Lhyfe has developed a neat combination, using wave energy and electrolysis to produce renewable hydrogen offshore. It installed an electrolyzer on a hybrid renewable energy platform from GEPS Techno that was launched in late September at the SEM-REV demo site offshore Saint-Nazaire, France. It's looking to scale up, working with Chantiers de l'Atlantique to develop minimum 100MW capacity that could work alongside existing fixed or floating structures.



**HMS-620 BUBBLE GUN  
MARINE SEISMIC SYSTEM**



**APPLICATIONS**

- Shallow Gas Hazard Surveys
- Offshore Wind Turbine
- Geotechnical Investigation
- Sand Resource Investigation







*Wavelet  
Correlation > 0.96*

*Portable System Requires only  
2KW at 250ms Ping Rate*



60.96m / 200ft

Sand Reclamation Data Collected Using HMS-620  
Courtesy URI Graduate School of Oceanography

**Falmouth Scientific, Inc.**  
 Pocasset, MA USA 02559 • Tel: +1-508-564-7640 • Fax: +1-508-564-7643  
 sales@falmouth.com • www.falmouth.com

## EdgeTech

[www.edgetech.com](http://www.edgetech.com)

EdgeTech is known for its side scan sonars, sub-bottom profilers, bathymetry systems, deep sea acoustic releases, shallow water and long-life acoustic releases, ropeless fishing systems and USBL systems. In the beginning of 2022, the company began shipping the new 6205s2 combined bathymetry and side scan sonar system. The redesigned 6205s2 is more compact, lighter, and includes additional features and benefits including the options for an integrated INS, a higher resolution frequency pair of 850/1600 kHz, EdgeTech's gap-fill side scan output, and optional sub-bottom integration. The EdgeTech 6205s2 produces real time, high resolution, three dimensional maps of the seafloor while providing an enhanced and fully integrated swath bathymetry and dual frequency side scan sonar system. Also in the first half of 2022, EdgeTech rolled out the 2205 side scan nadir gap fill technology. The AUV-based 2205 system with gap-fill was designed specifically for hosted platforms operating in shallow water or within close proximity to the bottom. The new 2205 system is available in several dual and tri-frequency configurations and the gap fill technology is

available in a number of frequency options. The most popular frequency set, the 850kHz and 1600kHz dual frequency combination, is ideal for high resolution side scan sonar surveys where the nadir gap can now be filled with data while the vehicle performs single pass survey operations. Unique to EdgeTech's gap-fill solution is the ability to "see" the nadir gap from both the left and right sides, providing shadows from either direction, as well as in a 3D aspect in the nadir gap. Gap fill shadows are perpendicular to the vehicle's path and consistent with traditional side scan methods enabling easy interpretation of data.

Additionally, gap fill data in the 2205 system is coincident with the side scan data and is therefore geospatially the same, unlike other solutions that look forward and across the vehicle path making target positions between the side scan and gap fill data less robust.

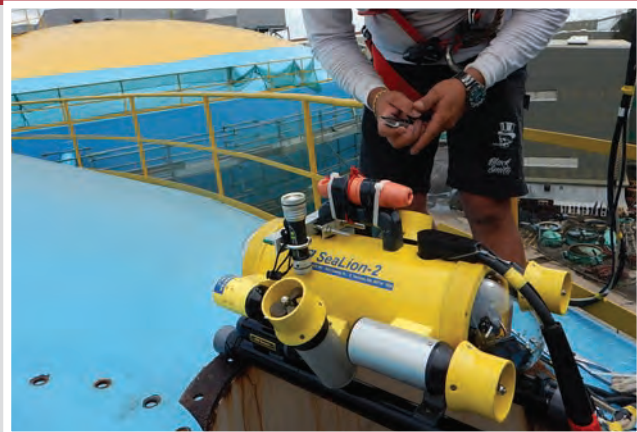
The area directly below the vehicle, until now often lacking in coverage, can now be viewed with the gap data mosaicked right into the main sidescan sonar display using SonarWiz.

## JW Fishers Mfg, Inc.

[www.jwfishers.com](http://www.jwfishers.com)

JW Fishers Mfg. was founded by the late Jack Fisher in the 1960's. The brand was founded on handheld underwater metal detectors, but quickly advanced into a full array of underwater search equipment. Today the line of product includes handheld and boat-towed metal detectors, magnetometers, underwater HD video systems, ROVs, sonar systems, acoustic pingers & receivers, pipe & cable trackers, a sub bottom profiler system and the Pulse 8X underwater metal detector.

JW Fishers designs/manufactures all of its underwater search systems at its factory in the USA. In 2022, the company introduced the 450/900 kHz Side Scan Sonar System. Building on over 30 years of sonar experience, CHIRP sonar offers the end user benefits over the conventional sonar such as longer-range operation and increased resolution. Fishers' new SONAR VIEW 2.0 software gives the operator complete control over the side scans operating parameters, ease of use and added features, while still allowing flexibility in scan ranges and color schemes. The main features of the updated software include increased touchscreen functionality, easier user interface and a modern feel. With included GPS positioning hardware, coordinates are automatically captured in the data. Move the mouse on a target, and position coordinates are displayed on the screen. Annotations can be added to images and stored. All files are stored in the industry standard XTF format for viewing and playback



Marc/Acebooks



# Tech Talk: The UMACK Anchor

CorPower Ocean, Maersk Supply Service and Dieseko have installed the first commercial-scale UMACK anchor to support the HiWave-5 demonstration project. The anchor has been installed 4km off the coast of Aguçadoura, in northern Portugal, where it will be used to anchor the CorPower C4 Wave Energy Converter, as part of the HiWave-5 project.

The UMACK technology is designed to provide a step-change improvement to the vertical holding capacity of pile-type anchors, touting reductions to cost and carbon footprints compared to both monopiles and gravity foundations.

“We installed the pile using a 500MU vibro-hammer supplied by Dieseko, supported by a heave-compensated crane on the Maersk Achiever vessel,” said CorPower Ocean Senior Engineer Ian Denton. “The installation method works by vibrating the anchor into the sea bed, offering a high speed, low-noise solution which minimizes impact on the marine environment.”

The UMACK anchor installed is 24m long, 1.6m diameter and weighs 43 tons, with an ultimate tensile capacity in excess of 15MN.

The Aguçadoura site will initially accommodate a single CorPower C4 WEC device, which later form part of a larger four-system array, and one of the world’s first grid-connected wave farms. The HiWave-5 Project ultimately aims to introduce certified and warrantied WEC products to the market. The Hiwave-5 project is funded by the Swedish Energy Agency and Portugal 2020 through AICEP Global and CCDR-N.



**Don't let your next repair project turn your budget upside down**

*"We fix ships!"*

**detyens.com**  
drydock@detyens.com

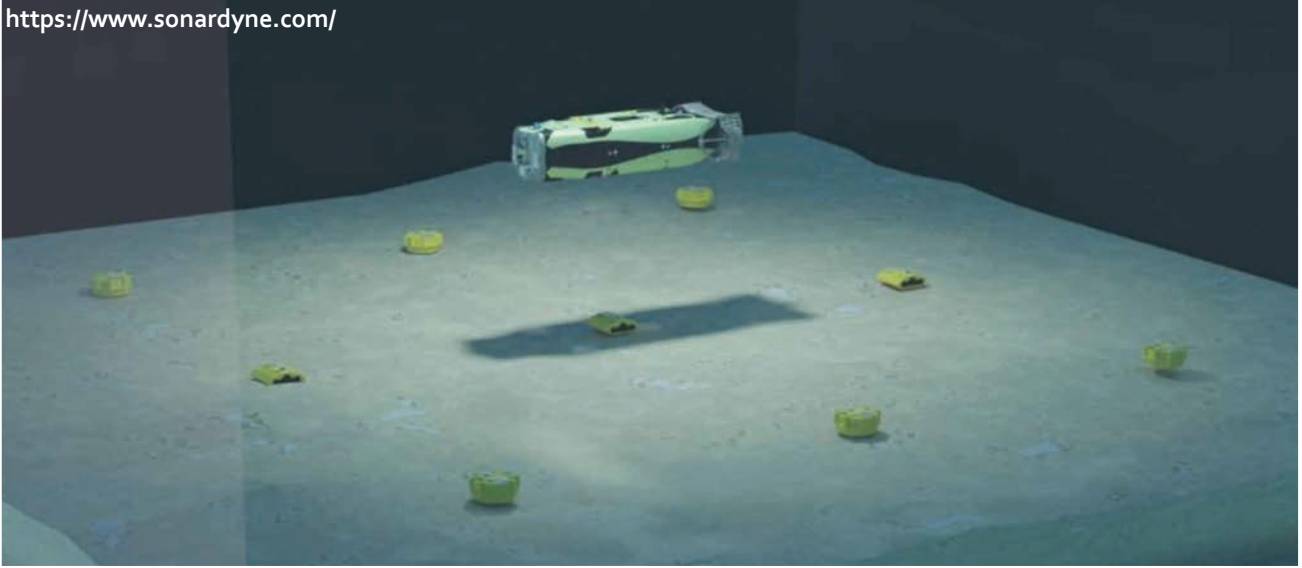
f t y i

Charleston, SC

**Detyens**  
Shipyards, Inc.

## Sonardyne

<https://www.sonardyne.com/>



Sonardyne works across acoustic, inertial, optical and sonar systems to solve the challenges that users of the ocean face, whether that's increasing marine autonomous system capability, interoperability and endurance or increasing sustainability by reducing reliance on crewed platforms.

Sonardyne has recently entered the latest phase of a first-of-a-kind project with Shell Brasil, Petrobras and Brazilian research institute SENAI CIMATEC. The project is focused on combining new, semi-permanent ocean bottom nodes that can acquire and then offload high resolution seismic data to an autonomous underwater vehicle (AUV) platform, with the help of Sonardyne technologies, including a variant of its high bandwidth optical communications, BlueComm. This will bring a step-change to 4D seismic data gathering in Brazil's deepwater pre-salt region, making it more sustainable and reducing cost and environmental footprint.

In the UK, Sonardyne has a strategic partnership with the University of Plymouth geared towards innovation within the UK's growing marine robotics and autonomous systems sector. This is leveraging the university's academic resources and research facilities with Sonardyne's COTS acoustic and inertial navigation technologies and access to the Smart Sound Plymouth marine robotics proving area.

Sonardyne's COTS and new technologies are also being developed in joint innovation projects with industry partners. For example, we worked with SEA-KIT and the UK's Defence and Security Accelerator (DASA) to ensure robust uncrewed surface vehicle (USV) navigation in challenging

environments using its SPRINT-Nav hybrid navigation instrument. Sonardyne is also working with the University of Southampton to develop new seafloor imaging capability for autonomous underwater vehicles (AUVs), through the 'BioCam' development, as well as collaborating with Newcastle University and Thales on a UK Defence Science and Technology Laboratory (Dstl) funded project to create a new waveform for secure communications between underwater naval assets.

Sonardyne has been working with Exeter-based USV innovator HydroSurv to develop rapid, seabed-to-shore data gathering capability for offshore wind operators. That project, supported by Innovate UK, brought together intelligent seafloor seafloor and vessel-mounted instruments with HydroSurv's REAV 40, satellite communications and cloud-based services; a combination demonstrated earlier this year to the developers of the Valorous floating offshore wind farm, in the UK's Celtic Sea.

Lastly, Sonardyne is also working directly with partners, including submersible manufacturer MSubs, to advance naval platform capabilities. This includes using Sonardyne's COTS navigation, communications and imaging payloads, such as SPRINT-Nav X, on MSubs' extra-large uncrewed underwater vehicles (XLUUV), as well as its Vigilant forward-looking sonar, developed by sister company Wavefront Systems and manufactured and commercialised by Sonardyne. Both technologies are helping to extend endurance and provide naval forces with enhanced situational awareness across the underwater battlespace.

# Kongsberg's new Hugin Edge

[www.kongsberg.com](http://www.kongsberg.com)

The Kongsberg HUGIN Edge made its debut earlier this year, and the Norwegian company is hoping to re-open the 1,000 m-rated AUV market with its new “autonomous by design” HUGIN Edge. The 4m-long vehicle, weighing just 300 kg and designed to work at 2-5 knots, is targeting those who want to go deep for up to 24-hours, but don't need to go 3,000m deep and don't necessarily want to have to be AUV experts to run it.

It's been designed to be operated with goal-based adaptive mission planning using AI and for ease of use from uncrewed surface vehicles (USVs), including autonomous launch and recovery and charging and data offload. Kongsberg hopes to deliver the first systems to customers by the end of 2023. The most distinctive feature is its design. This harks back to the first HUGIN design from the 1990s, which had a more Rankine-Carmichael hydrodynamic style, while also drawing on work Kongsberg is doing on naval strike missiles.

The early vehicle was very low drag and “super high efficiency,” but that efficiency was lost as soon as holes were cut in it for sensors or modular sections, he says. The new design, which has also had input from industrial designers (in a first for Kongsberg on the HUGIN), to give it its modern look, goes back to that hydrodynamic focus. To do this, it's had to go for a more fixed configuration.

Instead of the 120 kg EM240 multibeam echosounder, it's getting a 700-1400 kHz, survey grade Kongsberg Mesotech



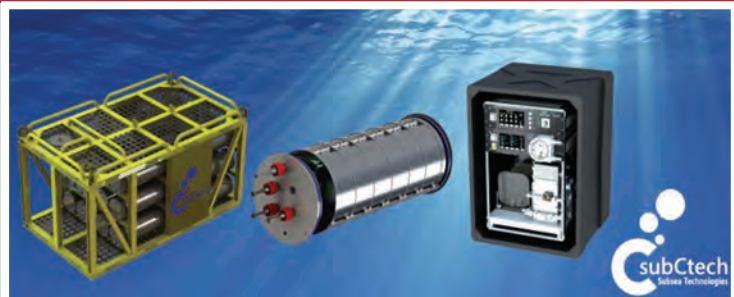
M3. It's getting a new Kongsberg synthetic aperture sonar, due to be released later this year. It'll also have a magnetometer and in the back of the vehicle there's a swappable sub-bottom profiler or camera. The HUGIN Edge is also getting a new Kongsberg forward looking sonar (FLS), which will also roll out across the HUGIN family of AUVs over time. This has wider horizontal coverage, out to 30 degrees, than the previous 7.5 degrees system used. This helps with contour smoothing and trajectory planning, including when traversing a slope or “crabbing”, to reduce the risk of heavy pitching that can cause gaps or smearing in data.

# SubCtech GmbH

[www.subctech.com](http://www.subctech.com)

SubCtech offers underwater power solutions and ocean monitoring systems. Li-ion batteries like PowerPacks, pCO<sub>2</sub> analyzers OceanPack and system solutions are our core products. SubCtech is certificated as a “proved vendor” in the offshore industry according to ISO 13628-6 and API17f for design and operation of subsea production systems and is also certified by ISO 9001:2015. Its engineers are educated and certified for highest-quality IPC-A-600/610 class 3 production and functional safety according IEC 61508 up to SIL-3.

The Li-ion PowerPacks and OceanPack measurement systems are used for scientific research and industrial monitoring of water quality and oceanographic parameters. Their unique technology, easy maintenance and construction built for rough ocean conditions make them perfect for any type of vessel or



platform. For example, the offshore oil and gas industry requires increasingly autonomous systems for greater and greater depths, like large energy storage systems. Projects in depths of up to 6000m are realized in the division of “Ocean Monitoring” with the adaptation of sensors for pCO<sub>2</sub>. The pCO<sub>2</sub> analyzers are used for maritime surveillance and research on buoys and ships.

## Ohmsett's 2.6m gallon Test Tank

<https://ohmsett.bsee.gov>

Ohmsett – The National Oil Spill Response Research & Renewable Energy Test Facility provides independent and objective performance testing. A realistic saltwater environment is essential to developing new technology for the marine industry. The outdoor wave and tow tank provide controlled, repeatable conditions to help validate engineering expectations and evaluate prototype designs under varying flow, position, and load conditions. Managed by the Bureau of Safety and Environmental Enforcement (BSEE) under a contract with Applied Research Associates, Inc. (ARA), it is the largest outdoor facility of its type in North America.

The most notable feature of the Ohmsett facility is the above-ground concrete test tank measuring 667 feet (203.3 meters) long by 65 feet (19.8 meters) wide by 8 feet (2.44 meters) deep and filled with 2.6 million gallons (9.8 million liters) of crystal-clear salt water. The wave generating capabilities include programmable formations that provide waves up to 3.28 feet (1.00 meters) amplitude suited for research and testing needs, along with a wave damping beach system. Sensors are positioned at several locations within the tank to monitor water depth and temperature to augment the environment database. A versatile data acquisition system is available to monitor customers' instrumentation, along with visual documentation by underwater cameras, webcams, and underwater viewing windows. During the recent 2021/2022 tank refurbishment and capital improvement project, the tank interior was resurfaced with a durable epoxy coating for concrete preservation and ease of cleaning, and restoration of three movable bridge systems. Tick marks and grid patterns were painted on the east wall of the tank to provide visual references during testing.



## RBR

<https://www.rbr-global.com>

Since 1973, RBR has been designing and manufacturing oceanographic instruments in Ottawa, Canada. From the ocean abyss to the polar ice caps, lakes, rivers, and coastal zones, RBR's sensors and loggers track water parameters including conductivity, temperature, depth, salinity, dissolved gasses, pH, and more.

RBR designs and manufactures high-precision oceanographic instruments and related systems. RBR's instruments can be configured to measure up to ten physical or biogeochemical parameters. Communication is available with USB-C as the standardized connector on every instrument, and Wi-Fi connectivity is available on every standard logger. All instruments run on standard, off-the-shelf batteries, have one cable that fits all, and have a single software tool to interface with all RBR instruments. Our low-power platform enables vertical profiling floats, such as Argo, and autonomous underwater vehicles, like ocean gliders, to sample more frequently or extend their mission duration. By increasing the sampling rate up to 32Hz, RBR instruments can be used for mixing studies and to resolve thin layers in the ocean. For system integrators, the RBR



loggers act as a 'sensor hub' to control and communicate with a suite of sensors (sound velocity, density, CTD, dissolved oxygen, turbidity, etc). The sensor hub approach improves operational efficiency by reducing redundant system integration efforts. This year, RBR introduced several new optical sensors, including a new series of PAR and narrow-band radiometers and compact loggers, and a new three-channel optical sensor, capable of making multiple fluorescence and backscatter measurements simultaneously. In addition to providing outstanding performance specifications, the sensors are designed with low power consumption, rugged packaging, and ease of use that users have come to expect from RBR.



# RTsys

<https://rtsys.eu/>

Specializing in underwater acoustics and robotics, RTsys deals with both civil and defense sectors with a focus on Anti Submarine Warfare (ASW) and Mine Counter Measures (MCM). RTsys manufactures ASW training targets, acoustic systems (PAM, sonar calibration and characterization, acoustic signature acquisition), and AUV and diver held sonar systems for EOD divers and Special Forces. Every RTsys device is run by SDA@ Technology (Synchronous Data Acquisition), allowing for high-computing capacities and low-energy consumption. RTsys' activity is divided into four areas of expertise: ASW systems, Manned and Unmanned systems for MCM, AUVs, and Passive Acoustic Monitoring systems for science and industry.

RTsys provides a real time acoustic monitoring buoy equipped with acoustic recorders, which analyzes data in real



time. Users on offshore wind farms, whether local regulators, planning boards or construction companies, are able to measure real time audio levels and carry out live monitoring when sound levels exceed regulation limits. The results are transmitted using 4G or Iridium to a specific internet platform developed by RTsys. This embedded algorithm is embedded on every RTsys underwater acoustic buoy.

# Saab Seaeeye

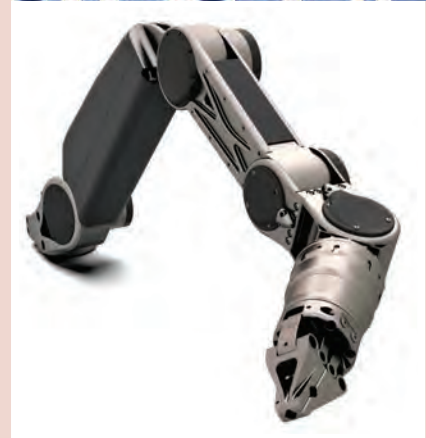
[www.saabseaeeye.com](http://www.saabseaeeye.com)

For more than 30 years Saab Seaeeye has built a reputation as a pioneer of underwater robotic technology that has led the industry by creating innovative solutions trusted to perform complex tasks in the most challenging environments on the planet. A wholly owned subsidiary of Saab, it has facilities in the UK and Sweden, along with substantial water tank and lake test facilities. Over 80% of its systems are exported to markets that span the globe with vehicles operating in more than 75 countries. The systems come in wide variety of siz-

es, power and tasking options, ranging from man-portable to deep-rated work systems and hybrid tethered/autonomous vehicles. Recently added is Seaeeye's pioneering new seven-function all-electric work-class manipulator. Intelligent control is at the core of our technology ecosystem providing a behavior-based modular network of distributed devices and software that enables real-time system control and feedback from the heart of every subsystem – and makes possible the ready adoption of new technologies.



**SAAB SEAEYE**



## Seaber

<https://seaber.fr/>

Seaber co-founder and CEO Vidal Teixeira said a problem for ocean science has been the high cost and difficulty of use of traditional AUV, a ‘problem’ Seaber aims to solve with its YUCO range of Micro AUVs. Seaber’s AUV is 12m diameter and 98cm to 123cm long, weighing up to 10.5kg and operable down to 300m water depth for 8-10 hours at 2-6 knots. They come in passive acoustic monitoring, CTD, AML multiparameter and side scan variants and are designed to be used by anyone via a simple web user interface (SEAPLAN) and handheld UHF locator (SEACOMM) with a ‘home’ button which triggers the vehicle to home in on that signal.

For navigation, with vehicles use Seaber’s INX (Intuitive Navigation eXperience) software that the company says works without needing external sensors, but can be used with a DVL to more accurate positioning.

YUCO-SCAN, the firm’s side scan sonar variant with Deep-vision 680 kHz side scan sonar and a Water Linked DVL costs under \$65,000.



## Copenhagen Subsea A/S

Copenhagen Subsea melds the technical with the aesthetic, creating products designed to be reliable, powerful and attractive. Copenhagen Subsea uses the latest manufacturing technology for its thruster and ROV technology; for example, they make diligent use of 3D printing for the propellers. Copenhagen Subsea offers a new powerful ROV, the Gorilla, which uses eight Copenhagen Subsea thrusters, designed to make it reliable and robust while keeping its position in strong currents and allowing for operation in harsh and demanding environments. The Gorilla ROV is equipped as standard with an intelligent Dynamic Positioning (DP) system, enabling automatic control of position, depth, altitude, heading, pitch and roll. The Gorilla ROV is based on industrial hardware from the Japanese industrial electronics company OMRON, built to handle extreme conditions such as high current inrush from the thruster during deceleration and current overload at fast shifting of the thruster direction.

## Seafloor Systems

<https://www.seafloorsystems.com/>

Seafloor Systems has been designing and building Unmanned Surface Vessels (USV's) for a decade. It has been expanding and evolving its fleet of USV options to accommodate complex multibeam sonar and similar payloads, adapting them for the needs of hydrographers for different survey applications, scenarios, and environments. Today, Seafloor Systems offer the HyDrone, Trident, EchoBoat and HydroCat lines of USVs. All are remote controlled and can also be fitted to operate autonomously with our AutoNav option. The AutoNav is integrated with standard navigation and data collection software packages, including HYPACK HYSWEEP, QPS, PDS2000, and Eiva. Seafloor's range of unmanned vehicles may not meet the requirements for every application. Its engineers can design and develop a custom solution, and we offer custom sensor integration for applications including hydrographic survey, security, MCM, Inspection, and Monitoring. Additional capabilities like Seafloor's Collision Avoidance Assist (CAA) system for unmanned survey vessels are



available, which includes an onboard computer, LiDAR, and 3D camera to navigate around both stationary and moving objects. Its point cloud 360-based system detects and tracks objects in real time within a standard 25m radius.

# Sea Machines

[www.sea-machines.com](http://www.sea-machines.com)

Sea Machines focuses on the development of autonomous command and control technology and long-range computer vision perception for the maritime industry by leveraging sensor expertise, artificial intelligence and machine learning.

The SM Series consists of the SM200 wireless remote helm, SM300 man in the loop autonomy and AI-ris computer vision sensor. The SM200 utilizes a wireless belt pack and joystick to enable remote-helm control from outside the wheelhouse, another vessel or shore, with 1,000 meters range. It provides real time vessel monitoring—including speed, positioning, heading, and alarms and allows for command and control of onboard payloads. The SM300 uses perception sensors, RADAR, AIS, IMU, depth transducer and video cameras and provides obstacle detection, dynamic path planning, and situational awareness via ENC-based GUI, tracker targets, video, and audio streams. AI-ris utilizes standard marine sensor and chart data fused with computer vision, autonomous control algorithms, and data driven MLAI models. It provides audible and visual alerts to crew and improves at-sea situational awareness, object identification and tracking capabilities.



# Sensor Technology Ltd

<https://sensortechcanada.com/>

Sensor Technology began in 1983 when founders Eswar and Shashi Prasad, transitioned Blue Mountain Pottery to hi-tech pottery called piezoceramics. In 1988, it moved from selling just ceramics to ceramics and hydrophones. In 2011, the owners of Sensor Technology took over. Sensor Technology is a manufacturer of piezoelectric ceramic solutions, custom acoustic transducers and custom hydrophones. Its Collingwood location is where it formulate the powder, produces its ceramics, and design its hydrophones and Transducers. Its Dartmouth facility is where it manufactures those hydrophones and Transducers. All formulations are made in-house and are proprietary to navy standards. Sensor Technology's focus for the past year has been evaluating its product line and making adaptations to accommodate the burgeoning uncrewed vehicles market. As vehicle manufacturers see their needs for customized payloads increase, it has been working together to supply miniaturized acoustic sensors to its partners for their unique missions. As part of its evaluation, the company are in the process of reviewing its offerings for hydrophone preamplifiers, with several high-performance options scheduled to be released this year. At its newly acquired Advanced Sonar Manufacturing facility, it is designing new systems electronics and firmware with manufacturing beginning in 2023.



## Silicon Sensing

[www.siliconsensing.com](http://www.siliconsensing.com)

Silicon Sensing Systems Ltd. is a market leader in silicon MEMS gyroscopes, accelerometers and inertial measurement systems, focusing on products delivering high performance, ultra-reliability and affordability. The company has supplied over 25 million MEMS sensors to thousands of customers worldwide and has a heritage in inertial sensing that can be traced back to the birth of the gyroscope over 100 years ago.

Silicon Sensing has a number of new products suited to the rigors of the maritime environment. The DMU41 is a 9 degrees of freedom (DoF) inertial measurement unit (IMU). Measuring 50x50x50mm and weighing 200g, its volume is 54% lower and weighs 42% less than its predecessor the DMU30. For those looking for a single axis gyro, the company's latest CRH03 high-performance/low-noise gyroscope consumes 30% less power than its predecessor and incorporates improvements in both micro electro-mechanical systems (MEMS) and electronics - with new drive electronics and improvements to the sensor head. CRH03 is available in five rate ranges, including a new option of 10 degrees per second. It is highly tolerant to external vibration, delivers excellent bias instability and angle random walk and can be delivered as a



packaged unit or an OEM item. For use in severe environments such as subsea downhole drilling, the company's new CRS39A upgrades the established CRS39 gyro. CRS39A includes a move to a single board from two, reducing the unit's mass by 40%. This allows far more easy installation in space-limited applications such as the 25mm diameter cylinders typically used in downhole drilling equipment. Supporting this latest generation of products is a family of established sensors and systems including the highly successful DMU11 IMU. Proven in maritime use, this 6 DoF IMU delivers complete motion sensing in three-dimensional space with performance calibrated over its full rated temperature range.

## Ocean Aero

<https://www.oceanaero.com/>

Ten years ago, Ocean Aero's unique hybrid sailboat-submarine was a novel idea being developed in a San Diego garage. Today, the company has a growing fleet of vehicles on the water and a \$14 million funding injection.

Ocean Aero's commercial offering is the Triton, a 4.4 m-long vehicle with a 3 m-high retractable wing sail and 1.5 m-deep keel. It has 200W solar panels embedded on the hull and a 4kWh lithium-ion battery to support underwater operations. On the surface, it operates as a sail boat, using wind for forward propulsion while charging its batteries. If there's bad weather, above sea state 5 for example, or it wants to avoid detection or gather data, it can then fold together and retract its wing sail into the hull and flood the hull to dive. Underwater, it has a ballast system to support dives down to 200 m. It can also use a dynamic buoyancy system to loiter or operate something like a glider, and/or its dual thrusters to navigate at up to 2kts. To return to sail mode, it returns to the surface, where a bilge pump type system pumps out the flooded hull to return it to a sail boat.

On the surface, they can run for months and months, but the



company typically recommends bringing them in every 90 days for routine maintenance and to remove marine growth.

Most of the Ocean Aero staff and management team have come in over the last two years to take the company forward as a commercial enterprise. A big part of that was a series C fund raise last year, which netted the company \$14 million. To underpin its growth, the company has also moved from San Diego to the Port of Gulfport, Mississippi, where it will again move into a 63,000 sq. ft. facility by the end of this year.



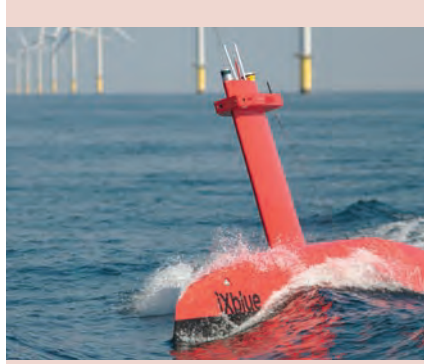
### SUBSEA EUROPE SERVICES

Germany's Subsea Europe Services sees an opportunity too, for fast, low-logistics specialist USVs, twinned with AI to be able to reduce the overheads and time involved in gathering survey data. Earlier this year, SES' acquired a 12 ft. Martac Mantas T12 USV – a fast, low-draft (7-in) craft popular in the defence community, which it has fitted with SES' integrated Hydrographic Survey System (iHSS), centred on a multibeam echosounder.

Initially, they're targeting nearshore cable landfall surveys, but see the opportunity to deploy from vessels of opportunity (from service vessels to crew transfer vessels – anything with a 500 kg crane – or even from transformer stations, where they could be recharged. For the German market, this could make operations easier, as USVs haven't been classified yet, so require guard vessels). For SES, a key aim is automating standardised tasks like depth of burial and scour monitoring could be more automated through use of AI, so data can be sourced faster but also with the need for fewer analysts.

Sören Themann, CEO, Subsea Europe Services says, "There are jobs so standardized today, it makes sense to start developing AI-based systems that targets those specialist applications, such as depth of burial and scour monitoring. These have very specific payloads with very clear specifications throughout the industry. Our job is to make it as autonomous as possible."

"We need one person responsible for 5-10 USVs, like an airport control," he says. "That's where we need to end up or it's not worthwhile."



### GRUPE GORGÉ ACQUIRES IXBLUE

French tech company Groupe Gorgé recently finalized its acquisition of iXblue. The deal brings together iXblue and ECA Group, creating a European high-tech industrial leader in the fields of robotics, maritime, navigation, aerospace and photonics. The two companies will benefit from a global workforce of 1,500 people and will achieve an annual turnover of \$250 million. Together, iXblue and ECA Group will provide customers with an offer ranging from components to complex systems to support critical missions in severe environments. Leading a long list of iXblue technologies is DriX, an 8m unmanned surface vehicle (USV) to conduct hydrographic surveys in order to map the oceans. Equipped with advanced sensors (radar, lidar, cameras) and its own artificial intelligence, DriX analyzes its environment, avoids obstacles and carries out its missions autonomously. The USV can autonomously map large areas in a reduced amount of time. Lighter than traditional vessels, and particularly hydrodynamic, DriX helps reduce hydrographic surveys' environmental footprint. Compared to traditional survey vessels, DriX decreases fuel consumption and greenhouse gas emissions by a factor of 50 and reduces radiated noise for greater respect of marine wildlife.



### REMOTE OCEAN SYSTEMS

Remote Ocean Systems (ROS) has been an industry leader in the design and manufacturing of reliable, high-tech equipment and systems for the most severe subsea, oceanographic, industrial, commercial and military environments since 1975.

Its product line includes underwater video cameras, underwater lights, rugged pan and tilt units and video inspection systems; manufactured primarily for the oceanographic, nuclear and defense industries.

ROS has developed two new leading technology products designed for deep ocean applications. The SeaStar is a high-powered, lightweight compact LED light that delivers 10,000 lumens output with full-range dimming capability. The SeaStar is completely Field Serviceable and available with flood or spot reflector options. It is depth rated to 6,000 meters. The Accu-positioner is a new ROS technology Pan & Tilt Positioner that features a reliable and rugged deep ocean design and computer-controlled accuracy to +/- 0.1 degree. The Accu-positioner is controlled with COTS controllers, devices and ROS GUI. It operates with zero backlash and is depth rated to 6000 meters.

ROS headquarters, a 28,000 sq. ft. research and manufacturing facility, is located in San Diego, California. This facility houses a modern machine shop, hydrostatic pressure test tank, electronics labs, advanced computer modeling and prototyping systems and environmental test chambers.

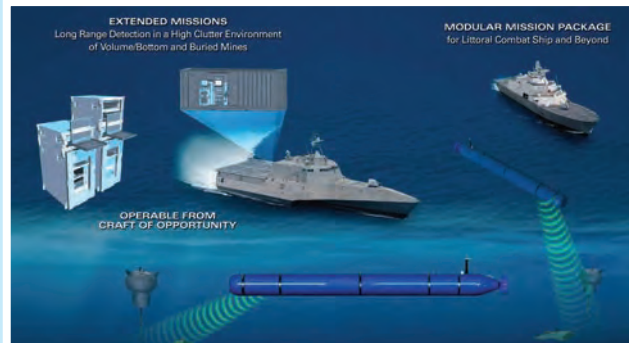


Marcus/AdobeStock

## Tech Talk: LFBB

The Naval Research Laboratory (NRL) in Washington, D.C. has developed Low-frequency broadband (LFBB), a technology area that exploits the structural acoustics involved with underwater sonar. According to Dr. Brian Houston, Acoustics Division Superintendent at NRL, LFBB can go beyond determining if something is there, it can also determine what it is.

“When you transmit sound, the acoustic return is very different depending on the physical object that is reflecting that acoustic energy. It might be a naturally occurring thing like a rock on the bottom, or something that’s man-made, like a mine. In the water column, it might be a submarine versus a whale. What’s in the acoustic return is very different for each of those targets. Sonar has traditionally helped us know where something is, how far a way it is, and sometime provides an image. But in addition to bearing and range, we can now determine what it is. That return has specific physics in it that we can exploit, and we can know something about the physical object and based on how it responds. Houston said LFBB is both a sensor approach as well as the methodical analysis of data. “We are now doing a lot of onboard processing, so we can take the data and process it on board the vehicle to enable au-



tonomy decision making,” he said.

The **General Dynamics Mission System Knifefish** 21-inch UUV uses the LFBB technology and is the only system currently available that is capable of detecting, classifying and identifying buried mines in a high-clutter environment. Knifefish is a program of record and part of the Littoral Combat Ship (LCS) Mine Countermeasures (MCM) Mission Package. According to a Navy statement, The Navy plans to procure 30 Knifefish systems--24 in support of LCS Mine Countermeasure Mission Packages and an additional six systems for deployment from vessels of opportunity.

## Teledyne Gavia's SeaRaptor

[www.teledynemarine.com](http://www.teledynemarine.com)

Targeted towards the traditional deepwater space is Teledyne Gavia's “survey-grade” SeaRaptor. This max 4 knot, 3,000m or 6,000m depth capable vehicle, with 50-60-hour range at 3 knots, was first unveiled in 2019, when a first delivery was made, Teledyne said at the time, with longer duration options now available. The flooded hull design vehicle is 6.8m-long and weighs 1.6 Mt. The modular design, with multiple pressure vessels for its control, navigation and electronics systems, etc., mean it's flexible in terms of sensor and (Kraken) battery configuration (“field-swappable”). The payload included EdgeTech side scan sonar or Kraken 120 MinSAS synthetic aperture sonar, Teledyne Reson T-50 multibeam and Benthos Chirp 3 sub bottom profiler, as well as CathX high resolution camera and laser and Teledyne BlueViewM450 Obstacle avoidance sonar. It can also be air-shipped in its component parts. Navigation includes INS and DVL, with acoustic aiding from Teledyne and third-party, with tracking using an acoustic modem out to 10km, and USBL or LBL.



# XOcean

[www.xocean.com](http://www.xocean.com)

XOCEAN was set up in 2019, performed its first offshore wind survey in 2020 at Greater Gabbard, and now has more than 170 staff. In 1H 2022, it's done 11,500 survey hours on offshore wind farms across 36 projects (some in the same wind farms) and seven jurisdictions. Early July, it was fitting out its 23rd 4.5m-long XO vehicle. Most of the work is multibeam, followed by sub-bottom profiling, for wide area surveys through to construction survey and routine surveys, e.g. scour monitoring, pre-jackup installation, array and export cable surveys in <100m water depth. It's hoovering up this data by scaling up its fleet and using multiple USVs on single projects, sharing surveyors across the fleet and doing more pre- and early processing on the boat, to reduce what needs to be done back onshore. For XOcean, it's all about innovating on data: how it's collected integrated, processed and delivered.



## Deep Ocean Engineering

Deep Ocean Engineering (DOE) has an electric, light work-class remotely operated underwater vehicle (ROV), the Phantom X8, designed for deep sea exploration and light intervention work. The vehicle is the largest and most heavy-duty ROV manufactured by DOE and packs a robust design for deep sea maneuverability and power. Configured with six vectored horizontal and two vertical 2.2 kW Tecnydyne brushless thrusters, the Phantom X8 has complete control and authority in any given direction, even in the toughest currents. For clarity underwater, the Phantom X8 boasts high definition (1080p) front (+/-90°) (pan optional) and rear (low light) cameras with 3 LED lights emitting 30,000 total Lumens with adjustable brightness controlled by the pilot control box or GUI.

[www.marinetechologynews.com](http://www.marinetechologynews.com)

## Ocean Engineering



OceanPack™ Underway



RACE



pCO<sub>2</sub> optical Analyzer

### pCO<sub>2</sub> Underway

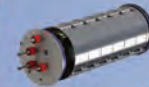
Modular, easy to use and reliable monitoring systems

### Li-Ion Batteries

Highly reliable, efficient and safe underwater power solutions



Li-Ion Batteries



Vehicle



Energy Storage System

SubCtech GmbH  
[www.subctech.com](http://www.subctech.com)  
[info@subctech.com](mailto:info@subctech.com)



## WEATHER WORKHORSES

INSTRUMENTATION ENGINEERED  
 AND BUILT FOR THE LONG HAUL



MARINE WIND MONITOR

**YOUNG**

[WWW.YOUNGUSA.COM](http://WWW.YOUNGUSA.COM)

MARINE WIND TRACKER

WIND • TEMPERATURE • PRESSURE • RELATIVE HUMIDITY • PRECIPITATION • VISIBILITY

## UKHO & the UK Center for Seabed Mapping

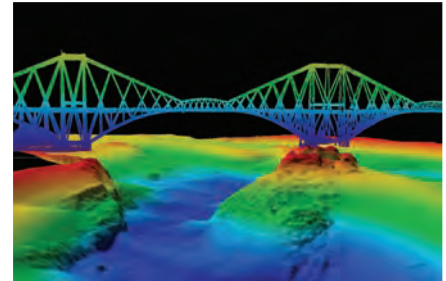
<https://www.admiralty.co.uk/uk-centre-for-seabed-mapping>

There are few more prestigious names in the world of hydrography than the UKHO, the world's largest center for hydrography. UKHO support a staff of 900 in Taunton, UK, with a small contingent in satellite offices in Singapore and Washington, DC. Its ADMIRALTY Maritime Data Solution product portfolio includes a series of around 18,000 electronic navigational charts which are carried by around 90% of the world's trading fleet, made available to mariners worldwide through a through a distribution network of 182 distribution offices. In addition, UKHO are the primary charting authority for just over 60 other nations

Various recent global initiatives have highlighted the importance of charting world's waterways to support the growing 'blue economy,' but there is a caveat. "It's fair to say that the interest in the understanding of the benefits of mapping the world seabed has definitely increased," said David Parker, Head of Hydrographic Programs, in an interview with MTR TV. "I think it's also fair to say though, that perhaps the funding, particularly from governments, to undertake that activity has not increased with that level of interest necessarily."

In early July, UKHO invited UK-based public organizations involved in seabed mapping who share common interests in optimizing the UK's national maritime assets to become

MARINE  
TECHNOLOGY  
TV



a member of the new UK Center for Seabed Mapping (UK CSM). Administered by the UKHO, UK CSM was submitted as a UK Government Voluntary Commitment to the United Nations at the UN Ocean Conference in Lisbon, Portugal in June 2022.

The UK CSM has a remit to increase the coverage, quality and access of seabed mapping data collected using public funds, as well as to better promote it as a critical component of national infrastructure. Created to spearhead a coordinated approach to the collection, management, and access of seabed mapping data – and to champion a more integrated marine geospatial sector in the UK – the UK CSM has established three initial working groups which members can join and contribute to: National Data Collaboration, International Data Collaboration, and Data Collection Standards.

## UTECH

[www.acteon.com](http://www.acteon.com)

UTECH provides a wide range of survey, positioning and data management services including site characterization, subsea positioning and construction support, dimensional control surveys, metocean, geophysical and AUV surveys, geotechnical sampling and consulting services, laser scanning, 3D modeling and iSite asset management portal, offering different levels of data interaction.

UTECH is a Geo-services brand in Acteon's Data and Robotics division. Acteon provides specialist engineering, services and technology to companies who develop and own marine infrastructure across the life of their assets.

UTECH and the wider Acteon Geo-services segment provides customers with geo-data that helps them to gain critical insights and make better-informed design and construction decisions. The company's marine surveys and site characterization services optimize the design and installation of marine structures. In 2012 UTECH developed its proprietary virtual asset management solution, iSite, which has since been used on over 100 projects globally, with over 3,000 external users. iSite allows customers to remotely manage any assets from

their desktop, driving down the cost of remote planning and communication. UTECH developed a bespoke inspection tool for an energy regulator to record on-going audit events across a wide range of assets and facilities, both onshore and offshore. The tool is designed to maintain a transparent database of findings to allow the identification and remediation of QHSE and integrity events, while providing the regulator 'real-time' progress, statistical analysis and reporting.

Development of a cloud based 4D visual management system for subsea survey data (e.g. seabed bathymetry, sub-bottom surveys, location of critical features etc) provided direct access to reportable events with user interrogation tools to provide an immersive way of interacting with large complex data.

In 2021 Acteon changed the way it operates by structuring its product- and service-line brands into strategic market segments. UTECH forms part of the Geo-services segment along with other Acteon brands Benthic and TerraSond.

UTECH has also recently invested in its remote services: processing, operations and monitoring. UTECH has developed a communications hub to provide the connectivity required.



# Valeport, Ltd

[www.valeport.co.uk](http://www.valeport.co.uk)

Valeport is a manufacturer of oceanographic and hydrographic instrumentation based in the UK that started by making instruments for measuring the speed of water in London's River Thames. Today, Valeport has a comprehensive portfolio of underwater measuring equipment and supplies a worldwide customer base including the environmental, research, defense, oil and gas, renewable energy, construction, port/harbor, dredging, civil engineering and scientific research sectors.

Valeport's key 2022 launches include a new integrated sensor suite, Bathy2, designed to meet customer bathymetric requirements for a reliable, accurate and robust instrument with functionality to suit specific operations up to 6,000m. An enhancement of the Midas BathyPack, Bathy2 uses state-of-the-art sensors to generate Sound Velocity and Density profiles for precision depth and height data. Bathy2 brings together the benefits of density corrected output directly from one instrument, alongside the flexibility of third party pressure sensor



input and Valeport interchangeable pressure modules to allow users enhanced accuracy at different depths. Additionally, the new SWiFTCTDplus Chlorophyll a is the latest in Valeport's range of SWiFT profilers and delivers enhanced accuracy and versatility for those requiring combined CTD measurements and fluorometry observations. It delivers survey-grade sensor technology coupled with Bluetooth wireless technology, rechargeable battery and an integral GPS module to geo-locate each profile.

# VideoRay, LLC

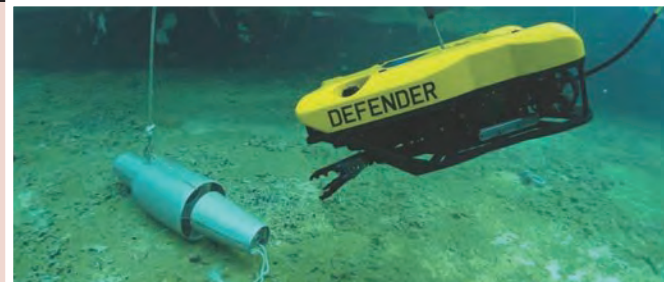
<https://videoray.com/>

Delivering its first ROV (remotely operated vehicle) system in 2000, VideoRay, LLC, is a manufacturer of underwater, portable, inspection-class underwater robots or ROVs. Its Mission Specialist systems are designed to integrate modular components, which enables maximum customization and real-time repairs while a mission is in progress and the implementation of the latest technology.

VideoRay's Mission Specialist Defender is the largest and most powerful configuration, optimized for precise control, heavier payloads, lifting and specialized operations. The Pro 5 system is designed for speed, efficiency and portability. Mission Specialist technology allows the addition of new sensors and tooling from a broad range of manufacturers, enabling it to accommodate a wide selection of power and communications options.

VideoRay is currently fulfilling a large and diverse order by the U.S. Navy for its Mission Specialist Defender systems. The Navy is standardizing on VideoRay Defender Mission Specialist systems due to superior capabilities, flexibility and upgradability of the large number of systems deployed since 2019. VideoRay's customer support for the Navy includes training facilities and personnel in Pottstown, Pennsylvania, and in San Diego.

Working with the U.S. Navy and several integration partners, VideoRay is developing innovative perception and autonomous technology for underwater robots. This technology helps keep vessels and personnel safe and out of harm's way



during explosive ordnance disposal (EOD) missions. Artificial intelligence (AI) technology also makes VideoRay's Mission Specialist systems easier to use. Perception technology can locate and identify objects before human operators can, saving time and money. Autonomous control adds vehicle control functionality by using sensor data to better understand and react to its environment. Autonomy is not only being applied to navigation tasks, but also complex intervention tasks including cleaning and manipulation. Autonomous and perceptive technologies have many commercial applications, and VideoRay is excited to bring these advances to its customers. The company will begin rolling out these new solutions over the next several months by introducing new Mission Specialist modules. The autonomy engine module is a subsea Edge processor that enables system control at the vehicle. Subsea vehicle batteries provide power at the vehicle instead of at the surface through the umbilical. This will enable the ROV to operate and "return home" if the umbilical is severed. This battery technology will enable tether-less ROV operations.

## Teledyne Marine: Technology Heart, ESG Soul

[www.teledynemarine.com](http://www.teledynemarine.com)

Teledyne Marine has evolved into an organization with 23 separate brands across the maritime, offshore energy, oceanography, defense, aquaculture, hydrography and water resources industries, and for this year's MTR100 we interviewed Dan Shropshire, VP, Marine Vehicles, Teledyne Marine.

Teledyne Marine is part of Teledyne Technologies Incorporated, an organization with an approximate market capitalization of \$16B. Teledyne Marine has evolved into an industry powerhouse, bringing Imaging, Instruments, Interconnect, Seismic, and Vehicle technology together to provide total solutions.

Like many leaders in the space, 'sustainability' has become a mantra that is helping to shape and re-shape Teledyne Marine and its many business units.

"(Sustainability) is front and center in our thinking about how we play in the larger sort of technology environment and what we're doing to advance technologies to address sustainability in the environment," said Shropshire. "As a whole, Teledyne Technologies has a goal of reducing our emissions by 40% by 2040."

Many of the company's sensors, "especially on the camera thermal imaging side," are used now for CO2 measurements, ozone measurements, and other types of measurements that are helping to understand the environment and the way the planet is changing over time. "Similarly in the ocean space here at the Teledyne Marine, and more specifically here in Falmouth, our gliders and our apex floats have contributed for years and years now to a better understanding of the way the ocean works" by being able to accurately measure and better understand the chemical make-up of the ocean.

Following in the footsteps of the aerial drone market, the sustainability mantra extends to and through the company's research and development, as today it focuses on delivering smaller, lighter sensors for small AUVs and ROVs, units able to deliver the same results as vehicle and sensor packages that are much longer, effectively helping to cut energy consumption at the vehicle and technology level. "So instead of having to get large surface ships to travel the world and use diesel power and gasoline and engine to get these items out into sea, we can use much smaller ships or RIBs or even electric powered ASVs to transport the units out into the water, resulting a smaller footprint to do the same job," said Shropshire.

New tech development and delivery is the core of any company in the ocean space – with energy efficiency, flexibility and durability leading a long 'to do' list. "We've had a number of advancements, especially in our AUV area. Looking at our Gavia AUVs, we've just developed a new 12-inch vehicle (the Osprey), which is a medium-size AUV for us that's going to enable us to carry new sensors, specifically synthetic aperture



sonars that are going to give higher resolution imagery of the bottom and longer duration mission," said Shropshire.

Another accomplishment is the completion of sea trials on its new SeaRaptor 6,000-m rated AUV for deepwater work, a vehicle pictured above and covered in greater depth on page 60 of this edition, a vehicle that will be deployed to, among other things, scout the seabed for marine mineral that can be harvested.

Looking outside of the vehicle group, Shropshire mentions the new Reson T51 sonar system, a system designed to produce higher resolution imagery and better data, but using even less energy than the T50 as the cumulative package has been engineered to be a much smaller footprint.

Another project Shropshire is keen to discuss is Teledyne Marine's involvement in the development of a ropeless fishing solution, a technology that has potential to dramatically impact 'sustainability' from a different angle: helping to keep the Right Whale from extinction. Today there are an estimated 400 Right Whales in the world, and their annual migration runs directly through the fertile fishing fields in U.S. Northeast. Rope is used widely, particularly in setting traps and for surface buoys to mark crab and lobster trap locations. These ropes, in turn, can create a serious entanglement problem for the Right Whales. Teledyne marine has been involved in a project with Smelts Technology and LobsterLift to advance ropeless fishing using acoustic modem technology.

"The general idea is that there's (a lobster or crab trap on the bottom) that includes an acoustic release or acoustic modem," said Shropshire. "When it's triggered acoustically from the surface or wirelessly from the boat, it either enables a lift bag, which is a CO2 cartridge enabled bag, that inflates and floats the trap to the surface, which then can be recovered. Or it pops open a door with a float in it that has a rope attached there and it pops to the surface, which can be grabbed immediately. So the rope's only in the water column for a very short period of time."

Shropshire that there are "hundreds of thousands of these traps worldwide, so the impact is pretty substantial."



Marc/Abbstock

# Tech Talk: Deep Divers



Credit: Rémy Jullife

Explorer Victor Vescovo, Founder of **Caladan Oceanic**, earlier this year completed what is touted as the first ever human descents to the deepest points of both the Yap and Palau trenches. The maximum depth recorded at the lowest point reached in the Yap Trench was 8,929 meters +/- 9 meters and in the Palau trench, 8,027 meters +/- 9 meters.

Victor Vescovo was joined by Master Navigator Sesario Sewralur of Micronesia for the Yap Trench dive and then Former President of Palau, Thomas Rememngesau for the Palau Trench dive – no human has ever previously visited the deepest points of these two trenches, and mechanical probes into them have been very rare. Both trenches were extensively mapped in detail by the expedition using their onboard multibeam sonar system prior to the dives to identify the deepest points and areas of interest to explore in the submersible.

The expedition was led by Rob McCallum and the team at **EYOS Expeditions**, and technical partners **Triton Submarines**.

This was the next leg of the Ring of Fire Part 2 (2022) expedition, to undertake extensive bathymetric mapping of the seafloor in the exploration area and collect samples at various depths of the trenches in cooperation with local scientific and other communities.

Dawn Wright, Chief Scientist at **Esri**, was the mission sonar specialist on the trek. Wright will release a series of maps and data from the dive on Esri's ArcGIS Living Atlas of the World, the foremost collection of geographic information – including maps, applications, and data layers – from around the world.

The lander deployments on these approved scientific dive expeditions collected samples for analysis by science experts Professor Sajmir Beqiraj of Tirana, Albania and Dr. Paige Maroni of the University of Western Australia to help further our knowledge of life in the deep ocean. All data and samples collected will be shared with the local communities as well as other international ocean research centers. Separately, the ship and team continued mapping the seafloor to support the GEBCO 2030 initiative to map the entire seafloor by the year 2030.

The crewed explorations of the two trenches yielded deep sea habitats similar to the Mariana Trench, but with slightly more wildlife given their slightly shallower depths. High vertical walls in both trenches were encountered where the Caroline tectonic plate is slowly being subducted (pushed lower) under the Philippine plate. At the Yap Trench, Vescovo and Sewralur ascended a deep ocean vertical wall over 1000 meters high in the submersible.

**Figure 1**

Schmidt Ocean Institute benthic lander is deployed from R/V Falkor for an operational test. Syntactic flotation high, integrated acoustic release low, and the expendable anchor weight suspended below the platform deck. The negative weight of the release is placed close to centerline for trim, and positioned low to act as a counterweight for stability. No instruments are mounted on the white marine grade HDPE frame. The anchor weight is rigged for recovery after the test.

# UNDERWATER RELEASES

*By Kevin Hardy, Global Ocean Design LLC*

“We can get anything to the bottom of the ocean,” quipped Don Walsh, Pilot #1 of Bathyscaphe Trieste. “The trick is getting it back.” A release is how we get our lander back. The anchor weight needs to be discarded, allowing the self-buoyant lander to float back to the surface. That’s the primary task of a release.

Releases serve other secondary purposes. They are used to initiate action such as deploying a drop arm, closing a water sampler or animal trap, or releasing a surface buoy or hydrophone string.

A clever at-sea adaptation of timer releases was reported by Scripps researchers Mantyla and Reid in 1977. Making measurements of salinity, oxygen and silicates in the Mariana Trench, they found the tapered wire rope on the hydrographic winch was of insufficient length to reach below 10km. Engineer Dave Muus proposed modifying a John Issacs “Monster Camera” free vehicle, a chain of components more like a short mooring than an ocean lander, to carry a string of Niskin bottles. A timer release of the messenger was set to occur 30 minutes after ETA on the seafloor. A second timer release was set to drop the anchor 10 minutes later. Dave rigged and deployed the free vehicle. It worked. Researchers found secondary benefits: the vehicle descended and rose twice as fast as the winch payout and inhaul, while the water samplers could be placed much closer to the bottom. They rigged and deployed a second time. It worked again.

Releases are available both as commercial products, and in-house customized solutions. They can be sorted into functional categories: Acoustic, Timer, Magnetic, Electrolytic, Galvanic, Fusible Link, Pressure, Melt and Dissolvable.

Expendable electrical release elements can be a burnwire (aka corrosive link, galvanic link) and fusible link or “flash wire”.

A release can be broken down into a handful of elements.

1. There’s the trigger that starts the release function, such as a countdown timer, acoustic command, bottom contact, or event sensor.
2. There is the load bearing release element. This could be a burnwire, a flash wire, a rotating thread, a rotating rod with a semicircular segment on the end, or a retracting plunger. This in turn may release a force multiplier, such as a lever or pelican hook.
3. There’s the power source, usually batteries, which could be supplemented by compressed air or squib gas generating cartridge.
4. There’s the housing, a sphere or cylinder.

## ACOUSTIC RELEASES

Today many commercial acoustic releases are available.

Most commercially available releases come as a fully integrated package, such as the EdgeTech 8242XS. The design allows the in-line load to be taken directly through the release housing. In-line tension is routed around the hydrophone by a heavy met-

al cage on the top. The cage also serves to protect the ceramic transducer from impact. The transducer is placed on top to provide a clear view to the surface for acoustic communication.

The release can be dualled with a second release, providing a back-up for critical functions, or paired with a strong back to substantially increase the load rating from 12,000-lbs to multiples higher. Typical lander anchor weights, however, are under 100-lbs, so the size, cost and weight are a little overkill. Some consider rotating shaft seals to be a weak point, though I’ve never seen those fail in the scores of sea trips I’ve been on.

The release also functions as a transponder, providing a ranging function. Anyone who’s been to sea will agree that’s another benefit: one ping means a lot when it’s coming from the bottom of the ocean.

Acoustic releases have an immense set of unique transmit/receive frequencies, command codes, and multiple frequencies to negate ambient noise fields, making them safe to use within acoustic range of each other. It’s wise to make a chart of manufacturers, release codes and frequencies then comparing those, especially if multiple groups are involved in a joint operation.

Acoustic releases are preferred for long term deployments, where the lander remains safely on the bottom until the ship returns. This allows for changes to ship schedules, bad weather, unexpected ship problems, crew health, plus Murphy and his prankster friends.

The top side part of an acoustic release is a matching deck communications box with overboard hydrophone.

Manufacturers of the integrated acoustic release design include:

### Applied Acoustics

[www.aatechnologiesgroup.com/applied-acoustics/](http://www.aatechnologiesgroup.com/applied-acoustics/)

**Desert Star Systems** [www.desertstar.com/page/arc-1xd](http://www.desertstar.com/page/arc-1xd)

**develogic GmbH** [www.develogic.de/products/flotation-and-mooring-frames/dw-release/](http://www.develogic.de/products/flotation-and-mooring-frames/dw-release/)

**EdgeTech** [www.edgetech.com/product-category/acoustic-releases-transponders-command-control-systems/](http://www.edgetech.com/product-category/acoustic-releases-transponders-command-control-systems/)

**iXblue** [www.ixblue.com/maritime/subsea-positioning/acoustic-releases/](http://www.ixblue.com/maritime/subsea-positioning/acoustic-releases/)

**Teledyne Benthos** [www.teledynemarine.com/acoustic-releases/](http://www.teledynemarine.com/acoustic-releases/)

**Sonardyne** [www.sonardyne.com/products/release-actuation/acoustic-release-transponders.html](http://www.sonardyne.com/products/release-actuation/acoustic-release-transponders.html)

**SubSeaSonics** [www.subseasonics.com](http://www.subseasonics.com)

## Figure 2

The EdgeTech 8242XS acoustic release.



Photo by Edgetech

Teledyne Benthos



**Figure 3**

Teledyne Benthos UTS-9500 Universal Topside, an acoustic release deck command unit and overboard hydrophone.

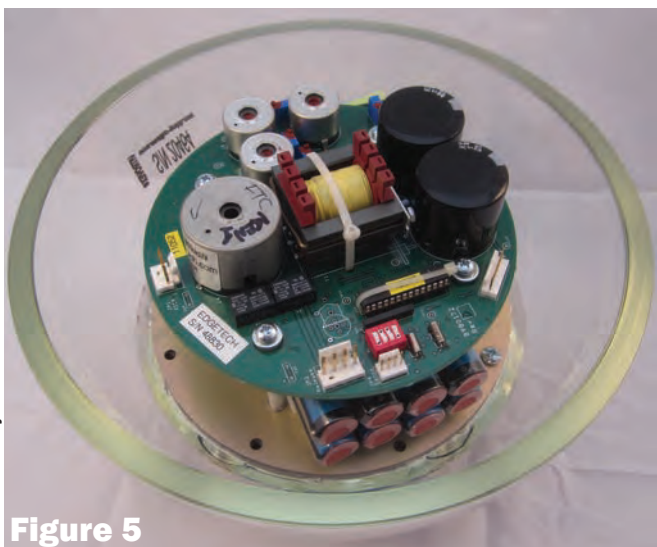
SubSeaSonics



**Figure 4**

The SubSeaSonics AR-60 acoustic release with deck command unit and overboard hydrophone.

Kevin Hardy



**Figure 5**

An EdgeTech circular BART board fits nicely inside a 10-in. Vitrovex glass sphere. The adaptation by Global Ocean Design has been used to 11km depth by multiple institutions.

Downsides include this type of release can be heavy, with a water weight of up to -62 lbs, limited to 6km (Benthos has a 12km version), and only a single release function. The air weight is 79-lbs, plus the weight of a 17” glass sphere to lift it (+57-lbs buoyancy, 51-lbs air weight), then add additional buoyancy, counterweights, scientific payload, and the frame to tie all together. The assembled weight of the lander on deck becomes something more than can be hand deployed, suggesting the larger release designs are better suited to moorings than small landers.

For shallow water, long term deployments, biofouling of the release mechanism can compromise a clean release. EdgeTech developed alternative release techniques including a “push-off” mechanism, where a threaded shaft unscrews a threaded link (PORT-LF) that holds the anchor weight, and a dual burnwire release (BRT-6000).

SubSeaSonics [www.subseasonics.com](http://www.subseasonics.com) offers a lightweight, low cost, 300m acoustic release, model AR-60. Anchor release is via electrolytic erosion of a burnwire with a maximum load release of 200 lb (91 kg).

The basic elements of an acoustic release can be dispersed to their optimum locations: load bearing element at the bottom, transducer at the top, electronics and batteries mid-body, all connected by underwater electrical cables.

One favorite of solution of mine is to house an EdgeTech circular BART (Burnwire Acoustic Release Transponder) board with dual burnwire release inside a Nautilus Marine Service Vitrovex glass sphere. It’ll easily fit in a 10” sphere, rated for 10km. A thick wall 13” or 17” sphere will provide full ocean trench rating, and more buoyancy. The LF (low frequency) transducers provides stable communication to the deepest ocean depths. This adaptation provides access to 4 additional BART commands, including two additional burnwires, plus two toggle-on/toggle-off control lines in a buoyant housing.

## TIMER RELEASE

A countdown timer is programmed for a predetermined time-until-release (TUR). The hours and minutes are calculated from a specific start time until the release function should begin. Carefully calculate elapsed time, and make good log entries of expected release time, programmed elapsed time, and actual start time. Smartphone pictures will help. Add 10 minutes for the burnwire corrosion, plus 1m/sec rise time for an approximate time when the lander will break the surface.

The SubSeaSonics TR-45 is the only commercially available underwater timer release I am aware of. The release unit contains a microcomputer and batteries. It has a replaceable burnwire link with a screw-on retainer cap.

System advantages include low cost, up to 170 days of deployment, and the ability to program the timer without opening the case. The system is limited to 180m depth, and its

single strand burnwires look to be sensitive to sideloading and torque. Global Ocean Design adapted the SSS timer to retain the best features, adding the capability of charging through the endcap, increasing the power for heavier burnwires, and using spherical or cylindrical housings for up to full ocean depth. A single high-power TR-45 is available in a 7075 Al housing rated for 11km.

## MAGNETIC RELEASE

A clever magnetic release uses two disks with embedded sets of neodymium magnets, arranged N-S-N-S. The concentric plates attract in one position, then one rotates 90° to repel the other. The design was successfully implemented by Victor Villagrán, University of Concepción, Chile.

Recall the Trieste used iron shot and an electromagnet for a release. That design takes continuous power, but perhaps the iron core of the electromagnet will attract a neodymium magnet until the moment it is energized. Be fun to try.

An electromechanical solenoid is a form of magnetic release, used successfully in the deep ocean since the 1960's with Frank Snodgrass at Scripps. They can be susceptible to biofouling at shallow depths, but should work to hadal depths as the coil is potted or oil filled, and the iron shaft is free floating with the coil.

## ELECTROLYTIC RELEASE

### Burnwires

A "burnwire" doesn't really burn, it's an electroplating process. Metal is extracted from the anode (burnwire) and plated onto the cathode. In practice, a waterfall of rust flows out of the burnwire, cascading downward. A burnwire provides tremendous mechanical advantage, holding hundreds of pounds, but corrodes with as little as 5 vdc. Higher power systems run 10-21vdc. An in-line burnwire has no moving parts, and is inherently reliable.

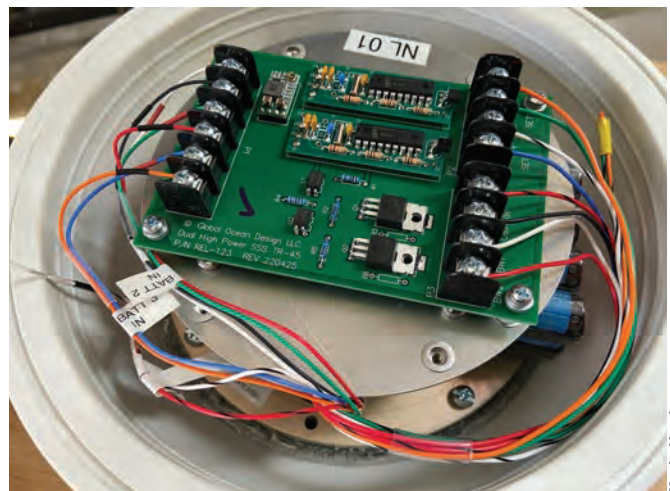
The simplest burnwire release I ever made was three parts: a 9.6v NiMH battery with the positive terminal tied to the burnwire (think "sacrificial anode") and the negative terminal tied to a cathode (think "cathodic protection"). The switch was the air gap. I had to pull the suspended anchor weight into the interior of a lander for deployment, then have it drop out and suspend below the lander before it reached the bottom. As soon as the lander hit the water, that burnwire started. The scheme worked.

Burnwires can be expensive, but lack of practice or training can be more so. Experience provides confidence and competence. A simple solution is to make "training burnwires". These are a 12" length of jacketed stainless steel wire rope (JWR), one end stripped about 3/8" for electrical connection, the other end sealed with a layer of marine grade heat shrink, overhanging and pinched flat on the end to seal it. The



**Figure 6**  
The SubSeaSonics TR-45 Timer Release with on-deck programmer.

SubSeaSonics



**Figure 7**  
The modified twin SubSeaSonics TR-45 timer boards provide a dual high-power release in this adaptation by Global Ocean Design.

Kevin Hardy



**Figure 8**  
A 100-hour scientific countdown timer is adapted for a time release. The 1.5vdc signal that powers the beeper is used as the gate input to a SCR. The 9.6vdc NiMH battery pack supplies power to a burnwire. Similar timers in 7075 aluminum housings have been used to the bottom of the Kermadec and Tonga Trenches.

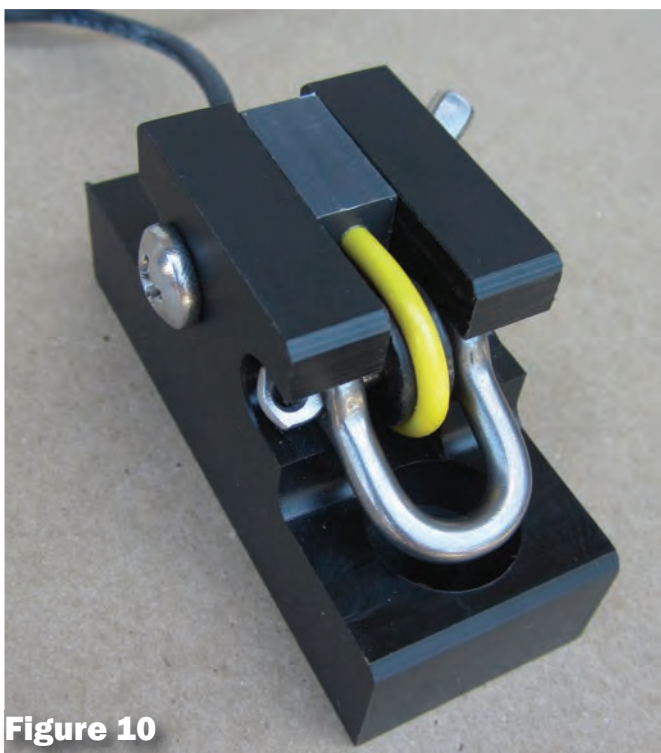
Kevin Hardy



**Figure 9**

A Global Ocean Design REL-238 burnwire. The Delrin spool maintains the minimum wire rope bend radius. The exposed wire rope is just behind the shackle.

Kevin Hardy



**Figure 10**

The Global Ocean Design burnwire mount with burnwire. The burnwire is kept from rotating and protected from side loading. On release, the shackle pulls straight out the bottom. The burnwire mount also fits the EdgeTech burnwire, both single and double strand.

Kevin Hardy

center of a heavy steel hex nut, like a 3/4-16 thread, is filled with 5-minute epoxy. After the epoxy sets, drill a center hole through the epoxy that is larger than the JWR OD, but smaller than the OD of the heat shrink. Then slip the nut on the JWR from the stripped end.

It should rest on the marine grade heat shrink. Add another layer of heat shrink if needed. Mark a spot on the JWR about 1/2" above the hex nut. Remove the hex nut and strip a narrow gap 1/8" wide around the JWR, exposing the SS wire beneath. Replace the hex nut weight. The training burnwire can be suspended in a bucket of seawater until the 1/8" gap is fully immersed.

The JWR can then be taped or clipped to a cross bar spanning the bucket. The stripped end is connected to the burnwire terminal of the release. A stainless-steel welding rod, placed in the bucket as a cathode, is connected to the cathode terminal of the release.

Single strand burnwires are more prone to work hardening from sideloading and torque than multistrand wire rope. This may cause the wire to break and drop the anchor at an unplanned time, so restraining those elements with a mount is important.

A burnwire must be mechanically connected to, but electrically isolated from, the steel drop chain.

If a burnwire is electrically connected to a steel drop chain, electrical power intended for the burnwire will be wasted as it attempts to corrode the length of chain. Whether made commercially or in-house, it's good practice to perform a simple load test to be certain there are no fabrication flaws that would compromise performance. Shackled end-to-end, several can be tested at once, hanging from a freestanding ladder, using a bucket of sand as the load. Some manufacturers do this before shipment.

Another handy design rule is there is no practical limit to the distance between the anode and the cathode. I've placed burnwires 15-ft from the cathode without problem.

## GALVANIC TIMED RELEASE

- International Fishing Devices US <<https://www.underseareleases.com/techspecs.htm>>

- Ocean Appliances AU <<https://oceanappliances.com.au/>>

Galvanic Time Releases (GTR) are driven by the potential difference between dissimilar materials in seawater, in this case anode grade zinc and stainless steel.

The Galvanic Timed Release has only three components: two cathodes and one anode. When the GTR is placed in an electrolyte such as seawater the cathodes, a more noble metal, cause the cylinder of less noble metal to electrochemically disintegrate.

The simplicity of the design makes them very inexpensive: about \$3 each.

International Fishing Devices advertises a standard accuracy of +/- 2.5% of the release's designed duration, but can increase the GTR's accuracy to within +/- 1%. The standard GTR is designed to be used under tension loads of approximately 10-lbs for 1-7 days. With the utilization of mechanical advantage, the standard GTR will restrain loads of up to 1,500 lb. Durations of 17-100 days and loads up to 1,000-lbs are also possible.



## FUSIBLE LINK (FLASH WIRE)

Developed by DesertStar for their ARC-1 acoustic release, a large capacitor is fully charged, then power dumped through a high resistance nichrome wire, causing it to instantaneously vaporize. Sometimes called a “flash wire”, the ARC-1 triggers just 10 seconds from the release command, and the trigger process itself takes just 0.03 seconds. The ARC-1 has only a single moving part, making it very reliable. Biofouling would not be a concern for the flash wire, though it may gum up the lever arm. It also operates in fresh water. Since its introduction, the system has accumulated tens of thousands of release cycles.

One can imagine the combination of a flash wire release, pressure sensor, and programmable controller for bottle closure that would allow the collection of water samples at precise depths by a free-ascending lander, now a profiling vehicle. A series of CTD casts could occur quickly with a small number of untethered free ascent rosettes.

## PRESSURE

The trigger is pressure. This is a sensor that activates a circuit at pre-determined depth, or a mechanical element that reacts to increasing ambient pressure in such a way as to initiate a release.

## MELT

### Hot wire

Weed whacker nylon cord or heavy monofilament nylon fishing line can directly attach an anchor weight to a lander frame. Crossing the monofilament like a bow on a cello, is a length of Nichrome wire. Current through the wire causes the nichrome to heat up, slicing its way through the nylon. Performance may be improved with thermal insulation from the environment.

### Ice

Ice has a very high compressive strength, as evidenced by Titanic’s head-on collision with that iceberg, or a USAF C-130 cargo plane landing on an Antarctic ice sheet.

As a result, ice makes an easy, cheap, and strong release capable of holding up to 300-lbs. Enclosed in the thermally insulating PVC, the release can take up to an hour to release. The ice will definitely melt, so a release is assured, though time may vary with water temperature.

## DISSOLVABLE

### Lifesaver

I remember reading an in-house technical brief shared with me by Scripps machinist Mert Ingraham, written by a Scripps grad student in the 1960’s describing the use of Lifesavers as a release. That student used a lever arm to multiply the force to hold a larger anchor.



**Figure 11**

A SubSeaSonics LK-80 release link electrically isolated from the steel chain with a plastic link.

Kevin Hardy



**Figure 12**

Galvanic time releases

Ocean Appliances, Australia



**Figure 13**

Featuring the fastest release of any release system, DesertStar’s ACR-1 opens in under a 1/10 sec.

Desert Star Systems

## Figure 14

Standard 1” sch 40 PVC pipe makes an ice release that will hold 300-lbs for up to an hour. An eye bolt passes through the top cap, with a flat washer and nut with RTV. A slot at the bottom allows for a loop of line to be inserted. The release is then turned with the slot up, filled with tap water, then placed in the freezer.



Kevin Hardy

Nikki Arm and Brianna Roberts



**Figure 15**

Cal Poly-San Luis Obispo undergraduate students Mason Gariepy and Kyle Walsh test a Lifesaver release used to deploy a baited arm on their lander DOV SEASTANG.

I shared that idea in recent years with two Scripps graduate students and an undergraduate team at Cal Poly-San Luis Obispo as a means to hold a baited drop arm in a retracted position during their lander launch and descent, then release the arm to rotate down to the seafloor. They each adopted the idea and found it worked fine. In a careful study, the Cal Poly students found all colors of lifesavers could hold up to 10-lbs (all broke at about 20-lbs), and would release between 17-25 minutes in flowing water, depending on the weight being carried.

### 3D printing filament

3D printing uses two kinds of filament. One for mechanical strength of the final part, and another to create support structure as the part is being made, if required. The support material must be removed from the final part before it is put into use. The support material Polyvinyl Alcohol (PVA) is removed by water immersion. Dr. Bart Chadwick, then a scientist at the USN SPAWAR laboratory on Point Loma, suggested PVA filament might be used as a dissolvable release link.

It's been tried by some, I understand, though I have not heard how it worked.

Once the release element is chosen, adapting it to a lander

Kevin Hardy



**Figure 16**

An EdgeTech burnwire, rated for 100-lbs, can restrain a load of 500-lbs using the mechanical advantage of a Pelican Release.

presents other choices.

A force multiplying lever can be used to increase the load carried by a given burnwire or release element. A pelican hook for example, is really a Class-2 lever, where the load and the restraining force are on the same side of the fulcrum.

Two releases may be used to hold a single anchor weight, providing a back-up release capability.

The ends of a "release chain" connect the two releases, forming a "V". With one end loose, a large steel ring link is placed on the release chain. The ring link is comfortably larger than any link or shackle required by the release that maybe on the end of the chain. The ring link is connected to the anchor weight by a second chain. When either end of the release chain is dropped, the buoyancy of the lander causes it to rise, while the negative weight of the anchor chain causes it to drop. The release chain continues to pull through the ring link that is attached to the anchor chain until it is free.

### **The Elegance of Simplicity**

As entropy describes a gradual decline into disorder, Murphy's Law defines a "seemingly spiteful behavior manifested by inanimate objects" brought about by "malignity of matter, the total depravity of inanimate things, whether the exciting



# OCEANS

CONFERENCE & EXPOSITION

October 17-20, 2022 | Hampton Roads, VA | In-Person & Virtual

## Resilient Coasts: Adapting **Today** to Secure **Tomorrow**

2,000 ATTENDEES | 500 TECHNICAL PAPERS | 100+ EXHIBITORS | UNLIMITED OPPORTUNITIES

[hamptonroads22.oceansconference.org](http://hamptonroads22.oceansconference.org)



Opportunity runs deep™



cause is hurry, worry, or what not.”

At an 1877 society meeting on steam boats, engineer Alfred Holt, reported, “It is found that anything that can go wrong at sea generally does go wrong sooner or later, so it is not to be wondered that owners prefer the safe to the scientific ... Sufficient stress can hardly be laid on the advantages of simplicity. The human factor cannot be safely neglected in planning machinery.”

Whatever release design you adopt, keep the part count to a minimum and the path for moving and releasing parts to be as clean as possible. Simplicity of design embodies reliability. KISS: “Keep it Simple, Sailor.”

### Shop Talk:

In the category, “I haven’t tried this yet, but it should work...”

We know when a timer release functions, the anchor drops and the lander rises to the surface. There is no signal from the lander that the release is in progress. Topside, there’s only the knowledge that the timer was set correctly, and was counting down when it was deployed. On the day of recovery, we hang out and wait at the prescribed time and place. Allowing for burn and ascent time, we scan the area around the boat, waiting for the lander to appear. First guy to spot the flag gets bragging rights. It’s not a precise time, so we learn patience if it’s a little late.

Similarly, imagine a receive only/no reply acoustic release using a Smartphone with a playlist called “Releases”. Each release command is downloaded as an MP3. At the prescribed place, the output of the smartphone feeds into a signal amplifier, then to an overboard hydrophone. We send the command, and hang out and wait, allowing for burn and rise time. This

is XMT only, no RCV. There is no signal from the lander that the release is in progress. We scan the area around the boat, waiting for the lander to appear. First guy to spot the flag gets bragging rights.

Such a system would cut the cost of the deck unit, while providing the advantage of releasing on command rather than a preset time, providing the scientific crew some flexibility with weather, ship, and personnel.

For further information on acoustic releases and how they function, please visit “Discovery of Sound in the Sea” (DOS-IT), <https://dosits.org/galleries/technology-gallery/basic-technology/acoustic-release/>.

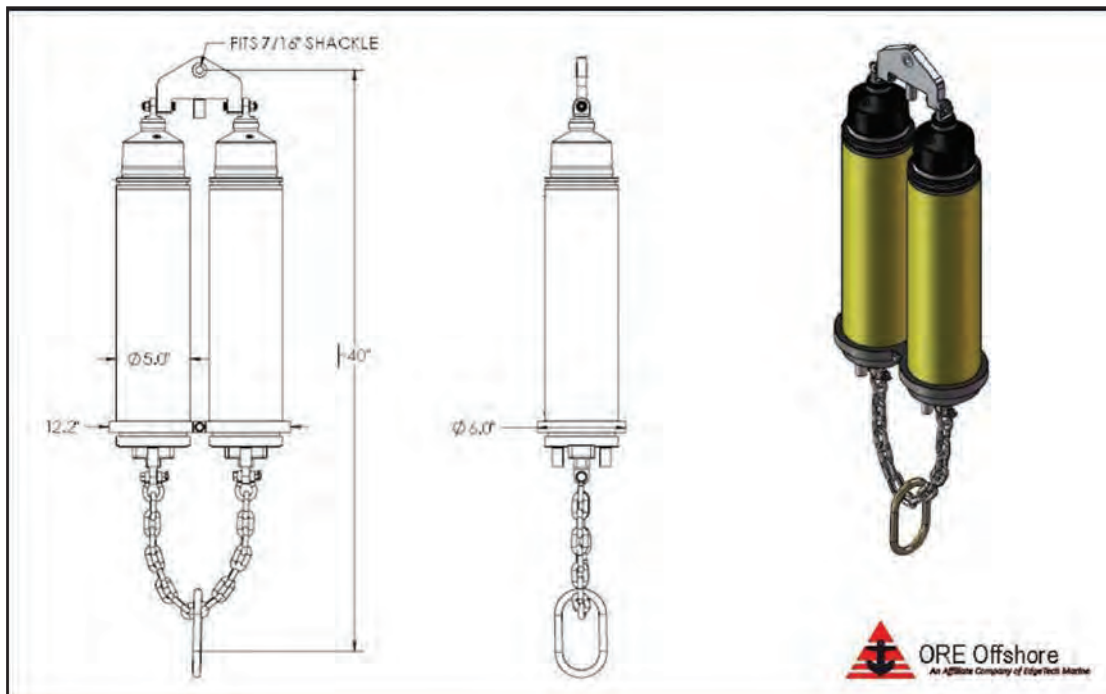
Ocean scientists once had to rely on clever hacks of everyday items for release mechanisms. These can still be useful, but new options have come around.

### Acknowledgements

The author thanks Greg MacEachern and Rob Morris, EdgeTech, Gary Burnhardt, formerly with Benthos, John Kemp, WHOI, Frank Snodgrass and Bob Truesdale, formerly from Scripps, Le Olsen, formerly of UW-APL, and Bart Chadwick, SubSeaSystems for their advice with applications, willingness to try new things, and always sharing from their wealth of experience and knowledge.

### Reader Feedback

Your comments and shared experiences are always welcome. Please send your thoughts, stories and photos to: Kevin Hardy [khardy@marinelink.com](mailto:khardy@marinelink.com) ... you may find yourselves in print.



ORE/EdgeTech

### Figure 17

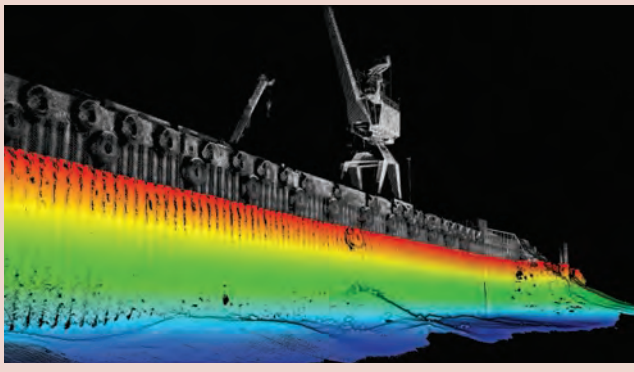
An example of a dual release arrangement sharing the load of the anchor, and providing a back-up release for critical applications. Landers can have burnwire mounts (Figure 10) on both sides, providing the same capability in a small lander.

# Norbit Subsea

[www.norbit.com](http://www.norbit.com)



NORBIT is a provider of tailored technology within selected niche markets headquartered in Trondheim, Norway. The Oceans business segment of NORBIT targets the global maritime market offering products and services within maritime monitoring, visualization, and measurement equipment. Some of the niches we work within include Defense & Security, Maritime Surveillance, Oil & Gas, Renewables, Marine Research, Hydrographic Survey, Salvage and Environmental Surveys. NORBIT Subsea Multibeam sonars offer cylindrical ultra-high resolution curved array bathymetric systems, designed for rapid anywhere anytime mobilization. The NORBIT WINGHEAD i77h, for example, is for quay wall and vertical structure inspections in ports and harbors. NORBIT's curved array technology allows beams to be steered electronically without physically rotating the sonar. Furthermore, with curved arrays, beam spreading occurs less, making it ideal for quay wall inspection work where high resolution is required.



[www.marinetechologynews.com](http://www.marinetechologynews.com)

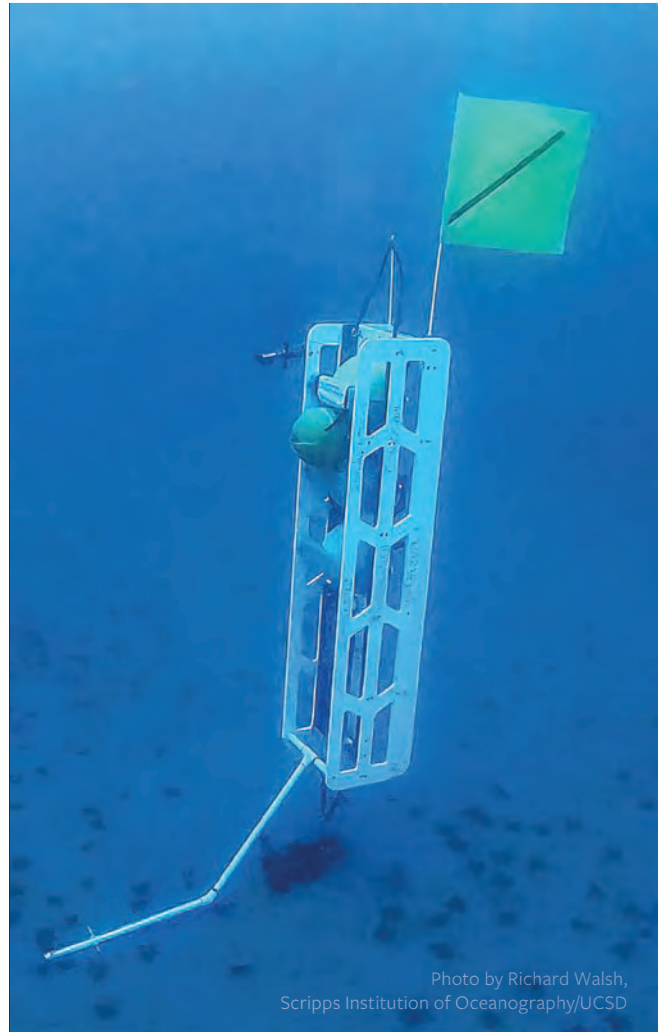


Photo by Richard Walsh,  
Scripps Institution of Oceanography/UCSD

## Ocean Lander COMPONENTS AND SYSTEMS

[globaloceanandesign.com](http://globaloceanandesign.com)

[info@globaloceanandesign.com](mailto:info@globaloceanandesign.com)

858.560.1799

## PLYMOUTH MARINE LABORATORY



## PLYMOUTH MARINE LABORATORY

A team of scientists from Plymouth Marine Laboratory have ‘trained’ an Artificial Intelligence (AI) model to recognize and classify the different types of marine plastic captured in images shot by a video camera mounted on the side of a boat. Funded by the PML internal research program and the European Space Agency (ESA), the study “*Detection and Classification of Floating Plastic Litter Using a Vessel-Mounted Video Camera and Deep Learning*” was carried out as part of an undergraduate placement project, with the results now published in the journal *Remote Sensing*. The AI model itself was trained using the MAGEO supercomputer (Massive GPU Cluster for Earth Observation) which is based at PML and operated by the Natural Environment Research Council Earth Observation Data Acquisition and Analysis Service.

## SUNFISH

Sunfish develops hovering AUVs for exploration and inspection. Its first vehicle SUNFISH is a person-portable, 6DOF machine that moves in any direction, assumes any orientation, and independently rotates about any axis. SUNFISH deployed alongside the 2015 NASA ARTEMIS AUV under ice in Antarctica, conducted the first fully autonomous exploration of a flooded subterranean labyrinth in 2017 at Peacock Springs, Fla., and in 2019 explored the largest subterranean lake on the planet, Dragon’s Breath in Namibia. Standard range is 5 km and 15 km with an upgraded battery. SUNFISH carries as standard equipment a 480 beam, 240 kHz multi-beam sonar and an HD forward-looking, bow-mounted camera.

## TRITECH INTERNATIONAL



## XSENS



## TRITECH INTERNATIONAL

Tritech’s portfolio consists of a suite of Mechanically Scanning and Multibeam Imaging sonar, profiling solutions and oceanographic bathymetric and depth sensing products. Tritech also sells navigation and tracking solutions for small subsea vehicles. Tritech released the Micron Gemini, dubbed the smallest Multibeam sonar in the world. The size and improved image makes the sensor ideal for small ROVs and diver applications. It also has a built in pressure sensor and optional AHRS.

## TDI-BROOKS

TDI-Brooks is a research and service company specializing in high-end environmental chemistry, multi-disciplinary oceanographic and environmental projects, surface geochemical exploration and heat flow, and geotechnical and offshore survey projects for the O&G industry, Renewables and federal and state agencies. Geochemical Seep-Hunting: The TDI-Brooks team conducts offshore Seabed Geochemical “Seep Hunting” Exploration and Heat Flow programs for leading petroleum producers. Geochemical Seep-hunting campaigns reduce offshore exploration risk and cost.

## UNIVERSITY OF ALASKA FAIRBANKS

Sea ice predictions have improved markedly since the founding of the University of Alaska Fairbanks Geophysical

Institute’s Sea Ice Prediction Network (SIPN) 14 years ago. As the amount of sea ice in the Arctic declines, thins and becomes more mobile, accurate forecasts are becoming even more vital for things like fisheries and resource development, shipping, subsistence activities and wildlife management. The SIPN team hopes to work with the Alaska maritime industry, especially the Bering Sea snow crab fishermen, to make ice forecasts even more accurate and useful to those who work in or live next to the world’s polar waters and to scientists studying sea ice decline and the Arctic climate. The SIPN team plans to enhance sea-ice predictions by including data for sea-ice thickness, surface roughness, melt ponds, and snow depth; involve the public in climate and sea-ice prediction; and evaluate the socio-economic value of sea ice forecasts.

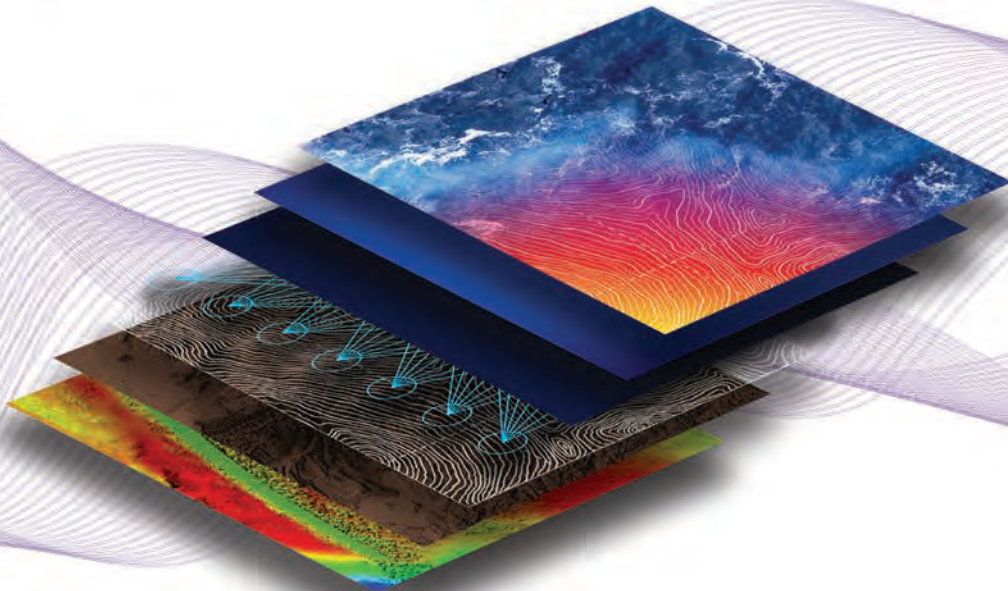
## XSENS TECHNOLOGIES

Xsens | Movella, with its its Motion Tracker Industrial-grade (MTi) product series, is a leader in MEMS IMUs, VRUs, AHRSs and (RTK) GNSS/INS. Its products are built on 20+ years of sensor fusion algorithms, software and component selection. Xsens | Movella provides systems for navigating, controlling and detecting movement in complex industrial settings, from autonomous vehicles and drones to warehousing and logistics.

# Oceanology international<sup>®</sup> AMERICAS

14-16 FEBRUARY 2023 | SAN DIEGO CONVENTION CENTRE, CA

CONNECTING THE OCEAN TECHNOLOGY, ENGINEERING & SCIENCE  
**COMMUNITIES ACROSS THE AMERICAS & ASIA**



AQUACULTURE



HYDROGRAPHY,  
GEOTECHNICS  
& SURVEY



IMAGING &  
METROLOGY



MARINE  
RENEWABLES



MARITIME  
SECURITY  
& NAVAL



OCEAN ICT  
& DATA



OCEAN  
OBSERVATION  
& SENSING



OFFSHORE  
ASSET  
INTEGRITY



OFFSHORE  
OIL & GAS



PORTS &  
HARBOURS



POSITIONING  
&  
NAVIGATION



UNCREWED  
VEHICLES  
& VESSELS

CALLING ALL OCEAN TECH, ENGINEERING & SCIENCE SOLUTIONS SUPPLIERS



**MEET** your next collaborator



**REACH** new multiple buyers from across the Americas & Asia



**FIND** new leads



**DISCOVER** new solutions for your business

Scan me  
to learn more



For more information visit:  
[oceanologyinternationalamericas.com/mtr](https://oceanologyinternationalamericas.com/mtr)

Organised by:



Technical Program Partners





Statement of Ownership, Management, and Circulation  
(Requester Publications Only)

1. Publication Title: **Marine Technology Reporter**

2. Publication Number: **0 2 3 - 2 7 6**

3. Filing Date: **9/20/2022**

4. Issue Frequency: **Nine issues per year**

5. Number of Issues Published Annually: **9**

6. Annual Subscription Price (if any): **None**

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®):  
**New Wave Media, International, 118 East 25th Street, 2nd Fl, New York, NY 10010**

Contact Person: **Kathleen Hickey**  
Telephone (include area code): **212-477-6700**

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer):  
**New Wave Media, International 118 East 25th Street, 2nd Fl, New York, NY 10010**

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank):  
Publisher (Name and complete mailing address):  
**John C. O'Malley, New Wave Media, International, 118 East 25th Street, 2nd Fl, New York, NY 10010**  
Editor (Name and complete mailing address):  
**Gregory Trauthwein, New Wave Media, International, 118 East 25th Street, 2nd Fl, New York, NY 10010**  
Managing Editor (Name and complete mailing address):

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of all individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)

Full Name	Complete Mailing Address
<b>John C. O'Malley</b>	<b>New Wave Media, International 118 East 25th Street, 2nd Fl New York, NY 10010</b>

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box:  None

Full Name	Complete Mailing Address
-----------	--------------------------

12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)  
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:  
 Has Not Changed During Preceding 12 Months  
 Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement.)

13. Publication Title		14. Issue Date for Circulation Data Below	
<b>Marine Technology Reporter</b>		<b>July/August 2022</b>	
15. Extent and Nature of Circulation		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
<b>Requester</b>			
a. Total Number of Copies (Net press run)		<b>12579</b>	<b>12306</b>
b. Legitimate Paid and/or Requested Distribution (By mail and outside the mail)	(1) Outside County Paid/Requested Mail Subscriptions stated on PS Form 3541 (include direct written request from recipient, telemarketing, and Internet requests from recipient, paid subscriptions including nominal rate subscriptions, employer requests, advertiser's proof copies, and exchange copies.)	<b>11269</b>	<b>11505</b>
	(2) In-County Paid/Requested Mail Subscriptions stated on PS Form 3541 (include direct written request from recipient, telemarketing, and Internet requests from recipient, paid subscriptions including nominal rate subscriptions, employer requests, advertiser's proof copies, and exchange copies.)	<b>0</b>	<b>0</b>
	(3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid or Requested Distribution Outside USPS®	<b>0</b>	<b>0</b>
	(4) Requested Copies Distributed by Other Mail Classes Through the USPS (e.g., First-Class Mail®)	<b>596</b>	<b>406</b>
c. Total Paid and/or Requested Circulation (Sum of 15b (1), (2), (3), and (4))		<b>11825</b>	<b>11911</b>
d. Non-requested Distribution (By mail and outside the mail)	(1) Outside County Nonrequested Copies Stated on PS Form 3541 (include sample copies, requests over 3 years old, requests induced by a premium bulk sales and requests including association requests, names obtained from business directories, lists, and other sources)	<b>0</b>	<b>0</b>
	(2) In-County Nonrequested Copies Stated on PS Form 3541 (include sample copies, requests over 3 years old, requests induced by a premium bulk sales and requests including association requests, names obtained from business directories, lists, and other sources)	<b>0</b>	<b>0</b>
	(3) Nonrequested Copies Distributed Through the USPS by Other Classes of Mail (e.g., First-Class Mail®, nonrequestor copies mailed in excess of 10% and mailed at Standard Mail® or Package Services rates)	<b>39</b>	<b>30</b>
	(4) Nonrequested Copies Distributed Outside the Mail (include pickup stands, trade shows, showrooms, and other sources)	<b>314</b>	<b>0</b>
e. Total Nonrequested Distribution (Sum of 15d (1), (2), (3) and (4))		<b>353</b>	<b>30</b>
f. Total Distribution (Sum of 15c and e)		<b>12178</b>	<b>11941</b>
g. Copies not Distributed (See Instructions to Publishers #4, (page 4))		<b>401</b>	<b>365</b>
h. Total (Sum of 15f and g)		<b>12579</b>	<b>12306</b>
i. Percent Paid and/or Requested Circulation (15c divided by 15f times 100)		<b>97.1%</b>	<b>99.7%</b>

\* If you are claiming electronic copies, go to line 16 on page 3. If you are not claiming electronic copies, skip to line 17 on page 3.



# ALL NEW DIGITAL MARKETING SOLUTION

**MARINE TECHNOLOGY REPORTER E-MAGAZINE**

**THE MARINE TECHNOLOGY REPORTER E-MAGAZINE BRINGS IN-DEPTH NEWS AND INFORMATION TO READERS IN A NEW DIGITAL FORMAT, WITH EXPANDED MULTIMEDIA ADVERTISING SOLUTIONS.**

These special editions will be distributed electronically to over 37,000 recipients. Premium positions, full and 1/2 page ads are available, with custom ad enhancements including: links, videos, interviews and company profiles.

**For pricing or to learn how *Marine Technology Reporter* can help build brand awareness across multiple platforms, download our media kit on [marinetechnologynews.com](http://marinetechnologynews.com) or call +1-561-732-1185**

UNITED STATES POSTAL SERVICE®

Statement of Ownership, Management, and Circulation  
(Requester Publications Only)

16. Electronic Copy Circulation

Marine Technology Reporter	Average No. Copies Each Issue During Previous 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Requested and Paid Electronic Copies (Line 15a)	<b>11796</b>	<b>11891</b>
b. Total Requested and Paid Print Copies (Line 15c) + Requested/Paid Electronic Copies	<b>23621</b>	<b>23802</b>
c. Total Requested Copy Distribution (Line 15f) + Requested/Paid Electronic Copies (Line 15a)	<b>23974</b>	<b>23832</b>
d. Percent Paid and/or Requested Circulation (Both Print & Electronic Copies) (15b divided by 15c x 100)	<b>98.5%</b>	<b>99.8%</b>

I certify that 50% of all my distributed copies (electronic and print) are legitimate requests or paid copies.

17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the **September/October 2022** issue of this publication.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner: *Kathleen Hickey* Date: **9/20/2022**

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).



  
...working together to make a difference in the world we share.

**Thank you for supporting Sonotronics in...  
"Working together to make  
a difference in the world we share."**



**SHOW US YOUR UNBOXING SONOTRONICS EQUIPMENT VIDEO  
FOR A CHANCE TO WIN A \$50.00 (USD) UBER GIFT CARD!**

- Follow Sonotronics on Instagram  @sonotronics
- Post your unboxing videos and tag us with #sonotronicsunboxing
- Your account will be entered to win a \$50 UBER Gift Card

View our MANTRAK unboxing on **YouTube**:  
[https://www.youtube.com/watch?v=syDZowU\\_2Ns](https://www.youtube.com/watch?v=syDZowU_2Ns)

[www.sonotronics.com](http://www.sonotronics.com) \* +1(520)746-3322

**INNOVATIVE.  
UNIQUE.  
PROVEN.**



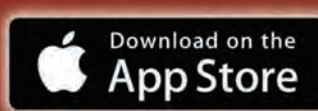
**ALLAMERICANMARINE.com**  
Bellingham, WA | 360.647.7602

Pictured: Spirit of Matushka - A 150 Passenger, hydrofoil-assisted catamaran, custom built for Major Marine Tours

# MARINE TECHNOLOGY REPORTER

# THE APP FOR NEWS

**Marine TechNews is designed to bring you  
all the industry news and marine you need,  
right when you need it. Marine TechNews is  
available on Google Play and iTunes.**



# Advertiser Index

Page	Company	Website	Phone#
11	.Blueprint Subsea	.www.blueprintsubsea.com	+44 (0) 1539 531536
3	.Copenhagen Subsea A/S	.www.copenhagensubsea.com	.Please visit us online
15	.Deep Ocean Engineering, Inc.	.www.deepocean.com	(408) 436-1102
51	.Detyens Shipyards Inc.	.www.detyens.com	.Please visit us online
39	.Digital Edge Subsea Ltd	.www.digitaledgesubsea.com	+44 (1229) 206456
35	.EdgeTech	.www.EdgeTech.com	(508) 291-0057
C3	.EvoLogics GmbH	.www.evologics.de	.49 30 4679 862 0
49	.Falmouth Scientific, Inc.	.www.falmouth.com	(508) 564-7640
75	.Global Ocean Design	.www.globaloceanandesign.com	(858) 560-1799
C4	.Huntington Ingalls Industries	.www.hii.com	.Please visit us online
33	.HydroComp, Inc.	.www.hydrocompinc.com/uv	(603) 868-3344
39	.Hydromea SA	.www.hydromea.com	.Please visit us online
5	.Intelatus Global Partners	.www.intelatus.com/Business/OffshoreWind	(212) 477-6944
29	.JW Fishers Mfg Inc.	.www.jwfishers.com	(508) 822-7330
1	.Kraken Robotic Systems Inc.	.www.krakenrobotics.com	.Please visit us online
17	.Ocean Sensor Systems, Inc.	.www.oceansensorsystems.com	(954) 796-6583
77	.Oceanology International Americas 2023	.www.oceanologyinternationalamericas.com/mtr	.Please visit us online
73	.Oceans 2022	.www.global22.oceansconference.org	.Please visit us online
61	.R.M. YOUNG COMPANY	.www.youngusa.com	(231) 946-3980
19	.Remote Ocean Systems	.www.rosys.com	(858) 565-8500
21	.SAAB Seaeye Limited	.www.saabseaeye.com	.Please visit us online
7	.SBG Systems	.www.sbg-systems.com	.Please visit us online
25	.Sensor Technology, Ltd.	.www.SensorTechCanada.com	(705) 444-1440
13	.Silicon Sensing Systems Limited	.www.siliconsensing.com	+44 (0) 1752 723330
61	.SubCtech GmbH	.www.subctech.com	+49 (0) 431-22039 884
9	.Teledyne CARIS, Inc.	.www.teledynegeospatial.com/cariscollect	.Please visit us online
23	.Valeport Limited	.www.valeport.co.uk	.44 (0) 1803 869292
C2	.VideoRay LLC	.www.videoray.com	(610) 458-3000

## BOOK YOUR COMPANY'S SPOT



Marine Technology TV provides insightful interviews with the industry's top executives. Now is your opportunity to promote a truly unique message about your company with a Marine Technology TV promotion package. Contact Terry Breese to learn more: [breeset@marinelink.com](mailto:breeset@marinelink.com)

*The listings above are an editorial service provided for the convenience of our readers.  
If you are an advertiser and would like to update or modify any of the above information, please contact: [productionmanager@marinelink.com](mailto:productionmanager@marinelink.com)*



Evo  
Logics®

## SMART SUBSEA SOLUTIONS

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

Accurate USBL and LBL positioning of underwater assets

Modem emulator and other cost-saving developer tools

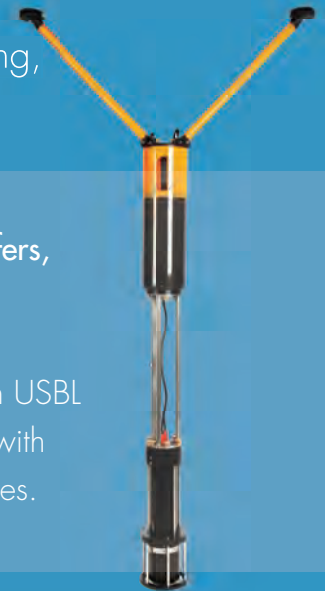
Autonomous surface vehicle for bathymetry, monitoring, search & rescue, and AUV support

### THE USBL BUOY

AVAILABLE  
NOW

Accurate USBL positioning and data transfers, just unfold and deploy:

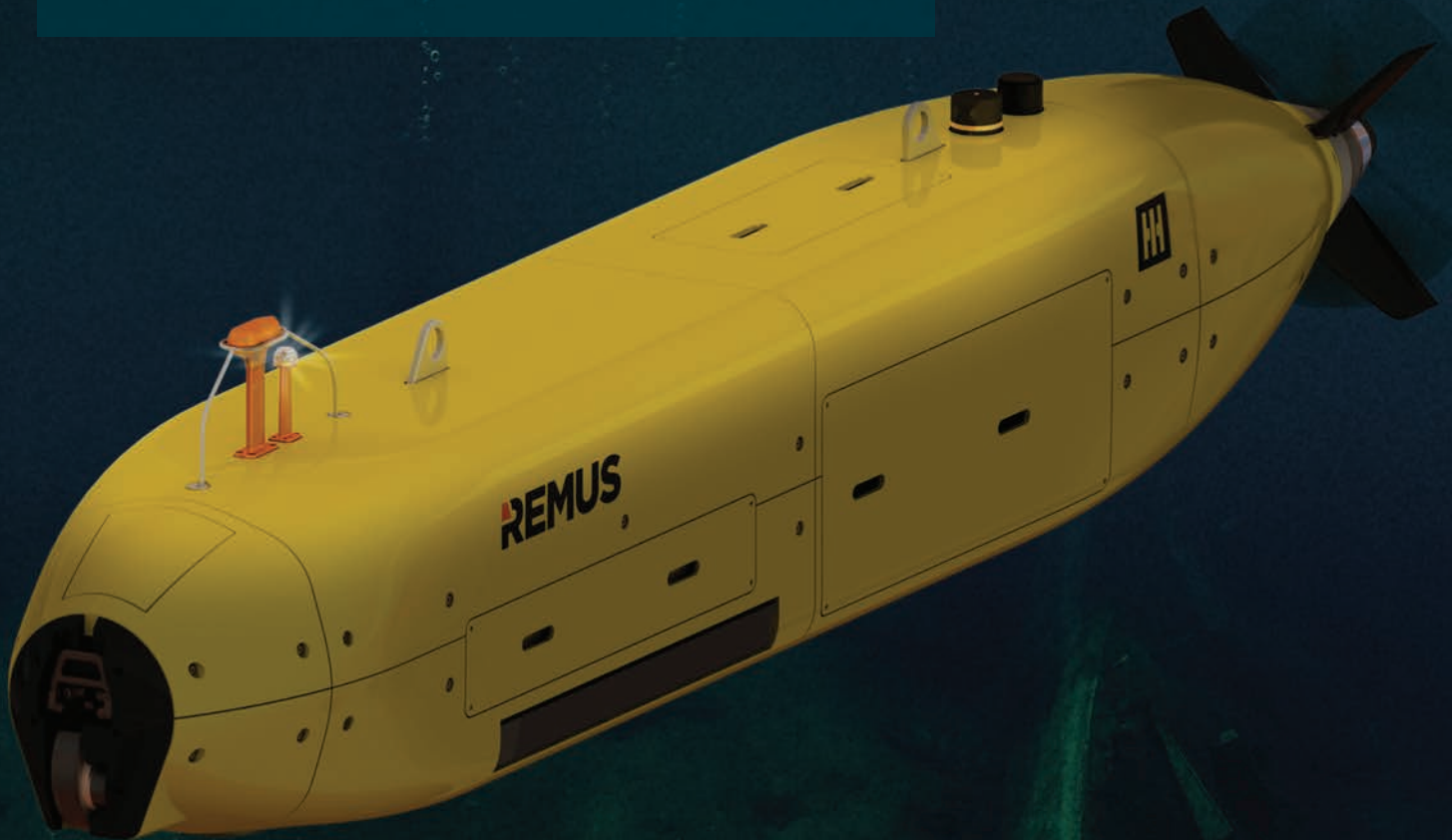
the all-in-one device features a modem with USBL antenna, AHRS, GNSS and on-board PC with positioning software, all ready go in minutes.





# DEEP WATER. DEEPER INTELLIGENCE.

Get all the reliability you've come to expect from REMUS 6000, now with an enhanced modular architecture and vastly improved run times. For 60+ hours at a stretch, REMUS 6000 delivers the highest quality undersea data for your unique national security operation. That's responsiveness you can rely on, from your true mission partner, HII.



[HII.COM](http://HII.COM)

